Student Success Outcomes and Predictors from the 2019 Student Survey
Linda Anderson

Revised January 2021

Averages of two student success measures, cumulative GPA and response to the survey question “To what extent have the Library’s resources and services contributed to your academic success?”, were estimated at two different levels of library resource usage and library building usage and for a variety of student groups, while adjusting for demographics and other predictor variables.

A library resource usage index was constructed from survey questions asking how frequently the respondent uses various library resources, producing an additive estimate of overall library resource use. Frequency of building usage was considered separately from library resources. Type of building space (individual or collaborative) and its importance/satisfaction to the respondent were also used as predictors, as was having received course-related instruction.

The variation of these averages and associations across groups was estimated for discipline, undergraduate class level/type of graduate degree program, and race/ethnicity groups. Even though some of these groups had few respondents, stable and conservative estimates were made by multilevel regression, where estimates are pooled and for groups with few respondents, shrunk towards the overall mean.

This analysis is descriptive and does not imply causality of library use on student success.

Plots show the median estimate of the average difference in the outcome variable between the two levels of the predictor as a dot or shape, with thick line segments showing the middle 50% of plausible values for this average difference, given the data, and thin line segments showing the middle 90%. There is a 50% chance of the real population difference being in the range of the thick segments, given our survey data, and 90% chance in the range of the thin segments. The wider the segment, the more uncertain is the estimate.
Predictors averaged over all subgroups

Undergraduates
Averaging over all subgroups while adjusting for demographics, disciplines and associated predictor variables, sampling strata, class/degree, and each of the other predictors, Figure 1 shows the predicted difference in cumulative GPA compared at two levels of each of the predictor variables.

In Figure 1, the median estimate of GPA is higher at higher levels of each of the predictor variables, except for averaged importance and satisfaction with collaborative space. Receiving course-related instruction, more frequent building use (4 times per month vs. once), more frequent library resource use, and a higher averaged rating of importance and satisfaction (average 4 vs. 3) with individual study space all predicted higher cumulative GPA, with a probability that the difference was greater than zero at least 75% for each of them.

For undergraduates, more frequent building use and more frequent resource use produced the same average predicted difference in cumulative GPA.

The general pattern of these predictors for undergraduates’ cumulative GPA holds up for another outcome variable – the answer to “To what extent have the Library’s resources and services contributed to your academic success?” (Figure 2).

A frequency of four times per month compared to one time per month for the library resource use index and building use predict 9% and 10%, respectively, higher probability of responding “very much” to the question. A higher average of importance and satisfaction with individual space (4 compared to 3) predicts 8% higher probability, while the same for collaborative space predicts possibly 1% higher probability. Receiving course-related instruction was estimated to predict higher probability of responding “very much”, but as with cumulative GPA, it was estimated with a great deal of uncertainty and a very wide range of plausible values.

After adjusting for the other predictors such as frequency of library resource use and building use, Hispanic or Latino undergraduates are 6% more likely than whites to respond “very much” while Black or African Americans are 8% more likely, with 97% probability for both groups.
Figure 1. Differences in predicted cumulative GPA compared at different levels of each predictor value, taking each predictor one at a time and adjusting for the other ones. Thin segments and thick segments represent the uncertainty of the estimate. Thick segments represent the middle 50% of the range of the estimates, while thin segments represent the middle 90% of the probable range of the estimates.
To what extent have the Library's resources and services contributed to your academic success?

*Undergraduates*

- Resource use 1->4
- Building use 1->4
- Individual Space
- Received CRI
- Collaborative Space
- Black or African American
- Hispanic or Latino
- American Indian or Alaska
- Two or more races
- International
- Asian
- Unknown

*Increase/decrease in probability of 'Very Much' with 50% and 90% uncertainty intervals Race/Ethnicity compared to White subgroup*

*Figure 2. Differences in probability of undergraduates responding “Very much” to the question “To what extent have the Library's resources and services contributed to your academic success?” compared at different levels of each predictor value, taking each predictor one at a time. Thin segments and thick segments represent the uncertainty of the estimate. Thick segments represent the middle 50% of the range of the estimates, while thin segments represent the middle 90% of the probable range of the estimates.*
Graduate students

Figure 3. Differences in predicted cumulative GPA compared at different levels of each predictor value, taking each predictor one at a time. Thin segments and thick segments represent the uncertainty of the estimate. Thick segments represent the middle 50% of the range of the estimates, while thin segments represent the middle 90% of the probable range of the estimates.
Figure 4. Differences in probability of graduate students responding “Very much” to the question “To what extent have the Library’s resources and services contributed to your academic success?” compared at different levels of each predictor value, taking each predictor one at a time. Thin segments and thick segments represent the uncertainty of the estimate. Thick segments represent the middle 50% of the range of the estimates, while thin segments represent the middle 90% of the probable range of the estimates.

In contrast to the undergraduates, more frequent building use predicts lower cumulative GPA for graduate students (Figure 3). Also in contrast, higher importance and satisfaction with collaborative space predicts higher GPA, while the same with individual space predicts lower GPA. Similarly to undergraduates, more frequent resource use predicts higher GPA, while the association of receiving CRI with GPA is not clear.

The general pattern of these predictors for graduates’ cumulative GPA doesn’t match as well for the perception of success outcome variable as it did for undergraduates. In fact, the pattern...
of the graduates’ predictors of this variable more closely matches the undergraduate pattern (Figure 4).

More frequent building use predicts a higher probability (6%) of responding “very much” to the contribution of library resources and services to academic success, although less than does library resource use (13%), while a higher average rating of individual space predicts a slightly higher probability (1%) of “very much”, with collaborative space predicting a slightly lower probability by 1%. The direction for these two predictors is switched for cumulative GPA, where higher rating of individual space predicts lower GPA and higher rating of collaborative space predicts higher GPA.

Receiving instruction predicts higher probability of responding “very much” but again is estimated with a lot of uncertainty, with a range including zero.

Hispanic or Latino graduate students are 4% more likely than whites to respond “very much” after adjusting for the other predictors, while International students are 3% more likely. There is about an 80% probability for each group that the probability to respond “very much” is different from the white group. Black or African American students are 6% less likely than white students to respond “very much”, with 86% probability of a difference between the two groups.

**Instruction and library resource use variation**

To illustrate the strength or lack of strength of the association between library resource use and cumulative GPA, an exploratory scatterplot shows each of the individual responses as dots, graphing cumulative GPA on the y-axis against the logarithm of library resource use index on the x-axis. The plotted line comes from a simple model including only library resource use index and the zero-use indicator as predictors, with varying slopes within disciplines. Although a positive slope is modeled in most of the disciplines, the cloud of points does not obviously slope upwards around the line and it is hard to see any trend in the scatter of points, indicating that the relationship may not be that strong.
Figure 5. Exploratory scatter plots of cumulative GPA on the y-axis and the logarithm of the library resource usage index on the x-axis, with a zero-use indicator in the model, for undergraduates (top) and graduate students (bottom).
Resource use and course-related instruction by discipline

The average predictive comparisons for both frequency of library resource use and for receiving course-related instruction vary across disciplines and vary in a similar way for cumulative GPA. If the difference for library resource use is large, generally the difference for instruction is large as well. Each prediction is adjusted for the other variable. The predicted cumulative GPA averaged over the whole range of library resource use with instruction set to yes, then compared as instruction is set to no and averaged over the whole range of library resource use present in the responses. Similarly, predictions are made with the library resource use index set to 4 and averaged over the proportion in the response reporting instruction, and again with resource use set to 1.

However, for responding “very much” to the success question, the results are different. Receiving course-related instruction, adjusted for frequency of library resource use, predicts little increase in the probability of responding “very much.” That holds true across disciplines and for both undergraduates and graduates.

Figure 6. For undergraduates, associations between cumulative GPA and higher frequency of library resource use (4 times per month vs once), and receiving course-related instruction vs no instruction for each discipline. The average predictive comparison for library resource use was adjusted for course-related instruction, and vice versa, along with adjustments for other factors.
Undergraduates

Course-related instruction and increased library resource usage each predict about the same degree of difference (mostly increases) in cumulative GPA in most of the undergraduate disciplines (Figure 6), although there may be some difference in Physical Sciences and Engineering, with a median estimate of 0.09 higher cumulative GPA for course-related instruction vs. 0.03 for more frequent resource usage. For Humanities receiving CRI does not predict higher GPA, but there is a 77% chance that more resource usage predicts a 0.03 higher GPA.

The smallest average predictive comparisons for both resource use and instruction were in the Social Sciences discipline, where neither predicted higher cumulative GPA (possibly lower GPA by 0.02 and 0.01). In Agriculture and Life Sciences, more frequent resource use predicted a 0.1 higher GPA and course-related instruction predicted a 0.08 higher GPA.

To what extent have the Library's resources and services contributed to your academic success?

Undergraduates

![Figure 7](image)

*Figure 7.* For undergraduates, associations between responding that the library contributed “very much” to their success and higher frequency of library resource use (4 times per month vs once), and receiving course-related instruction vs no instruction for each discipline. The average predictive comparison for library resource use was adjusted for course-related instruction, and vice versa, along with adjustments for other factors.

For undergraduates (Figure 7), more frequent resource use predicts a much larger difference in the probability of ascribing academic success to the library than does receiving course-related
instruction, adjusted for the frequency of resource use, in contrast to the predictions for GPA. In most of the disciplines, there is an estimated 2-3% increase in probability of responding “very much” with CRI, while there is a 9-11% increase in all the disciplines except Business and Economics and Arts and Design.

Figure 8. For graduate students, associations between cumulative GPA and higher frequency of library resource use (4 times per month vs once), and receiving course-related instruction vs no instruction for each discipline. The average predictive comparison for library resource use was adjusted for course-related instruction, and vice versa, along with adjustments for other factors.

Graduates
In the graduate disciplines (Figure 8), there was little to no difference between the average predictive comparisons for more frequent library resource use and for receiving course-related instruction, with the exception of Veterinary Medicine. Vet Med has by far the largest average predictive comparison for library resource use (predicting 0.07 higher cumulative GPA), while instruction predicts a 0.01 higher GPA, with only 55% probability that this is different from zero.

The range for instruction across all disciplines is 0 to 0.02 (Social Sciences) higher GPA. The range for more frequent resource use across all disciplines except Veterinary Medicine is -0.01 (Business and Economics) to 0.02 higher GPA.
Figure 9. For graduate students, associations between responding that the library contributed “very much” to their success and higher frequency of library resource use (4 times per month vs once), and receiving course-related instruction and not for each discipline. The average predictive comparison for library resource use was adjusted for course-related instruction, and vice versa, along with adjustments for other factors.

As with undergraduates, graduate students receiving instruction predicts much less of an increase in the probability of attributing their success to library resources and services than does more frequent library resource usage (Figure 9). In most disciplines there was a 2% increased probability of responding “very much” with instruction, with 75% probability that this is greater than zero. For more frequent resource use, increases ranged from 9% (Interdisciplinary) to 18% (Social Sciences and Humanities), with near certainty given the data that there was a difference.

Comparison with 2016 survey results
In comparing results from 2016 and 2019, the ratings of individual space and collaborative space were not included in the model because the questionnaires did not ask these questions the same way in the two different years.

The two-year model did include an indicator for zero library resource usage. If an interaction with year for this indicator was included, allowing the estimate to be different for each year,
the indicator showed a positive effect in 2016 but no effect in 2019. In our 2016 data set, some students had excellent grades while not using the library, but there weren’t as many examples of that in 2019.

In the model including both years, this zero usage effect was averaged over both years rather than allowed to vary. This made the average predictive comparisons for usage at 4 and 1 times per month in both years more similar than they would be if the coefficient was allowed to vary by year. On the other hand it caused the 2019 average predictive comparisons to be different from the model including 2019 only, since that model didn’t result in a noticeable zero-use effect. These are arbitrary modeling choices; having a positive coefficient for the zero-use predictor increases the coefficient (makes the slope steeper) for the library resource use predictor, predicting a higher GPA with more frequent library use at levels above zero.

Figure 10. Differences in the predicted average cumulative GPA at two levels of the library resource usage index: 4 times per month compared to one time per month, for both 2016 and 2019, for undergraduates by discipline.

In Figure 10 (Undergraduates), there is likely little difference between 2016 and 2019 in the size of the association between higher cumulative GPA and more frequent usage of library resources. The estimates for each year are not discernibly different as their 50% credible
intervals overlap. In most of the disciplines, a higher average cumulative GPA is predicted at higher levels of library resource usage.

The Agriculture and Life Sciences discipline has the largest predicted average difference (median estimate of 0.1 higher average cumulative GPA in 2019) when comparing library resource usage index at a level of 4 times per month and 1 time per month. There is at least a 98% probability for both 2016 and 2019 that these differences are greater than zero.

In 2019, most of the other disciplines are in the 0.04 to 0.05 range (probability that average grades are higher with more library resource usage is at least 73%), while Business and Economics and Social Sciences both have a median estimate of -0.01, with the probability that higher grades are predicted with more library resource usage 39% or less.

In five of the disciplines the median estimate for 2019 is less than for 2016. Social Sciences has the highest probability that 2019 is less than 2016, at 85%.

Figure 11. Differences in the predicted average cumulative GPA at two levels of library resource usage: 4 times per month compared to one time per month, for both 2016 and 2019, for graduate students by discipline.
In Figure 11, there is basically no difference between years for most of the graduate disciplines. Veterinary Medicine shows the largest association between cumulative GPA and more frequent library resource usage, with 0.1 higher average GPAs in 2019 for students with library resource usage index of 4 times per month vs. once per month. Vet Med students, like undergraduates have a much larger range of GPAs than other graduate students. The predicted difference is smaller than it was in 2016 (0.14 higher GPA), with a probability that 2019 is smaller than 2016 of 86%.

In 2019, the Agriculture and Life Sciences discipline and the Arts and Design discipline both have a median estimate of 0.03 higher predicted GPAs on average with more frequent library resource use. The probabilities that these average GPAs are higher with more frequent library resource use are 94% and 86%, respectively. Physical Sciences and Engineering and Interdisciplinary groups have 0.02 higher predicted GPAs (77% and 74% probabilities), while the remaining disciplines with the exception of Business and Economics have a median estimate of 0.01 higher GPAs, with at least 69% probability the 2019 average predictive difference is positive. For Business and Economics, more library resource usage does not predict higher average cumulative GPAs, although it did in 2016. The probability that the 2019 estimate is smaller than the 2016 estimate is 88%.

It looks like there is a difference between 2016 and 2019 for Physical Science & Engineering graduate students, with more frequent library resource usage predicting a higher GPA in 2016 compared to 2019. The probability that the 2019 estimate is lower than the 2016 estimate is 98%.
Building usage and cumulative GPA by class and type of degree

As with the library resource use index, a simple model containing only the logarithm of frequency of library building use as a predictor with varying slopes by class/degree was run to create an exploratory scatter plot to illustrate the strength or lack of strength of the association between building use and cumulative GPA. Again, the cloud of points does not cluster around the plotted line very close, with a wide range of GPA at each frequency of use, indicating the relationship may not be that strong (Figure 12).

Figure 12. Exploratory scatter plots of cumulative GPA on the y-axis and the logarithm of the frequency of library building use on the x-axis, for undergraduates (top) and graduate students (bottom).
Figure 13. Associations between cumulative GPA and frequency of library building use, for each of undergraduate classes 1 through 4, and for Master's degree and PhD graduate students, with results from 2016 and 2019.

The building use predictions vary, both across years and across classes of undergraduates (Figure 13). While more frequent building use (compared at 1 to 4 times per month) predicted lower cumulative GPA in 2016 for all class levels, in 2019 building use predicts higher GPA for classes 3 and 4 in 2019, while predicting lower GPA for class 1 and no difference for class 2. Given our data, there is a 97% chance for class 3 and a 99% chance for class 4 that the 2019 estimates are larger than the 2016 estimates.

In 2019, more frequent building usage predicted a lower freshman GPA by 0.04 with 88% probability that the association was negative, given the data. For seniors, a 0.06 higher GPA with more frequent building use was predicted with 99% probability that the association was positive.

More frequent building usage predicts lower cumulative GPA for graduate students in 2019, by 0.01 for master’s students and 0.03 for PhD students. For PhD students the probability that GPAs are lower is 99%, given the data.
Figure 14. Associations between attributing academic success to the library and frequency of library building use, for each of undergraduate classes 1 through 4, and for Master’s degree and PhD graduate students, with results from 2016 and 2019.

The pattern of predictions of building use frequency by class and degree on responding “very much” to the contribution of library resources and services to academic success (Figure 14) matched the predictions for cumulative GPA, although in this case all the predictions were positive. For undergraduates the lowest predicted increase in probability were from classes 1 and 2 (8% and 9%); while PhD students the predicted increase (5%) was less than for Masters students (7%). Again these were predicted increases; while for GPA undergraduate classes 1 and 2 and graduate students they were predicted decreases.
Undergraduates by Race/Ethnicity

Although there is more variation in the predictive abilities of library resource use for cumulative GPA across disciplines and of building use across class/degree levels, there is still some variation across race/ethnicity groups. The groups in Figure 15 and 16 (undergraduates) and Figure 17 and 18 (graduates) are ordered by the size of the resource use association and show varying patterns across the predictors in each group. Instruction shows more variation across the groups, although there is more uncertainty in its estimates. For the success outcome variable, there is not as much difference between the variation across disciplines and across race/ethnicity groups.

Figure 15 (Undergraduates). Comparing average predicted cumulative GPA for building use at 4 times per month vs. once a month and for a library resource use index of 4 times per month vs. once for each of the race/ethnicity groups, as well as received course-related instruction vs. no CRI. For each comparison, adjustments were made for each of the other predictors and a zero-use indicator, the average importance and satisfaction ratings of individual space and collaborative space, gender, discipline, class, and sampling stratum. Groups are sorted by size of resource use/GPA association.
To what extent have the Library's resources and services contributed to your academic success?

Undergraduates

Building use 1→4 Resource use 1→4 Received CRI

American Indian or Alaska International Asian Hispanic or Latino

Building use 1→4 Resource use 1→4 Received CRI

Two or more races Unknown Black or African American White

Figure 16 (Undergraduates). Comparing probability of responding “very much” for building use at 4 times per month vs. once a month and for a library resource use index of 4 times per month vs. once for each of the race/ethnicity groups, as well as received course-related instruction vs. no CRI. For each comparison, adjustments were made for each of the other predictors, the average importance and satisfaction ratings of individual space and collaborative space, gender, discipline, class, and sampling stratum. Groups are sorted by size of resource use/GPA association.

Resource use: In all groups higher resource use predicted either little discernible difference or higher cumulative GPA and it predicted at least 7% higher probability of responding that the library contributed “very much” to their success, after adjusting for other factors. The median differences in GPA ranged from 0.02 for white undergrads (84% probability the difference is greater than zero), to 0.05 for American Indian/Alaska Native and international students (90% and 93% probability the difference is greater than zero). Most groups ranged around 0.03 higher GPA (Black or African-American, 75% probability greater than zero, two or more races (90%), and unknown ethnicity (84%)) to 0.04 (Asian and Hispanic/Latino students).

Building use: The association between cumulative GPA and more frequent library building use is either neutral or positive for all groups, ranging from no change for Black or African Americans and international students to higher GPA by 0.06 for Hispanic or Latino group and 0.07 for the unknown ethnicity group (at least 94% probability that the difference is positive for both groups). More frequent library building use also predicts a greater probability of responding the library contributes “very much” to success, with at least an 8% median estimate in each of the groups.
Course-related instruction: In all groups receiving course-related instruction predicts higher cumulative GPA, although the estimates have a wider range of plausible values than for the other predictors, indicating more uncertainty in the estimate. Receiving CRI predicted a 0.07 higher GPA (median estimate) for members of the Asian, international, and white subgroups, with at least a 91% probability that the difference is greater than zero, while the predicted difference was 0.03 for Hispanic or Latino and 0.01 for Black/African Americans students (69% and 58% probability that the difference is greater than zero). Receiving course-related instruction predicts a much-smaller increase in probability of responding “very much” to the library/academic success question than does either building use or resource use, with the median estimates ranging from 2% to 4%.

Graduate students by Race/Ethnicity

Figure 17 (Graduate students). Comparing average predicted cumulative GPA at two levels of building use (4 times per month vs. once a month) and for library resource use index for each of the race/ethnicity groups, as well as for receiving course-related instruction. For each comparison, adjustments were made for each of the other predictors and a zero-use indicator, the average importance and satisfaction ratings of individual space and collaborative space, gender, discipline, CRI, class, and sampling stratum. Groups are sorted by size of resource use/GPA association.
Figure 18 (Graduates). Comparing probability of responding “very much” for building use at 4 times per month vs. once a month and for a library resource use index of 4 times per month vs. once for each of the race/ethnicity groups, as well as received course-related instruction vs. no CRI. For each comparison, adjustments were made for each of the other predictors, the average importance and satisfaction ratings of individual space and collaborative space, gender, discipline, class, and sampling stratum. Groups are sorted by size of resource use/GPA association.

**Resource use:** In most graduate student groups higher resource use predicted higher cumulative GPA, after adjusting for other factors. There were a few groups where it predicted little or no difference in GPA. The median differences ranged from about 0 for international students to 0.04 for white students. The difference for other groups was 0.01 (Black/African American and two or more races, with 71% probability the difference was greater than zero) or 0.02 to 0.03, with at least 84% probability that the difference was greater than zero. Higher resource use also predicted higher probability of responding “very much” to the academic success question, ranging from 9% more likely to the unknown group to 18% for the two or more races group.

**Building use:** In no group was cumulative GPA predicted to be higher with higher building use. Either no difference or a lower GPA by up to 0.03 was predicted. In contrast, higher building use did predict higher probability of responding “very much” to the academic success question, although not as high as for resource use, ranging from 4% to 10% higher.
**Received CRI:** In most groups receiving CRI did not predict higher cumulative GPA, although for members of the Black/African American, unknown, and white groups, it did predict a 0.01 to 0.02 higher GPA, with 67-69% probability that the difference was greater than zero. CRI also predicted a 1% to 2% higher probability of responding "very much" to the success question.

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1 One important change from the original version is averaging over the 2016 and 2019 results for the zero-use indicator in the cumulative GPA model (no interaction by year). This made estimates of the average predictive comparisons for library resource usage for each year more similar, in the model for results from both years. There were other changes in modeling as well.
