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How Different Student Demographics affect the Course Grades of the Different Teaching Modes for Hybrid Teaching Instructors Only

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Abstract: Certain demographics of students may prefer certain modalities, and certain demographics may achieve higher mean grades in some teaching modalities than others. This study used student-section data from five years of all the undergraduate courses at Kennesaw State University (KSU) from 2015 to 2019. This data set with individual student course outcomes included full student demographics and course types, including previous university grade point average (GPA), sex, age, ethnicity, course department, modality, etc. The study only used data from those instructors who taught hybrid sections, as well as in-person and online sections, to avoid the effect of instructor bias. Previous research found that instructors who taught hybrid sections gave higher grades for their online and F2F sections compared to those instructors who had not taught hybrid sections. The results showed that that hybrid-teaching instructors gave higher mean course grades for their hybrid sections than their online or F2F sections and higher mean course grades than non-hybrid teaching instructors in all modalities. This effect held for all demographics.

Keywords: *Hybrid teaching, online teaching, student demographics.*

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Introduction

Hybrid Modality education is becoming more common. The concept of hybrid education is to use the best of face-to-face (F2F) and online teaching. Hybrid at KSU is where half, one-third, or two-thirds of the course is online (usually lectures), and the rest is in-person (usually discussions and interactive activities). This study found far less research comparing hybrid modality teaching to online and F2F teaching modalities than research comparing online to fully in-person modalities. Nearly all this research assumes that there are no demographic differences in the students entering different modality sections of a course. Many studies [from Stern (2004) to Amparo et al. (2018)] have looked at the outcomes of pure online teaching compared to face-to-face (F2F) teaching. This study found far less research [from Reasons et al. (2005) to Lovern (2010)] comparing hybrid teaching to online and F2F teaching. A possible gap in these comparisons is that nearly all the researchers assume that there is no difference in the characteristics of the students entering F2F, hybrid, or online sections of a course. Most comparison research, such as McFarlin (2008), has considered a single course or instructor. Moreover, some research, such as Blau and Drennan (2017) has considered student satisfaction with different teaching formats, as well as the academic outcome or grades.

The objective of this study is to ascertain the effect of student demographics on the observed differences between outcome grades in different teaching formats or modalities. It is also to examine the effect of different modalities on the performance of different student demographics.

The research gap identified is that there may be a difference in demographics between students who opt for one format over the others and that certain student demographic groups may achieve higher mean grades proportionally in certain teaching modalities. This research uses the entering characteristics of students, a large sample of many instructors, and the final mean course grade achieved for a large university over several years to see if the benefits (including negative benefits) of hybrid and online over F2F modalities depend on the characteristics of the entering student. Xu and Jaggers (2014), and Cavanaugh and Jacquemin (2013) hinted that student demographics can differ for different formats.

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This analysis only used data from instructors who had taught hybrid sections. Moodie (2022) found that teaching instructors who taught hybrid sections overall gave higher than average final mean course grades in their F2F and online sections, compared to teaching faculty who did not teach hybrids. That is, instructors who did not teach hybrid sections, on average, gave lower grades in F2F and online sections than those who taught hybrid. If one compares hybrid section grades to all online and F2F sections, then a misleading result may occur due to instructor differences between those who taught hybrid and those who did not. Thus, using only instructors who taught some hybrid sections, the research negates the possible confounding effect of these higher instructor-based grades.

Research Questions

The research questions are:

1. Do students from different demographics and with previous academic achievement prefer different modalities? An example might be that black students prefer F2F sections. Another example is, do students with a high GPA prefer online, hybrid, or F2F sections of a course?
2. Are the mean final grades of students with different demographics different in different modalities? The hypothesis is that some demographic groups in some teaching modalities have relatively higher mean course grades than in other modalities. For example, do females do better in hybrid sections?
3. What is the effect of different student demographics and previous academic achievement have on mean course grade in different modalities? For example, do black students do better in F2F sections? Another example is, do high GPA students do better in online sections?
4. Do different modalities have different mean course grades? On the whole, is there a difference between modalities in mean final course grades?

Literature Review

The literature will report on how previous research has examined the difference in the type of students taking different formats or whether the research assumed that students taking different modalities were the same on average. We first examine the larger research output that does not include hybrid courses, then the smaller research that includes hybrid courses.

Online to F2F Comparisons Including Student Demographics

Xu and Jaggers (2014) analyzed a very large data set of online and F2F courses (500,000 student-course sets). They examined the effects of differences in pre-course GPAs. They found that males, younger students, black students, and those with lower pre-course GPAs did worse in online courses, whilst females and Asians had no significant differences. Older students had higher mean course grades in online sections. They also reported that majors in computer science, communication, and health had no significant differences. All other disciplines had higher mean course grades in F2F than in online courses. The social sciences, business, law, and nursing showed the biggest differences. Starting students had higher differences due to teaching modality than continuing students.

Nguyen (2015) summarizes research comparing F2F and online teaching methods. He found that, generally, research considers online learning to be better, but there were problems with much of this research due to selection bias and a lack of rigorous methodology. Amro et al. (2015) showed that F2F students got higher grades for their algebra courses than those studying online. Although they looked at age and gender factors, they did not look at pre-course GPAs to see if the students were similar in ability.

Biel and Brams (2016) compared student performance in online and F2F courses. They encountered mixed results; some studies showed the F2F courses were better and some the online courses. Sun and Chen (2016) did a review of 47 papers comparing online and F2F teaching methods. They concluded that online teaching works as well as or better than F2F if done properly. That is a course that has well-designed content, motivated interaction, and well-prepared and supported instructors.

Hybrid Comparisons that Looked at Student Demographics

Brau et al. (2010) reported on completion and success results in a course transitioning from F2F to hybrid and online formats. They found that completion rates increased significantly as did success rates. They did not think this was due to better students entering online and hybrid sections. Hybrid sections had higher completion rates than online sections.

Price et al. (2016) looked at the effect of factors on student performance and satisfaction across formats. They looked at age, sex, interaction, clarity, control, and motivation. They found little correlation between age or sex and student outcomes. They found that course design (participant interaction, learner control, and course clarity) did affect student outcomes. The teaching modality had no significant effect. Kim and Krueger (2017) compared hybrid and F2F courses. They concluded that using two modalities, F2F and online, in the same course can be challenging for instructors. Baum

and McPherson (2019) examined learning in online and hybrid sections, taking into account the academic weaknesses of entering students. They suggested that students with weak academic backgrounds and other risk factors, including socioeconomic status, struggle in online classes. Hybrid sections did not exhibit these problems.

Moodie (2021) used data from KSU's business school courses only. The biggest predictor of a student's final grade in a course was their previous university GPA at the start of the course. Generally, female students tend to get higher final grades than male students in all modalities and courses. Alien followed by Asian students tends to get the highest final course grades. Black students tend to get lower grades than other ethnicities. Hybrid gives the highest final course grades for all ethnicities. However, the hybrid advantage is largest for Blacks and least for Hispanics. Overall, hybrid grades were higher than online grades, which were higher than F2F grades. Hybrid courses tend to be junior or senior courses. Only half the business disciplines use hybrid modes. It could be argued that this may affect results. However, in all disciplines with hybrid courses, the hybrid mean course grade is higher than that for online or F2F.

Moodie (2022) looked at student outcomes by demographic groups at Kennesaw State University between 2015 and 2019. The biggest predictor for final course grade was previous GPA, but many students did not have a previous GPA. This showed that females achieved higher mean course final grades than males for all demographic groups. Blacks achieved lower mean course grades than all other groups. Other demographic and course differences (such as age, course level, etc.) were not as important. Hybrid sections had higher mean final course grades than equivalent F2F and online sections.

In conclusion, previous research that compared online and F2F sections of courses seldom allowed for differences in any pre-course GPAs or demographics of students. They nearly all found no significant differences in the effects of previous GPA with modality on mean final grades. Many studies did not examine the effect of demographic factors.

Hybrid Comparisons that did not Examine Student Demographics

Several studies looked at comparing hybrid to either or both F2F and online modes. Reasons et al. (2005) examined the three teaching formats and concluded that online was better in achieving a higher final course grade than hybrid or F2F. McFarlin (2008) examined grade results for hybrid and online sections. He found that student learning, as represented by grades, increased in hybrid and online sections compared to F2F sections. Lovern (2010) found no significant difference in outcomes between online, hybrid, and F2F sections of the same course. They did not examine pre-course GPA self-selection. Son et al. (2016) looked at a lab class that they offered in the three formats. They concluded that grades were highest in a hybrid mode, and lowest in a pure online format. Kanetaki, Stergiou, Bekas, Jacques, et al. (2022) and Kanetaki, Stergiou, Bekas, Sgouropoulou, et al. (2022) in France and Greece modelled hybrid courses grade predictions. They generally showed lower predictions than actual results. Xing and Saghaian (2022) in China and the US reported that online classes had lower grades than F2F or hybrid.

Studies Using Student Demographics

Most studies did not look at the effect of demographic factors. However, Cavanaugh and Jacquemin (2013) found that students who had been more successful previously tended to choose online courses. Xu and Jaggers (2014) reported the grade differences between online and F2F sections changed with race, gender, previous GPA, and age. They showed that older students did slightly better in online courses. These two studies hinted that demographics and pre-course GPA might affect course outcomes. Blau et al. (2019) used the students' intent to transfer as an output measure. Amro et al. (2015) examined the effect of age and gender on F2F and online mainly Hispanic students. They found that they were predictors of student achievement.

Methodology

The study used an existing dataset that included the records of students in all courses and sections for the years offered by KSU. The study focused on a subset of this data set, including only hybrid sections. Thus, there is no survey or applied research design. The research analyzed this smaller data set using basic statistics (correlations, t-tests, and ANOVA) and manipulating the dataset in an Excel spreadsheet. However, this was not a sample analysis but a complete population analysis. Thus, statistics based on sampling did not apply to a complete population data set. This research was approved by IRB because students and instructors were given randomly generated identity numbers rather than their names. The study used Excel as it was mainly looking at overall differences between populations. Full statistical analysis is usually used for samples, not populations. The study also used the Excel statistical analysis package.

The Data Set

KSU provided every student-course record in KSU's Banner system from Spring 2015 to Fall 2019 for all KSU undergraduate courses. The demographic data was what the students reported to the university. I define hybrid types as instructors who teach hybrid sections, as well as F2F and online sections; online type instructors teach online and

F2F sections only; and multi-type instructors teach either online or hybrid or both, as well as F2F. Thus, hybrid types are a subset of multiple types. The variable terms used were those used by KSU records.

1. The researcher removed from the data set all student-record data that had no grade awarded or had a grade of I (incomplete), S (satisfactory), or U (unsatisfactory), as these grades did not give a full indication of student learning. S/U graded courses do not give enough difference between students to see the effect of modalities S and U, also not be converted to a numerical 0 to 4 scale and thus were considered outliers. The study looked at the effect on final grades of students who complete a course. I, W, and WF grades are for students who do not complete a course., and so were removed as outliers. Ideally, one would like the final % of points that students achieved, or at least use + and – to give a finer set of outcomes. Unfortunately, KSU does not provide that data or allow + and -s.
2. Each student-course record set originally consisted of the following, many of which were not used in this analysis.
3. An arbitrary random number instead of a student name. The researcher deleted this column from the working database as not useful.
4. Course grade in letters. This was converted to numbers; A = 4, B = 3, C = 2, D = 1, F = 0.
5. Previous overall university GPA of a student at the start of the course. Their previous GPA varied from zero to 4. Starting transfer and freshmen students would have no previous GPA.
6. Age. This varied from 14 to 75. The study removed all those under 18, a very small number, as IRB would not let us use data from minors.
7. The analysis converted the Teaching Modality, online (OL), hybrid (Hy), or face-to-face (F2F), to zero-one variables. That is , online is [1, 0, 0], hybrid is [0, 1, 0], and F2F [0, 0, 1] for columns online, hybrid, and F2F. Although two 0-1 variables can represent three variables, three columns were used to avoid complications in analysis.
8. Term – Fall, Spring, or Summer. Some analysis used 1 for summer and 0 for Fall or Spring. This is because the summer term is a different length (8 weeks rather than 15 weeks) and a different set of students.
9. Calendar year.
10. Department of the course. Some departments had many prefixes.
11. Course number and prefix (major). The first digit of course number gave Course Level (1, 2, 3, or 4).
12. Reported sex of student. Sex converted to Male = 1, and Female = 0.
13. Ethnicity. This converted an ethnicity of Alien, Asian, Black, Hispanic, Multiethnic, and White to zero or one variables. For example, Alien was [1, 0, 0, 0, 0, 0, 0] for columns Alien, Asian, Black, Hispanic, Multiethnic, Pacific, and White. Other ethnicities, such as Pacific Islander, unknown, or missing, would be [0, 0, 0, 0, 0] for Alien, Asian, Black, Hispanic, Multiethnic, and White columns. Ethnicities are self-reported. Alien is a non-US citizen, that is international students. All terms are standard KSU options for students.
14. This analysis used Instructor ID to identify who are the hybrid-teaching instructors. There were 715 hybrid-teaching instructors in this analysis.

This gave 225255 associated student-course data records for the hybrid-teaching instructors from the 939917 records of the complete data set, which resulted after 108660 records were deleted for S, U, I, W, and WF grades.

Hybrid Teaching Instructors are Different.

Figure 1 and Table 1 comes from previous analysis of the complete data set of the previous paper (Moodie, 2022) and shows why this study compared the mean course grades for F2F and online sections from all instructors, including those who had not taught hybrid sections, with the means from instructors who had taught hybrid sections. Note that hybrid instructors are a subset of multi-instructors, who are a subset of online instructors, who are a subset of all instructors.

Table 1. Mean Course Grade Differences for All Students by Instructor Type and Modality

	Instructor Type			
Modality	**Hybrid**	**All**	**Difference**	**t-value**
F2F	3.099	2.959	0.139	-136.44
Online	3.081	2.988	0.093	-15.47
All	3.106	2.975	0.132	-49.75

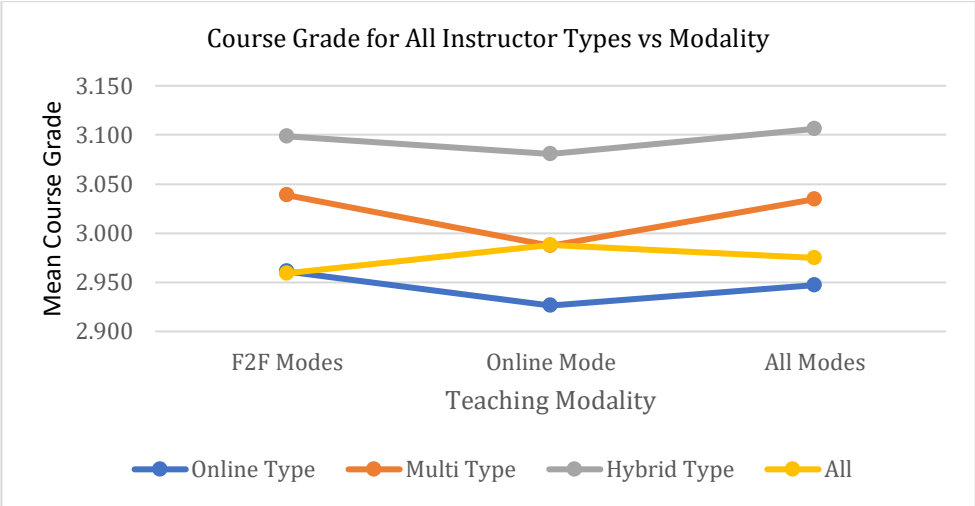

Figure 1. Mean Course Grades for Different Instructor Types for Different Modality

As shown above in Figure 1 and Table 1 above, the mean course grades from hybrid teaching faculty for their F2F and online sections are higher than those from the entire faculty for both F2F and online modalities. To avoid the confounding effects of hybrid teaching instructors being easier graders or better teachers, the analysis only looks at the mean grades for those instructors who also teach hybrid sections, one can compare results across Modalities without this instructor type distortion. Thus, this analysis only looks at data from those instructors who teach hybrid sections. The analysis considers these significant grade differences of approximately 0.1 are meaningful.

Results

The first part of the analysis looked at the data set for hybrid teaching instructors only. The analysis compared final course grades for hybrid teachers by teaching Modality, using t-test Modality mean grade differences in Table 2, ANOVA in Table 3, and correlations in Table 4. These are all from the Excel statistical package.

T-test

Table 2. T-test of Final Course Grade by Modality

Modalities Compared	t-test	Difference in Means	Cohan's d	p-value	df
Hybrid - Online	10.620	0.0748	.093	1.24E-26	103079
Hybrid – F2F	9.481	0.0563	.0515	1.29E-21	86017
F2F - Online	3.164	0.0185	.0163	.000778	105602

Table 2 shows that hybrid sections have a significant and meaningful positive difference in mean final course grade over online and F2F sections, when taught by hybrid teaching instructors. There is a significant but very small but probably not meaningful difference between the mean final course grades of online and F2F sections with hybrid teaching instructors.

ANOVA

Table 3. ANOVA Results for Hybrid Teaching Instructors

ANOVA	Single Factor		Course Final Grade	
Modalities	**Count**	**Sum**	**Average**	**Variance**
F2F	120633	373847	3.099	1.193
Online	57451	176982	3.081	1.390
Hybrid	47171	148840	3.155	1.196
Source of Variation	**SS**	**df**	**MS**	**F**
Between Groups	157.8	2	78.879	63.424
Within Groups	280139.6	225252	1.244	
Total	280297.3	225254		

Table 3 shows that there are significant differences in grade course means for modality. However, the eta-squared is only 0.000563.

Correlations

Table 4. Some of the Correlations of the Variables for Hybrid Teaching Instructors Data Set.

Variables	Course Grade	F2F	Hybrid	Online	White
F2F	-0.009				
Hybrid	0.028	**-0.528**			
Online	-0.015	**-0.641**	**-0.313**		
Sex Male	-0.085	0.059	-0.047	-0.023	
White	0.087	-0.001	-0.020	0.020	
Black	**-0.110**	-0.011	0.019	-0.006	**-0.600**
Asian	0.017	0.008	0.000	-0.009	**-0.248**
Hispanic	-0.012	0.015	0.001	-0.018	**-0.352**
Alien	0.021	0.008	0.003	-0.012	**-0.148**
Multi-ethnic	-0.012	-0.009	0.007	0.003	**-0.249**
Summer Term	0.042	**-0.133**	-0.034	**0.179**	-0.002
Age	0.007	**-0.143**	-0.024	**0.182**	-0.042
Previous # F2F	0.001	0.006	0.020	-0.025	0.033
Prev. # Online	0.001	**-0.282**	-0.076	0.384	0.034
Prev. # Hybrid	0.013	**-0.125**	**0.137**	0.015	-0.027
Level	0.087	-0.048	0.061	-0.002	0.019
Year #	0.021	**-0.116**	-0.020	0.147	-0.031
Previous GPA	**0.438**	0.027	-0.009	-0.022	0.128

The highest correlation is between the final course grade awarded to a student in a course and the student's previous GPA. There is a negative correlation between black students and course grade.

Regression

The analysis then used a regression, with the course grade awarded for the course as the predicted variable and all the other variables as predictor variables. Table 5 shows the regression analysis results without an intercept.

Table 5. Results of Regression for Final Course Grade Without an Intercept.

Regression Statistics				
Multiple R	0.9431			
Adjusted R Square	**0.8895**			
Standard Error	1.0973			
Observations	225255			
ANOVA	**df**	**SS**	**MS**	**F**
Regression	16	2182366	136398	113288
Residual	225239	271187.	1.20	
Total	225255	2453553		
Variable	**Coefficients**	**Standard Error**	**t Stat**	**P-value**
F2F	**3.084**	0.0192	160.70	0.0000
Hybrid	**3.120**	0.0197	158.45	0.0000
Online	**3.050**	0.0199	152.90	0.0000
Sex Male	**-0.205**	0.0047	-43.74	0.0000
White	0.015	0.0163	0.94	0.3484
Black	**-0.321**	0.0167	-19.25	0.0000
Asian	0.040	0.0192	2.07	0.0388
Hispanic	**-0.111**	0.0177	-6.28	0.0000
Alien	0.086	0.0236	3.64	0.0003
Multi-ethnic	**-0.143**	0.0192	-7.43	0.0000
Summer Term	**0.141**	0.0073	19.49	0.0000
Age	0.001	0.0004	2.15	0.0312
Previous # F2F	-0.003	0.0002	-14.14	0.0000
Prev. # Online	-0.008	0.0007	-11.83	0.0000
Prev. # Hybrid	-0.005	0.0014	-3.51	0.0004
Level	**0.103**	0.0026	40.07	0

The regressions backed up the correlation analysis. The most significant predictor of a student's course final grade was the student's previous GPA. However, the modality was the second biggest predictor, with ethnicity next. This shows that Alien and Asian ethnicities tend to get higher course grades than Whites, who in turn get higher grades than Hispanics, who get higher grades over Blacks.

The detailed variable results that follow are grouped by type of variable, individual (modality and previous GPA), demographics (age, sex, and ethnicity), and university (course level, term, college, department, year).

Analysis of Modality Effect

The initial statistical analysis suggested that the choice of teaching modality affected final course grade. Therefore, the analysis in Table 6 looked at teaching modality effects.

Table 6. Data for All Students by Modality

	Mean or Percentage for Modality			
Variable	**F2F**	**Hybrid**	**Online**	**All**
% All	53.55%	20.94%	25.50%	
Course Grade	3.099	3.155	3.081	3.106
Previous GPA	3.113	3.088	3.073	3.097
Sex Male	52.32%	44.39%	46.97%	49.27%
White	55.60%	54.04%	57.15%	55.66%
Black	21.62%	23.34%	22.01%	22.09%
Asian	4.82%	4.65%	4.29%	4.65%
Hispanic	9.53%	9.27%	8.06%	9.10%
Alien	1.88%	1.73%	1.50%	1.75%
Multiethnic	4.44%	4.94%	4.80%	4.64%
Summer Term	8.12%	9.62%	22.77%	12.18%
Age	21.65	22.09	24.51	22.47
Previous # F2F	14.2	14.6	15.2	14.5
Prev. # Online	1.32	1.74	4.77	2.29
Prev. # Hybrid	0.84	1.45	1.18	1.05
Level	2.161	2.323	2.316	2.235
Year	2016.9	2017.0	2017.4	2017.1

Separating results by teaching Modality shows that the hybrid modality leads to higher course grades over the F2F modality, as does the online modality marginally over the F2F modality. However, these results are for all students. Online students tend to be older. Male students prefer F2F compared to female students, who prefer online and hybrid. KSU offers few hybrid sections in the summer but offers proportionally far more online sections in the summer than in fall or spring.

Analysis of Previous GPA

The analysis then looked whether previous university GPA affected the final course grade, as this had had the strongest correlation in the statistical analysis.

Table 7 shows the regression analysis results without an intercept for Previous GPA only.

Table 7. Results of Regression for Final Course Grade Without an Intercept for Previous GPA.

Regression Statistics				
Multiple R	0.9538			
R Square	0.9098			
Adjusted R Square	**0.9098**			
Standard Error	0.9936			
Observations	191614			
ANOVA	**d. f.**	**SS**	**MS**	**F**
Regression	1	1908566	1908566	1933248
Residual	191613	189166.7	0.9872	
Total	191614	2097733		
Variable	**Coefficients**	**Standard Error**	**t Stat**	**p-value**
Previous GPA	**0.998**	0.00072	1390.4	0

These regressions backed up the correlation analysis. The most significant predictor of a student's course final grade was the student's previous GPA. Therefore, the study calculated the mean final course grade for ten different previous university GPA bands by modality in Figures 2, 3, and 4. For age bands, n+ means from n to just below the next highest band.

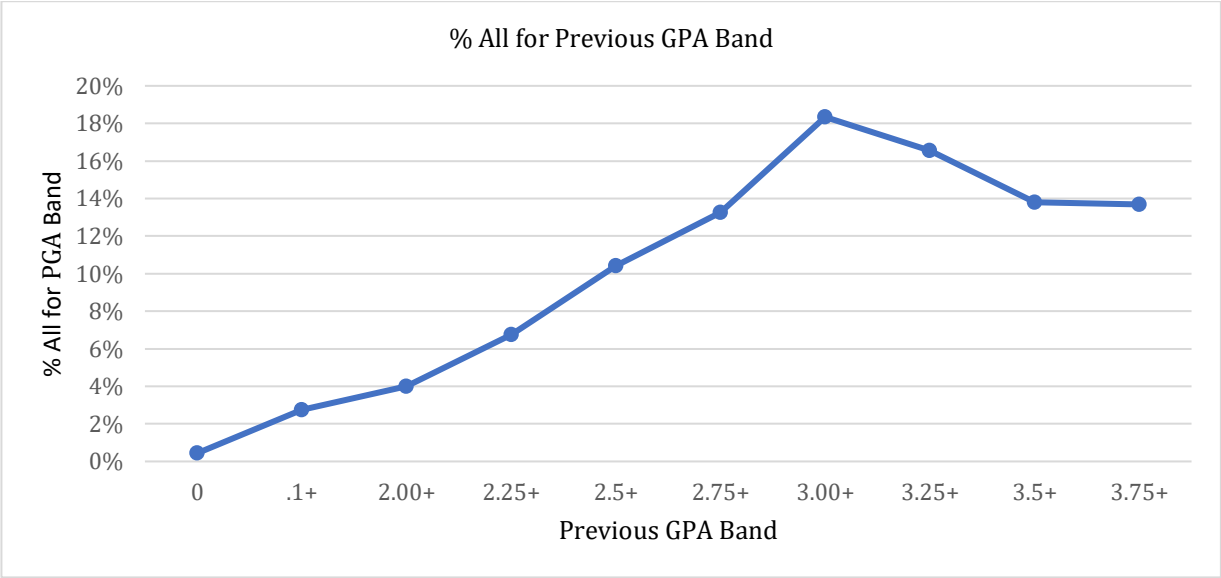

Figure 2. Percentages in Each Previous GPA Band by Previous GPA Bands

Previous GPA band proportion rises to the previous GPA of 3.00+ band and then declines slowly.

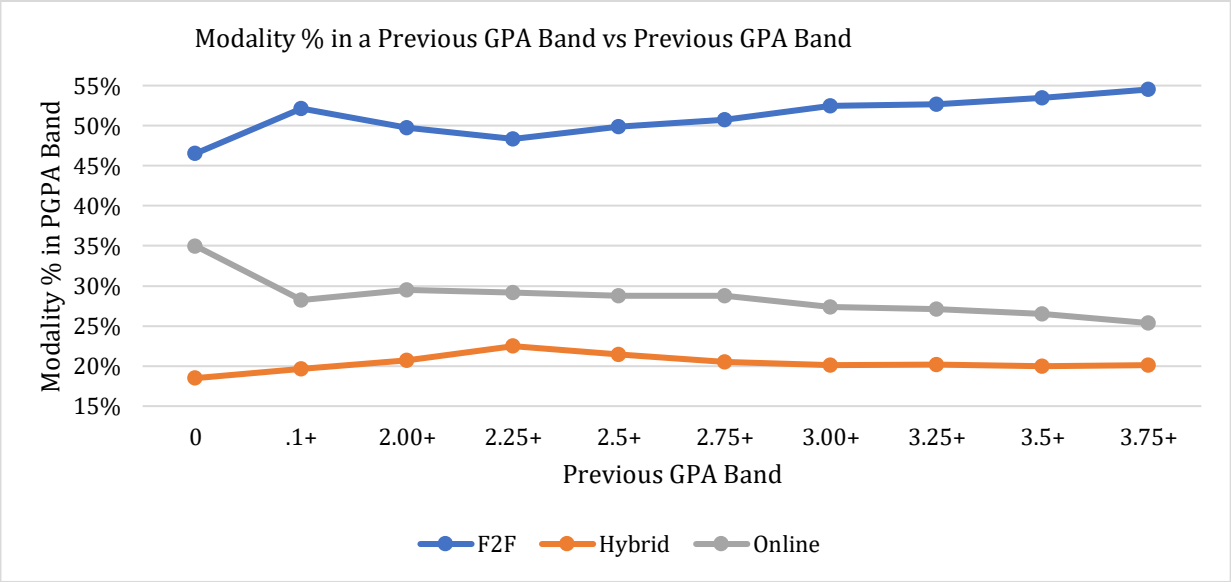

Figure 3. Modality Percentages for All Students in a Band by Previous GPA Bands

Other than the very few students with a previous GPA of zero, there is very little difference in student choice breakdown for hybrid between the previous GPA bands. Online preference drops slightly and F2F preference rises slightly with students who have higher previous GPAs.

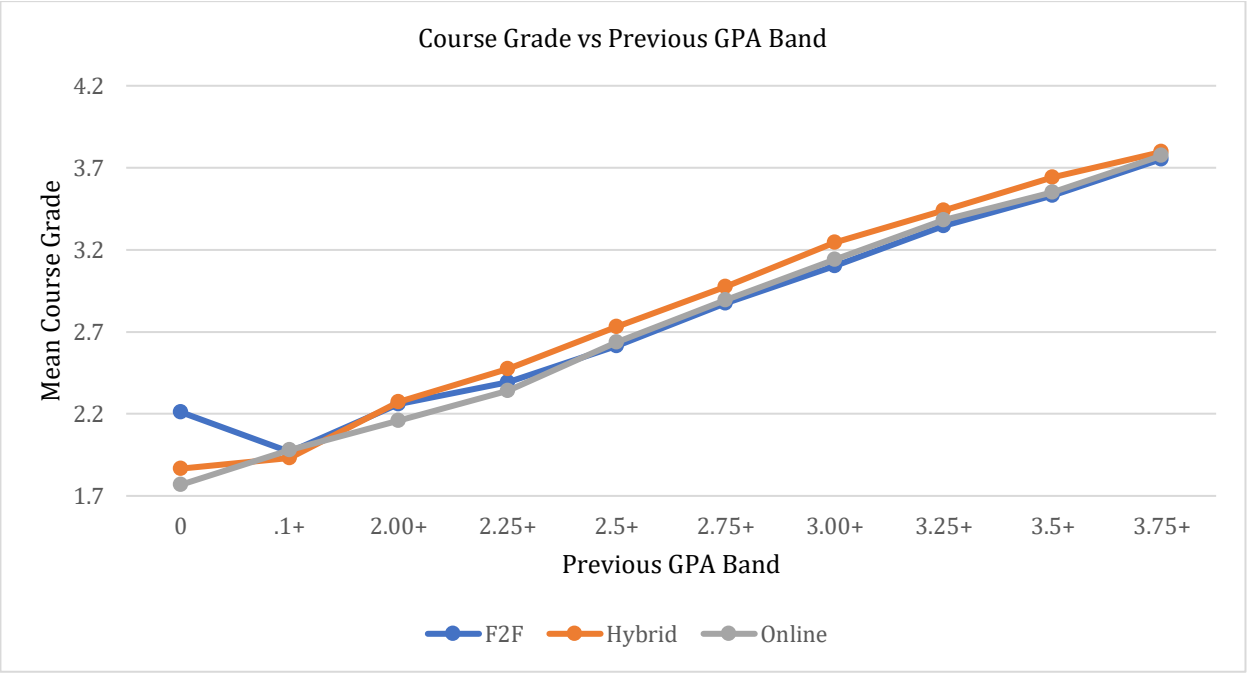

Figure 4. Mean Course Grade for All Students by Previous GPA Bands

Analysis by Age

Then the analysis looked at results by various student characteristics, starting with the age of the student. The analysis examined what effect student age had on mean final course grades with seventeen age bands in figures 5, 6, and 7.

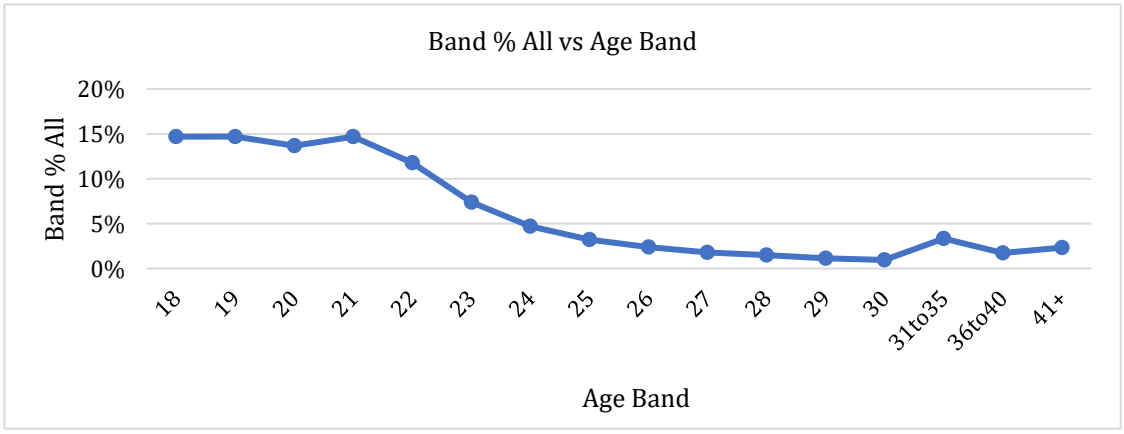

Figure 5. Band Percentage of All Students by Age Band

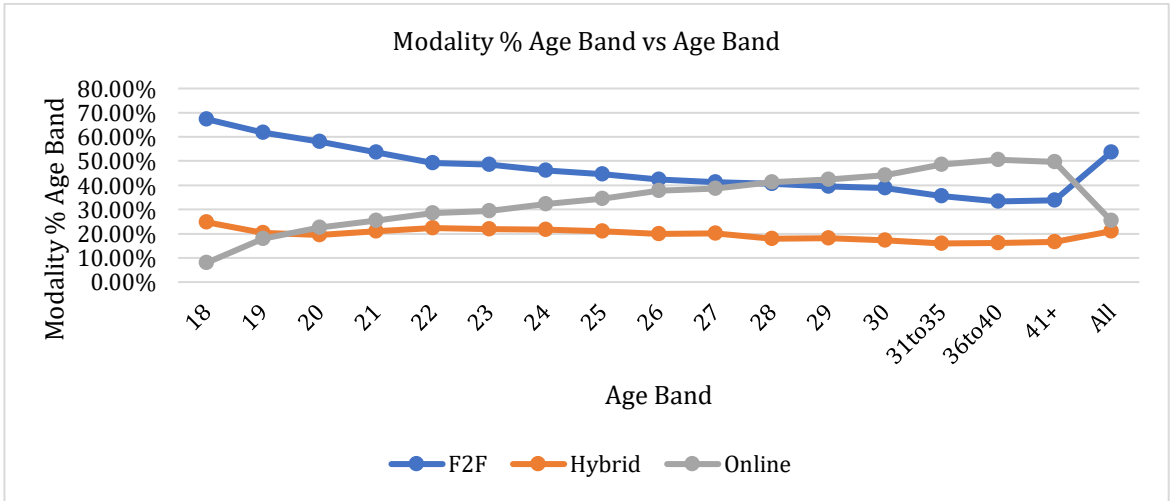

Figure 6. Modality Percentage of Band by Age Band

The proportion preferring F2F sections falls off steadily with increasing age, and those preferring online sections increase. The proportion taking hybrid sections is steady.

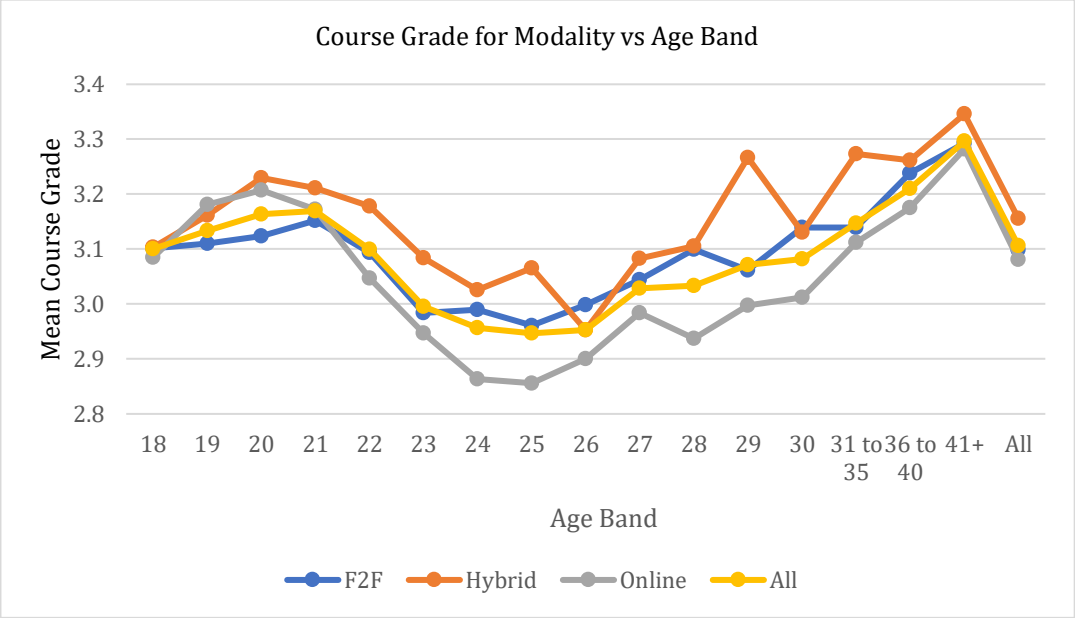

Figure 7. Mean Course Grade for All Students by Age Band

Analysis of Sex

The analysis then turned to the effect of sex in Figures 8 and 9.

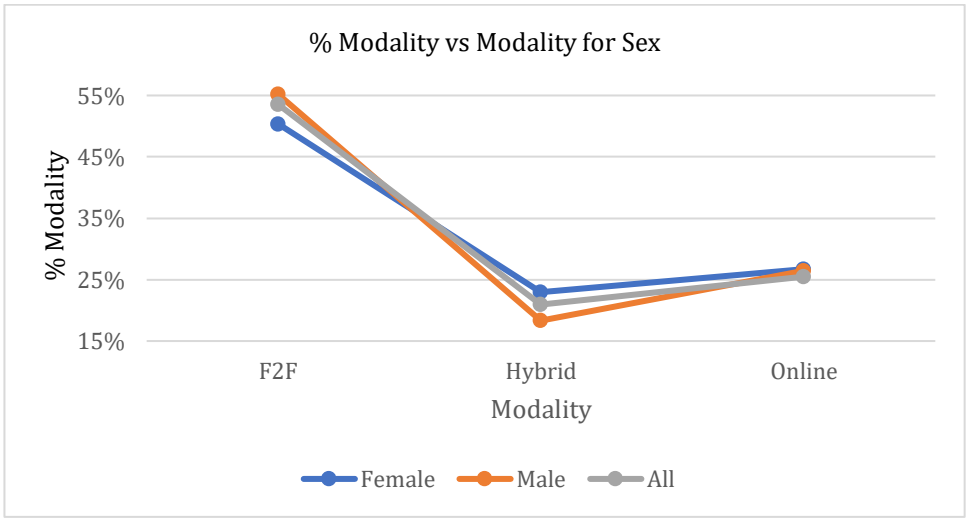

Figure 8. Percentage of Modality for Sex and Modality

First, notice in Figure 8 that the overall sex balance is 50.7% male to 49.3% female. Despite this, proportionally more females (23%) take hybrid sections than male students (18%) do. More male students (55%) take F2F sections than females (50%). The proportion for online sections is similar.

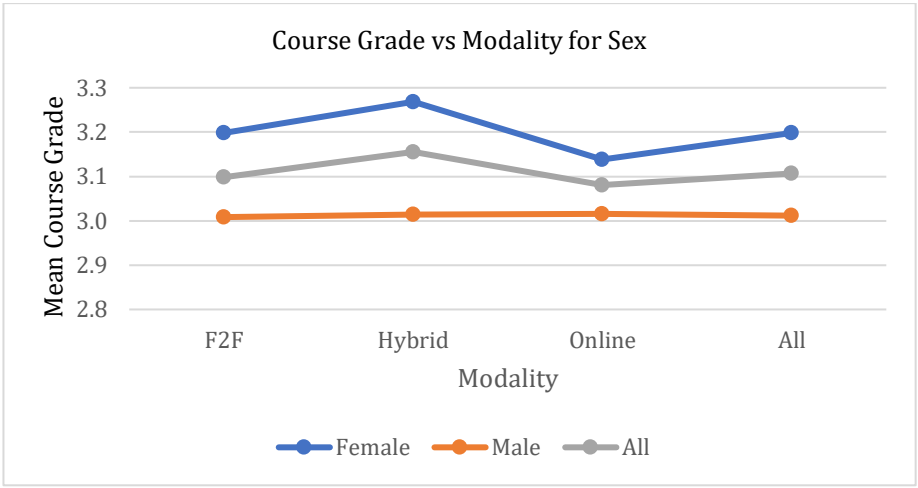

Figure 9. Mean Course Final Grade for All Students by Sex and Modality

Analysis by Ethnicity

The analysis next looked at the effect of ethnicity on final course grade by modality. The study deleted any students whose ethnicity record was missing. Figures 10, 11, and 12 show the effect of ethnicity.

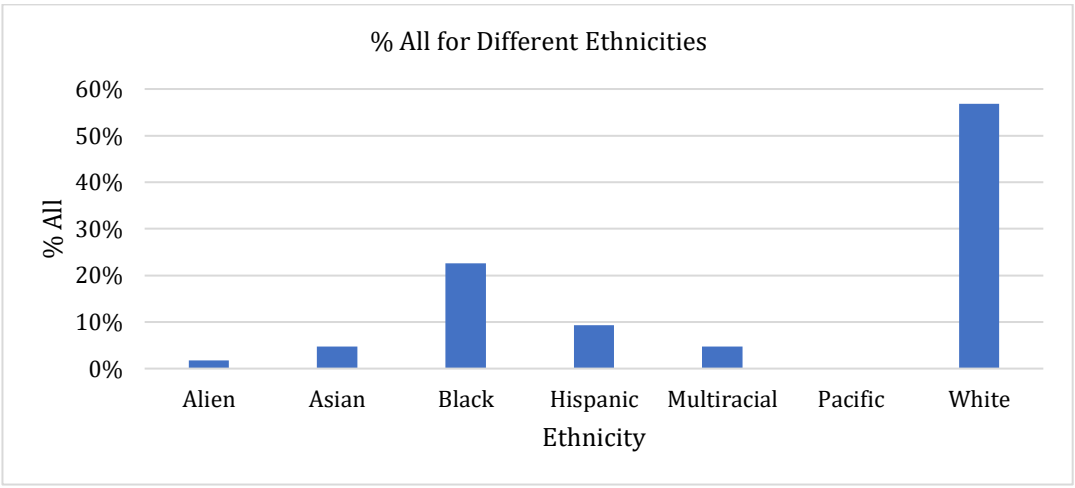

Figure 10. Percentage of all Students for an Ethnicity

The white and black ethnicities dominate this dataset proportionally.

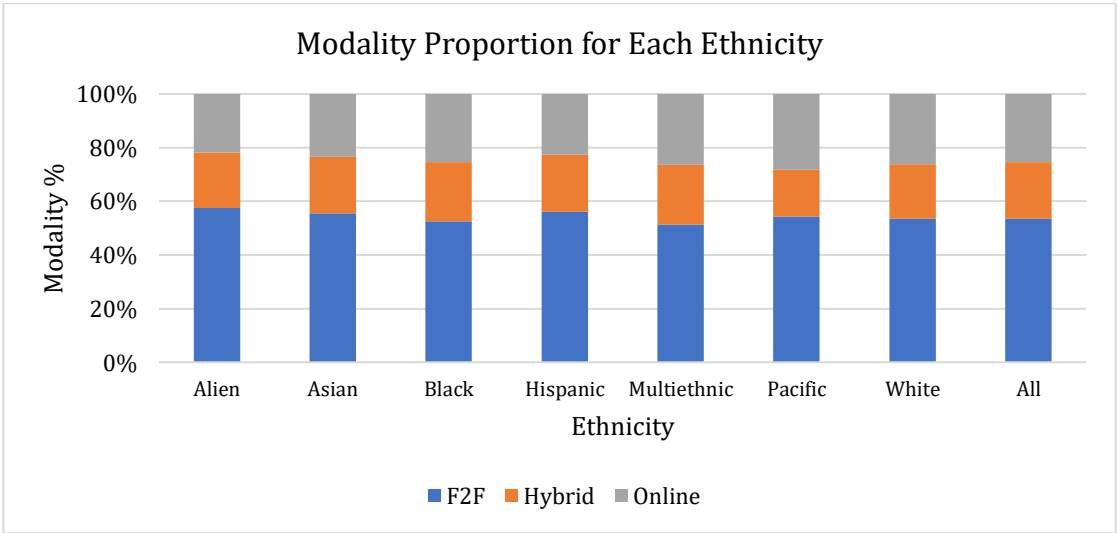

Figure 11. Percentage of an Ethnicity by Ethnicity for Different Modalities

Asian and Alien ethnicities relatively take less sections online than other ethnicities. This may be due to ICE visa requirements requiring them to take at least 12 credits of F2F or hybrid courses each term. Multiethnic and black ethnicities take marginally more hybrid, whilst multiethnic, Pacific, and white ethnicities take the most online proportionally.

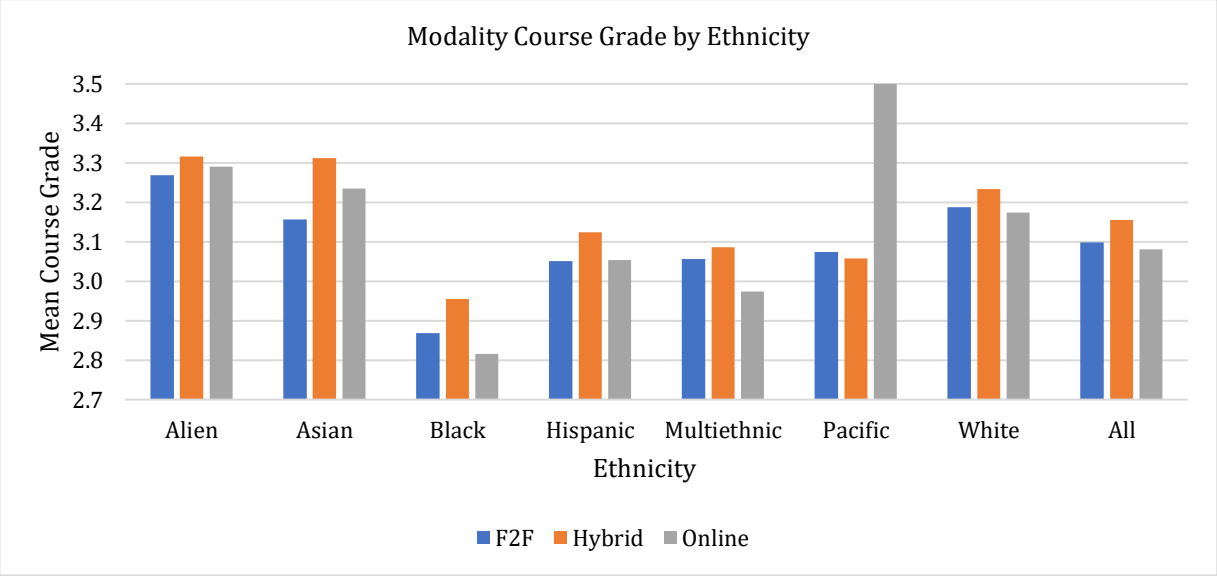

Figure 12. Mean Final Course Grade for all Students by Ethnicity and Modalities.

Hybrid is superior for all ethnicities except Pacific, which has a tiny number of students and whose results are therefore suspect.

Analysis by Sex and Ethnicity

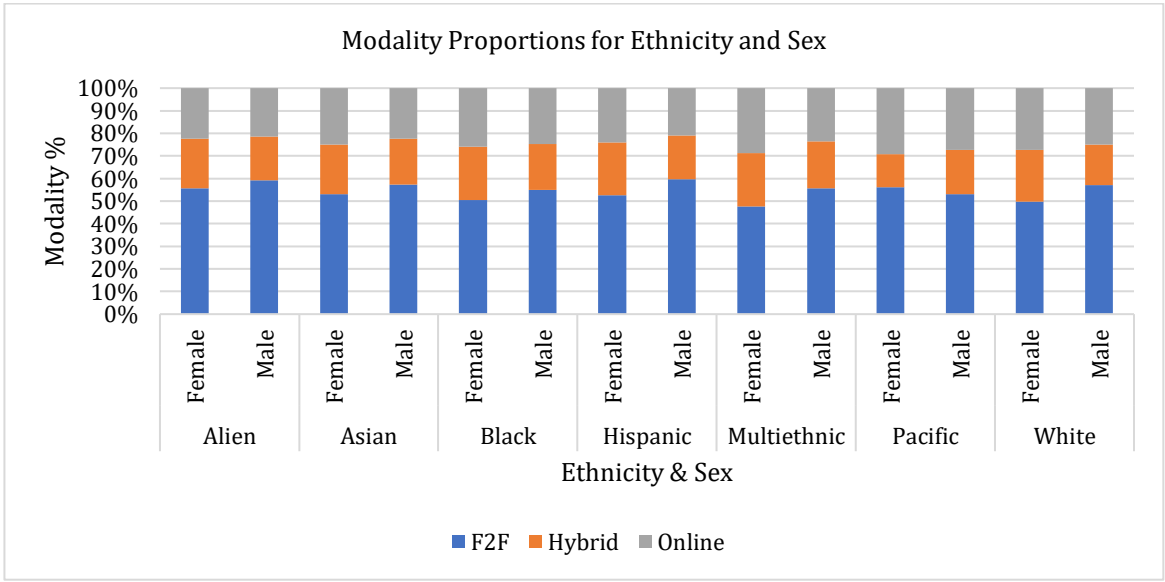

Figure 13. Percentage for Modalities by Ethnicity and Sex

Figure 13 shows that males take more F2F proportionally and females more hybrid, except for Pacific. Females take more online sections proportionally for all ethnicities.

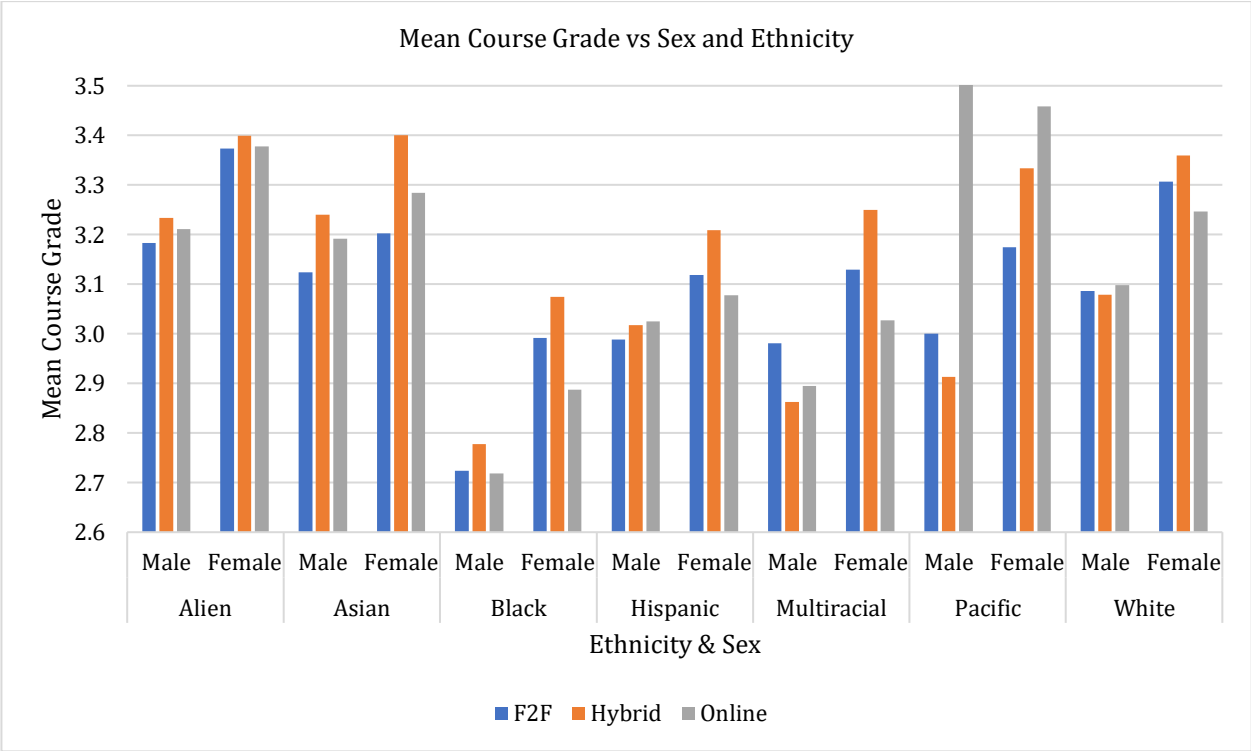

Figure 14. Mean Course Grades for Modalities by Ethnicity and Se14x

Note that in Figure 14, females achieve higher grades than males for all ethnicities and Modalities, except for Pacific online. The biggest differences are for the black and multiethnic ethnicities

Analysis of Course Level

The analysis examined in Figures 15 and 16 whether the course level affected results.

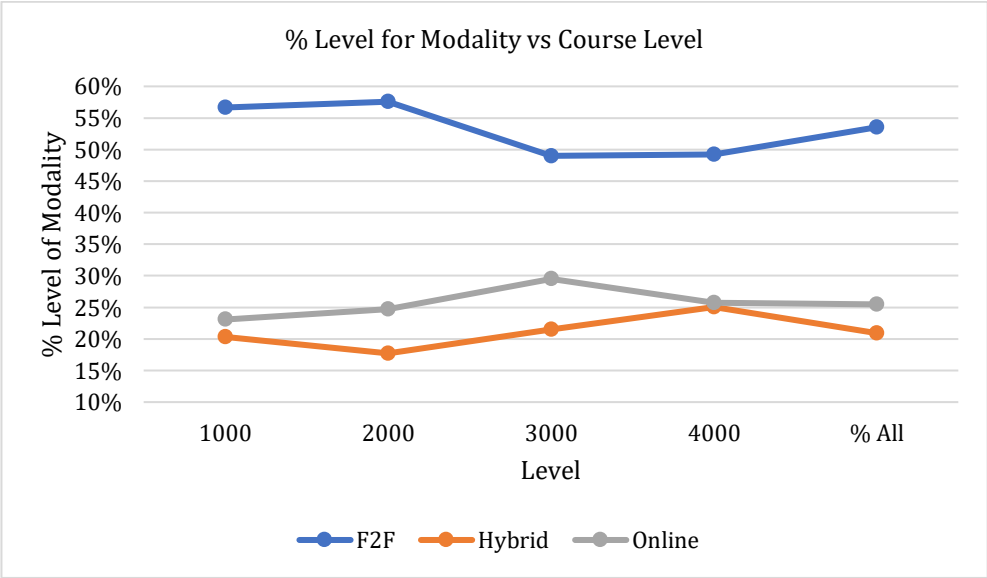

Figure 15. Percentage of Level for All Students by Course Level and Modality

Online usage peaks at junior level and hybrid at senior. F2F declines for junior status.

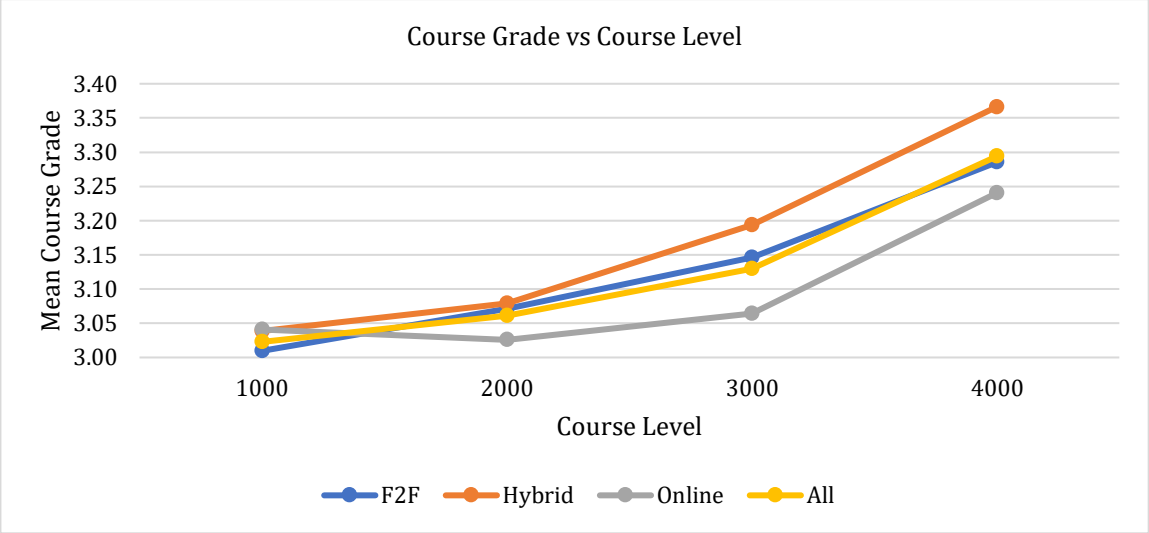

Figure 16. Mean Final Course Grade of Level for All Students by Course Level and Modality

Analysis by Term

The next variable the analysis examined is whether the term the section was in affected the results. Fall and spring terms are 15 weeks long; whilst the summer term is 8 weeks long. In addition, many students skip summer classes, so there may be a demographic difference in the student body. Therefore, the study compared fall and spring results, which showed little differences, to the summer term results in Figures 17 and 18.

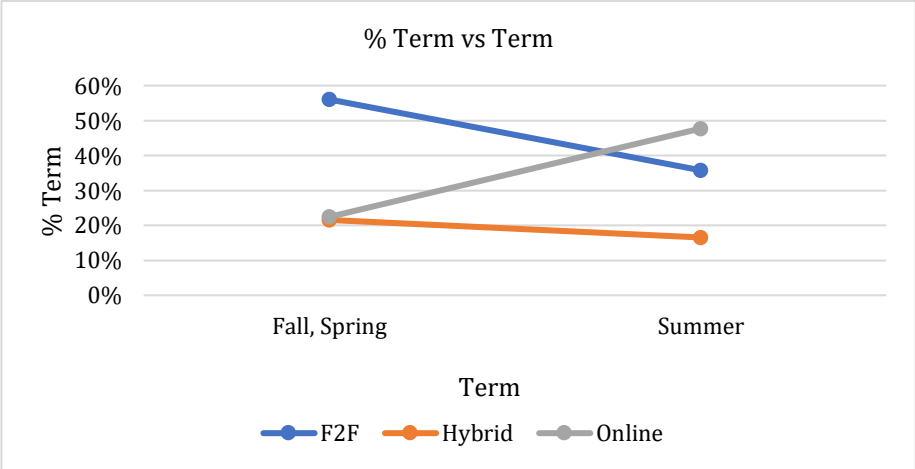

Figure 17. Percentage of Records for All Students by Term and Modality

Note that online proportion peaks in the summer, whilst hybrid proportion does not change much.

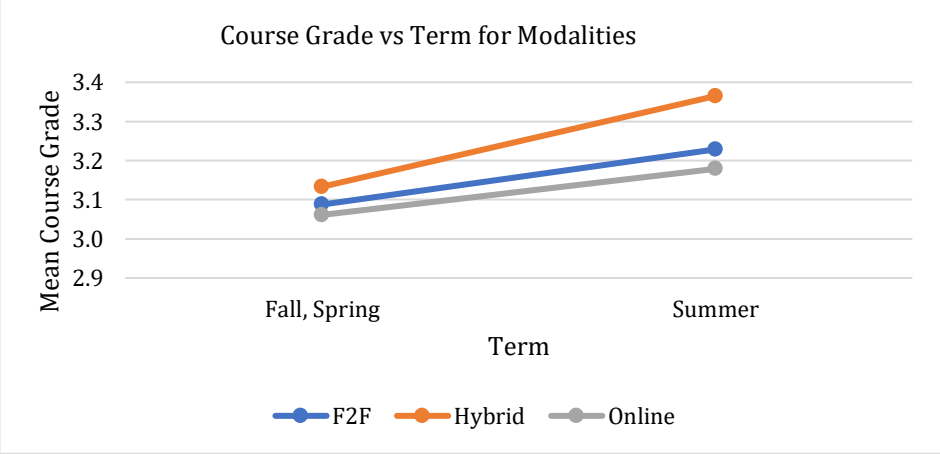

Figure 18. Mean Final Course Grades for all Students by Term and Modality.

Note that mean course grades for all modalities rise in the summer.

Analysis by College

Next, the analysis looked at data by college to see in Figures 19. 20, and 21.

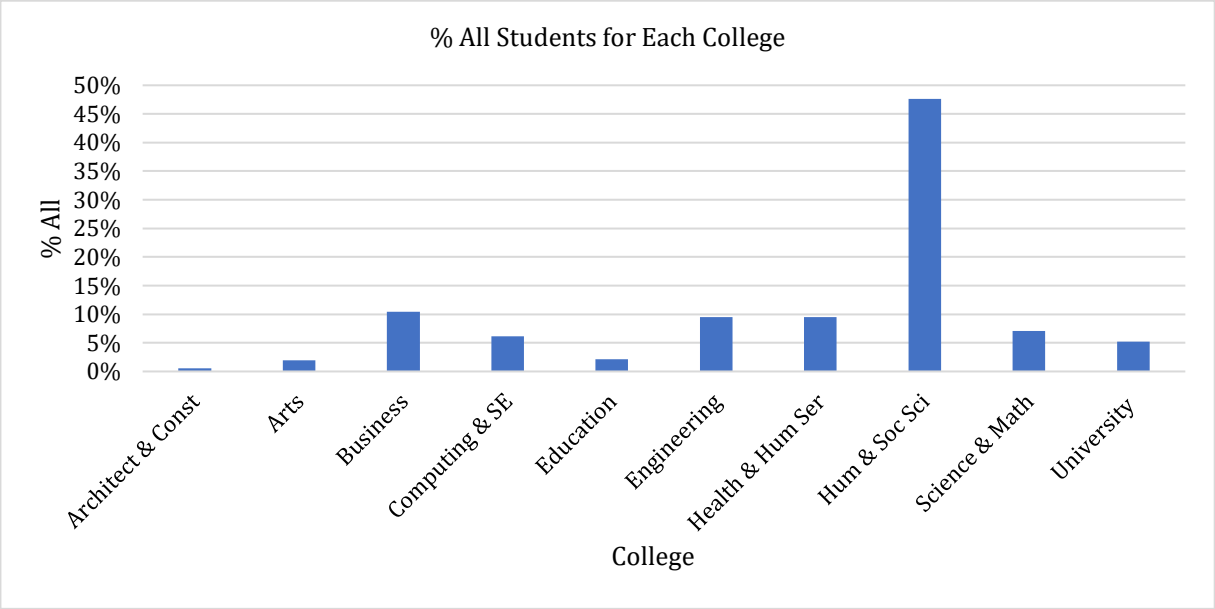

Figure 19. Percentage of All Students in Each College

Note that Humanities and Social Sciences is almost half of all student-courses.

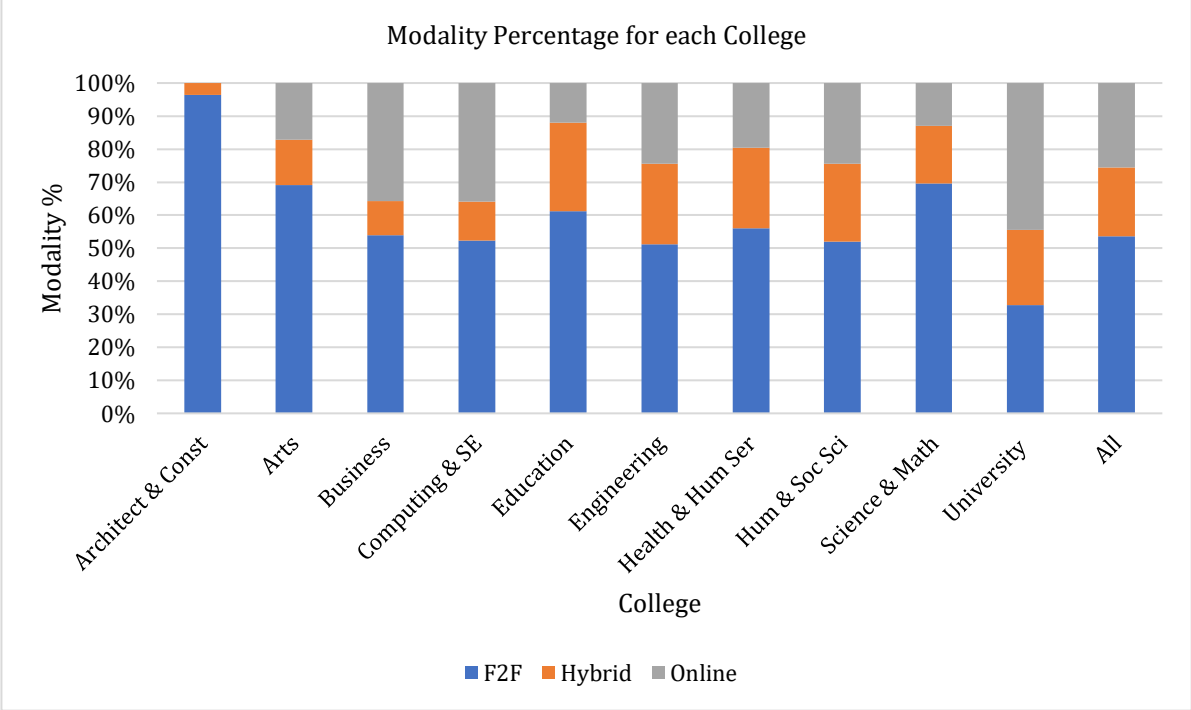

Figure 20. Modality Proportions in Each College

Note the large variation in the use of different modalities amongst colleges.

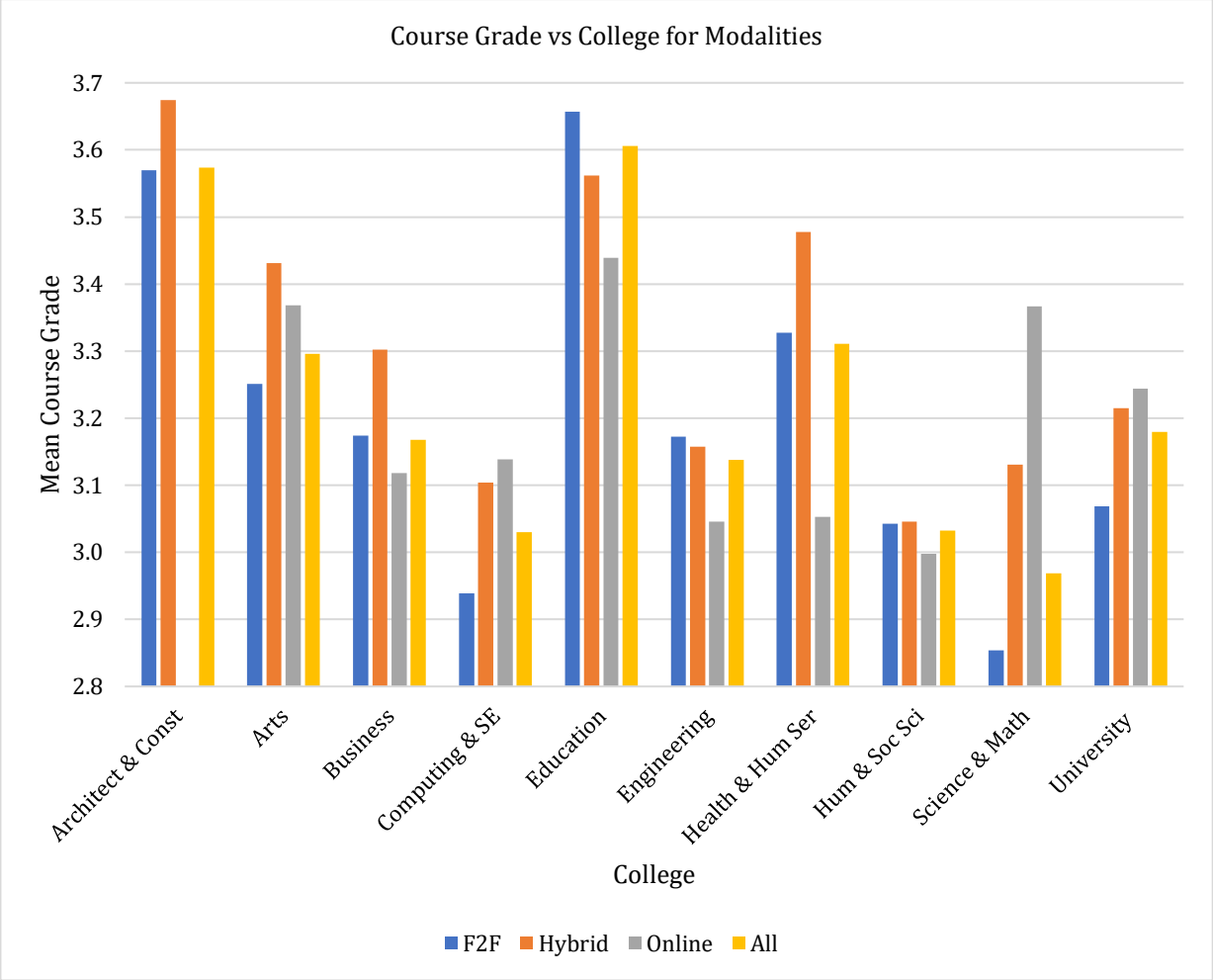

Figure 21. Mean Course Grade by Modality in Each College

Note the large variation between colleges.

Analysis by Department

Next, the analysis looked at how the differences varied with departments, as shown in tables 8 and 9. Departments that did not teach hybrid sections are not on the list.

Table 8. Percentage of All and Modality Proportions in Each Department

Department	F2F	Hybrid	Online	% All
Accountancy	75.5%	1.8%	22.7%	0.86%
Art & Design	44.2%	25.4%	30.3%	0.84%
Biology	72.9%	1.8%	25.4%	2.83%
Chemistry & Biochemistry	66.8%	33.2%	0.0%	2.93%
Civil & Environmental Engineering	72.1%	14.9%	13.0%	2.40%
Communications & Media	56.0%	27.5%	16.4%	5.80%
Computer Science	71.9%	16.0%	12.2%	1.79%
Construction Management	96.3%	3.7%	0.0%	0.52%
Culinary & Sustainable Hospitality	92.8%	7.2%	0.0%	0.63%
Early Childhood Education	68.6%	21.2%	10.1%	1.09%
Economics, Finance, & Quant. Anal.	72.9%	14.4%	12.7%	3.73%
Engineering Technology	42.4%	27.7%	29.9%	1.18%
English	57.2%	26.5%	16.3%	14.55%
Exercise Science & Sport	60.3%	16.6%	23.1%	2.25%
First Year & Trans Studies	54.1%	26.0%	19.9%	1.07%
Foreign Languages	32.1%	21.1%	46.8%	1.05%
Geography & Anthropology	37.9%	11.9%	50.2%	4.78%

Table 8. Percentage of All and Modality Proportions in Each Department

Department	F2F	Hybrid	Online	% All
Government & International Affairs	64.7%	6.7%	28.6%	4.59%
Health & Physical Education	47.8%	25.9%	26.2%	4.28%
History & Philosophy	71.1%	1.9%	27.0%	0.77%
Inclusive Education	60.7%	22.1%	17.3%	0.44%
Industrial & System Engineering	18.2%	41.3%	40.4%	3.44%
Information Systems	54.5%	21.5%	24.0%	0.92%
Information Technology	31.9%	12.6%	55.5%	3.19%
Integrative Studies	8.1%	36.7%	55.2%	0.31%
Interdisciplinary Studies	31.8%	26.2%	42.0%	2.33%
Leadership	16.3%	23.4%	60.3%	3.23%
Management, Entrepreneurship, Hos	34.5%	12.3%	53.2%	3.73%
Marketing & Sales	50.2%	2.4%	47.4%	1.35%
Mathematics	71.7%	16.4%	11.8%	0.56%
Mechanical Engineering	87.3%	9.3%	3.4%	1.64%
Music	82.6%	3.3%	14.1%	0.60%
Nursing	55.7%	42.0%	2.3%	1.06%
Psychology	47.7%	32.7%	19.5%	10.72%
Secondary & Middle Grades Educ.	44.9%	42.7%	12.4%	0.57%
Social Work & Human Services	69.1%	21.0%	9.9%	1.93%
Sociology & Criminal Justice	62.4%	5.6%	32.0%	1.01%
Software & Game	76.2%	6.8%	17.0%	1.43%
Statistics & Analytical Science	64.2%	12.3%	23.5%	0.57%
Tech Comm. & Interactive Design	51.6%	26.3%	22.1%	0.55%
Theatre & Public Speaking	92.8%	7.2%	0.0%	0.55%
All	53.3%	21.1%	25.6%	

There is a large variation between departments in how much they use different Modalities.

Table 9. Mean Course Grade for Each Modality in Each Department

Department	F2F	Hybrid	Online	All	Best
Accountancy	3.009	3.435	3.010	3.017	Hybrid
Art & Design	3.098	3.547	3.469	3.325	Hybrid
Biology	2.785	2.723	3.494	2.963	Online
Chemistry & Biochemistry	2.961	3.259	-	3.057	Hybrid
Civil & Environmental Eng.	3.259	2.979	2.795	3.113	F2F
Communications & Media	3.067	3.119	-	3.064	Hybrid
Computer Science	2.803	2.474	2.536	2.718	F2F
Construction Management	3.578	3.674	-	3.582	Hybrid
Culinary & Sustainable Hosp.	2.892	3.267	-	2.919	Hybrid
Early Childhood Education	3.686	3.563	3.210	3.611	F2F
Economics, Finance, & QA	3.089	3.206	3.231	3.123	Online
Engineering Technology	2.503	2.908	2.681	2.668	Hybrid
English	3.120	3.007	2.972	3.066	F2F
Exercise Science & Sport	2.982	3.625	3.320	3.167	Hybrid
First Year & Transition Studies	3.170	2.612	2.642	2.920	F2F
Foreign Languages	3.452	3.332	2.791	3.118	F2F
Geography & Anthropology	2.869	3.133	3.099	3.016	Hybrid
Government & Intern'l Affairs	2.896	2.911	3.260	3.001	Online
Health & Physical Education	3.363	3.312	2.953	3.242	Hybrid
History & Philosophy	2.945	2.879	2.834	2.914	Hybrid
Inclusive Education	3.461	3.456	3.765	3.512	Online
Industrial & System Eng.	3.521	3.272	3.178	3.279	Online
Information Systems	3.222	3.039	2.824	3.080	Online
Information Technology	3.046	3.469	3.267	3.222	Hybrid
Integrative Studies	2.821	3.818	3.451	3.535	Hybrid
Interdisciplinary Studies	3.256	3.288	3.207	3.244	Hybrid
Leadership	3.174	3.346	3.291	3.284	Hybrid

Table 9. Continued

Department	F2F	Hybrid	Online	All	Best
Management, Enter., & Hosp.	3.330	3.561	3.158	3.267	Hybrid
Marketing & Sales	3.369	3.622	3.251	3.319	Hybrid
Mathematics	2.637	2.442	3.189	2.670	Online
Mechanical Engineering	3.265	2.974	3.298	3.239	Online
Music	3.329	2.767	3.064	3.273	F2F
Nursing	3.651	3.928	3.855	3.772	Hybrid
Psychology	2.950	2.984	2.785	2.929	Hybrid
Secondary & Middle Gr. Educ.	3.755	3.603	3.449	3.652	F2F
Social Work & Human Services	3.481	3.301	2.811	3.377	F2F
Sociology & Criminal Justice	3.154	3.063	2.746	3.019	F2F
Software & Game	3.257	3.192	2.743	2.949	F2F
Statistics & Analytical Science	2.976	2.918	2.777	2.922	F2F
Tech Comm. & Interactive Des.	3.162	3.105	2.880	3.085	F2F
Theatre & Public Speaking	3.288	3.125	-	3.276	F2F
All	3.098	3.158	3.081	3.106	Hybrid

There is a large variation in mean course grades and the best modality amongst departments. The total breakdown of how many of each department does best in a certain modality is in Table 10.

Table 10. Number of Departments with a Certain Modality as Best for Hybrid Teaching Instructors

Best Modality	Departments
F2F	14
Hybrid	20
Online	8

Analysis by Year

The analysis examined whether the results changed with the calendar year.

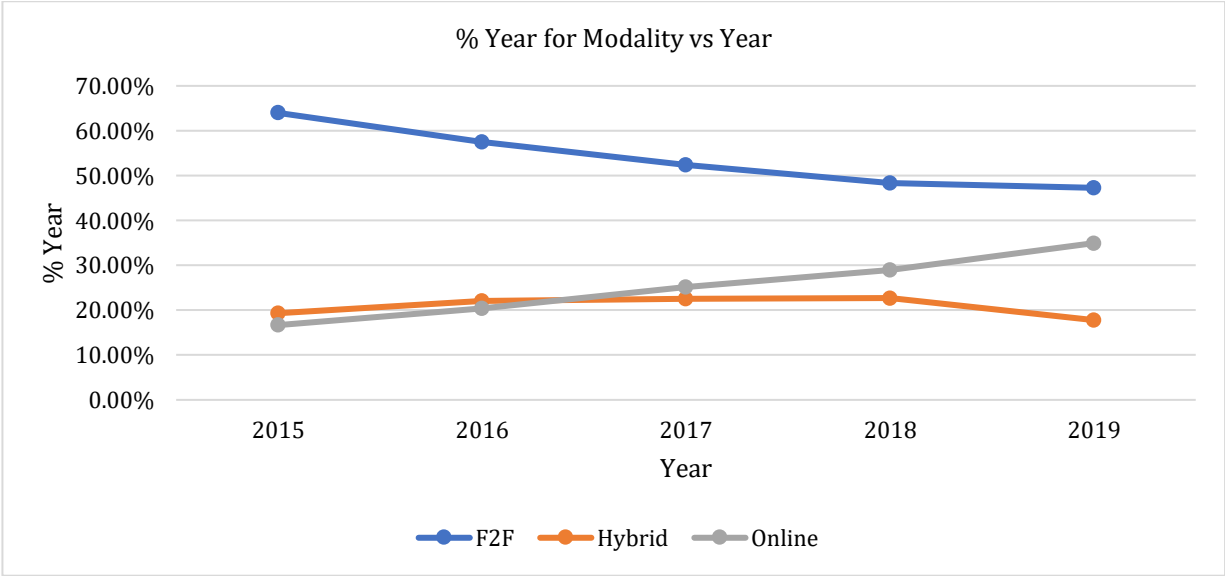

Figure 22. Percentage for Modalities by Year

Note the slow decline in F2F and slow increase in online proportions. Hybrid's proportion has not varied much.

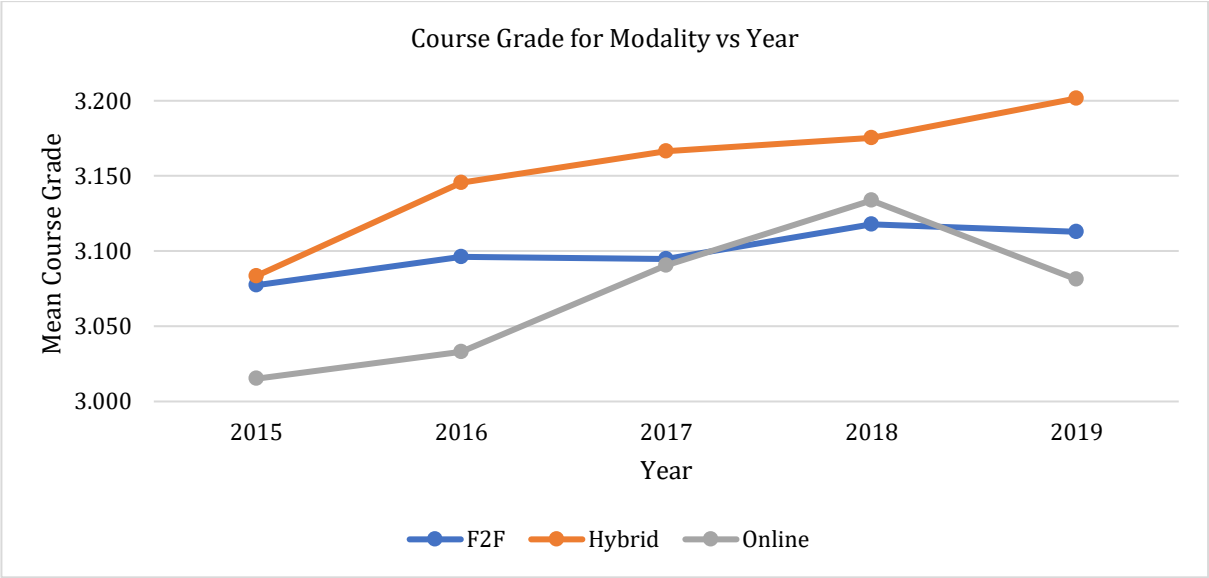

Figure 23. Mean Course Grades for Modalities by Year

Mean grades have generally risen over time for all modalities, except for a drop in 2019 for online. Notably, the gap between hybrid and online and F2F has increased.

Discussion

The analysis used the mean final course grade as the objective. The analysis was to see what demographic factors and teaching modality affected course grade. The study looks at each factor in turn. The only interaction effect looked at was sex and ethnicity. Further interaction effects may well exist and would make a suitable subject for further research.

Modality – Hybrid in most cases had higher mean course grades than online and F2F. Online and F2F were similar. Some other studies such as Baum and McPherson (2019) backed this result.

Previous GPA - Correlation and regression analysis showed that the biggest predictor of a student's grade in a course was their previous GPA. Hybrid were better than F2F and online for all previous GPA bands, except those under with a previous GPA under 2.0. One would expect students with high previous GPAs to get a high grade on a course. Higher previous GPA students take more F2F proportionally and less online. The proportion of hybrid sections chosen does not seem to vary much with previous GPA. Other studies did not consider previous GPA, but it makes intuitive sense that students that have done well in the past would do well in the present.

Age – There is a trend for less F2F and more online sections with higher age. Hybrid proportion stays constant. The fact that the mean final course grades decline until 25 then rise again with increasing age for all modalities is interesting.

Sex - Female students got higher grades than male students in all Modalities. They also prefer hybrid compared to males, who prefer F2F sections, whilst online proportions are similar. Males mean grades did not vary much with modality, whilst female students did better in hybrid than F2F.

Ethnicity – The proportions student chose did not vary much with ethnicity except for Pacific Islander, whose sample was very small. Alien followed by Asian students tend to get the highest course grades. Black students tend to get lower grades than other ethnicities for all Modalities. Hybrid gives the highest course grades for all except Pacific Islanders.

Sex and Ethnicity - Except for Pacific Islanders more males than females chose F2F and less online and hybrid. Hybrid was the best for all combinations except male Hispanic and both Pacific Islanders, who all did better online.

Year – There has been a decline each *Course Level* – Online peak proportion was junior year, whilst hybrid was senior year. For senior, junior, and sophomore and year, the result showing F2F worse than the other modalities. Hybrid was the best for all years except freshman. year with the proportion of F2F classes, and a rise in the proportion online. Hybrid 's proportion has been relatively static. Mean grades have been rising for all modalities but less for F2F. The one exception was online for 2019.

Term – The fact there are few summer F2F courses and far more online courses proportionally in summer, with little change in hybrid proportions. Hybrid was the best in all terms, with online the worst. All grades tend to be higher in summer for all modalities.

College – In all colleges except University, F2F was the preferred modality. Business, University, and Computing preferred online to hybrid, whilst there was little difference in the other colleges. Hybrid had the highest mean grades

except Education and Engineering who's highest was F2F, and Computing, Science and Mathematics, and University, who's highest was online.

Department **–** The proportions of which modality they used were all over the place for departments. However, in all disciplines with hybrid courses, the modality that gives the best mean course grade varies.

Discussion of Research Questions

1. Students with different demographics and previous academic achievement preferred different modalities. This ties in with previous research.
2. The mean final grades of students with different demographics are different in different modalities. Some research has supported this.
3. Different student demographic groups and previous academic achievement affect mean course grade differently in different modalities. This was expected.
4. Different modalities have significantly different mean course grades. Thus, this study concluded using this data set that in general, students achieve the highest course grades in the hybrid modality, followed by the F2F modality, and least with the online modality. The study was surprised that online and F2F outcomes were so similar. This study definitely should encourage faculty to teach more hybrid sections if they are interested in raising student's final grade in a course.

One major problem with looking at what affects the mean final course grade is that some factors probably confound the effect of others. That would be a fruitful subject for further study.

Conclusion

Due to the large number of student-course records, I consider this analysis gives useful information. The analysis also showed there was little difference in the type of student who did each modality, except that older students tended to take more online courses. This research often replicates most of the previous studies with larger student populations, but with more information of how student demographics affect the results.

If you assume that the objective of choosing a teaching modality is to raise the mean final course grade (as many studies from Stern (2004) on have assumed, as opposed to reacting to student demand), then this study shows that hybrid or online modalities achieve this with instructors who teach hybrid modality sections. In practical terms, students and instructors choose a teaching modality for a host of good and bad reasons, such as perceptions on how hard a section is [Senn (2008)], fitting in class around other activities like work, personal preferences, quality of their home internet, wishes to socialize with other students and meet with faculty, etc. The analysis also showed the only factors that affected final course grades appreciably were previous university GPA, as Cavanaugh and Jacquemin (2013) reported, and the ethnicity and the sex of the student, as Xu and Jaggers (2014) related.

The importance of the work is that it suggests that researchers should examine which student demographics should learn best from different teaching modalities. Data on this could help student councilors in advising students on what modality to take. This study suggests that course schedulers should consider the demographics of their students when making decisions on what modalities to offer for which courses, as well as what the student demand is. It may be that certain demographics of students may need nudging to take courses in certain modalities. At present, it appears that a lot of students chose modalities for convenience.

Another possible conclusion is that instructors should not use one teaching format in a course. For example, instead for one-way dissemination, maybe well produced videos and games are better than straight lectures. Whilst for interactive learning, in-person interactions are superior to virtual interactions, whether synchronous or asynchronous. Note this study did not examine synchronous online courses.

Recommendations

Based on this data, one may consider counselling black ethnic students to take hybrid sections of a course. Other implications are that the administration may want to consider offering more hybrid sections in courses. Alternatively, it may be that the type of instructor who wants to teach in a hybrid modality gives higher mean course grades anyway, and that the results of this study would not apply if instructors who prefer F2F teaching, started to teach hybrids (as has happened during Covid). Another huge implication is that, if junior and senior students do better in online and hybrid sections, is that a university need not build new classrooms to handle an increased student load. Alternately, if student numbers are falling or are the same, then administrators should consider reducing their number of classrooms by selling off or repurposing their surplus real estate.

As teaching theory says that different students learn best in different ways, maybe faculty should look at using all teaching formats in a course, in-person lectures and tutorials, videos, games, synchronous and asynchronous online teaching, etc., so that the course include the best format for all their students.

Future Work

As instructors are teaching many courses, which due to Covid, are using the rotating hybrid (where different sets of students are in class each week to allow Covid spacing) and synchronous online modalities, then there should be research to examine how these new teaching modalities affect results. However, there will be a large confounding effect if one uses results after Fall 2019, as unlike before 2020, new to online and hybrid modality instructors received far less training and often did not choose (but were made to by Covid distancing rules) online and hybrid modalities for their courses. Another confounding effect would be that the administration at KSU told faculty to go easy on grading during Covid. It would also help if researchers did similar analysis for other universities, to discover whether the conclusions of the effect of demographics from this dataset applies in other locations.

While this study showed hybrid teaching had better results than F2F, it did not show why. One line of interesting research would be to find out why hybrid sections have higher mean grades. One theory could be that hybrid only does the interesting interactive stuff in person, while the less interesting basic learning is done online. Another theory might be that knowledge acquisition is best done using a student's preferred learning times and speed, whilst more advanced interactive learning is best done in an in-person manner.

Another line of research might be the relationship between the instructors who wanted to teach hybrids and why they gave higher course grades in all modalities. It could be they are better teachers, or it could be because they are lighter graders, or a combination of both. One would need an outside test to compare the rigor of different instructors to see if higher grades meant students learned more or that higher grades just meant easier grading (marking) by instructors. There is also the possibility that the instructors who give higher grades tend to be those who teach hybrid courses.

It would be interesting to analyze similar data from other universities and colleges to see if KSU's patterns are similar or different. If done with several other teaching institutions and one found similar results, then one could make generalized conclusions on the effect of teaching Modality on course grades.

Also, there are many other teaching formats than the three in this study. Perhaps teaching formats that mix in-person interactions with synchronous and asynchronous teaching would do better than KSU format hybrid courses. Research could compare other teaching formats to the three used in this study.

Limitations

1. The use of previous GPA to represent the academic ability of an incoming student is a convenient assumption, as GPA is how most students and administrators rate their achievement in courses.
2. The use of course final grade to represent learning from a course is a common approximation of learning, that may not be true.
3. This analysis did not consider other factors like how many online or hybrid courses the student had done before the course, how many online or hybrid courses the student took at the same time, or whether the student was only taking online courses or mixing F2F with online and hybrid courses. The initial analysis found that these factors were not that important in the prediction of final course grades.
4. The data for this case study comes from one university. Other universities and colleges may show completely different patterns.
5. This study only considered purely asynchronous online sections; it did not look at synchronous online sections. There are other teaching formats that were not considered, such as in-person lecture combined with in-person or virtual tutorials. The use of AI could revolutionize online teaching formats.

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