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## Evaluation of Course Modality and Student Performance in a College Anatomy and Physiology Course

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EVALUATION OF COURSE MODALITY AND STUDENT PERFORMANCE IN A  
COLLEGE ANATOMY AND PHYSIOLOGY COURSE

By

Madeline Kjera

A Thesis Submitted in Partial Fulfillment  
Of the Requirements for the  
University Honors Program

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Department of Arts and Sciences  
The University of South Dakota  
May 2021

The members of the Honors Thesis Committee appointed  
to examine the thesis of Madeline Kjera  
find it satisfactory and recommend that it be accepted.

---

Mr. Scott Druecker  
Assistant Professor of Basic Biomedical Sciences  
Director of the Committee

---

Dr. Shane Nordyke  
Director, Government Research Bureau  
Associate Professor of Political Science

---

Mr. Stephen Bambas  
Instructor of Basic Biomedical Sciences

---

Dr. Lisa Bonneau  
Assistant Provost of Academic Affairs

## ABSTRACT

### Evaluation of Course Modality and Student Performance in a College Anatomy and Physiology Course

Madeline Kjera

Director: Scott Druecker

As technology evolves, so does the integration of online alternatives to face-to-face learning within institutions of higher education. The growth of the virtual education platform has led many researchers to wonder if it is equivalent to traditional teaching methods. While the idea of whether or not a performance gap exists between different modalities of the same course is well-researched, the results vary. As such, this study aimed to evaluate the relationship between delivery method (face-to-face or online) and final grade while controlling for the variables of instructor, gender, ethnicity, and ACT score. The data included final grade percentages and demographic information for students completing multiple online and face-to-face sections of PHGY 220 either at the University of South Dakota Community College of Sioux Falls or the Vermillion main campus. Analysis of the main research question used a linear regression model. Overall, the model was statistically significant and provided evidence of a statistically significant relationship between delivery method and final grade when controlling for instructor, gender, ethnicity, and ACT score.

**KEYWORDS:** Modality equivalence, Anatomy and Physiology, Demographics

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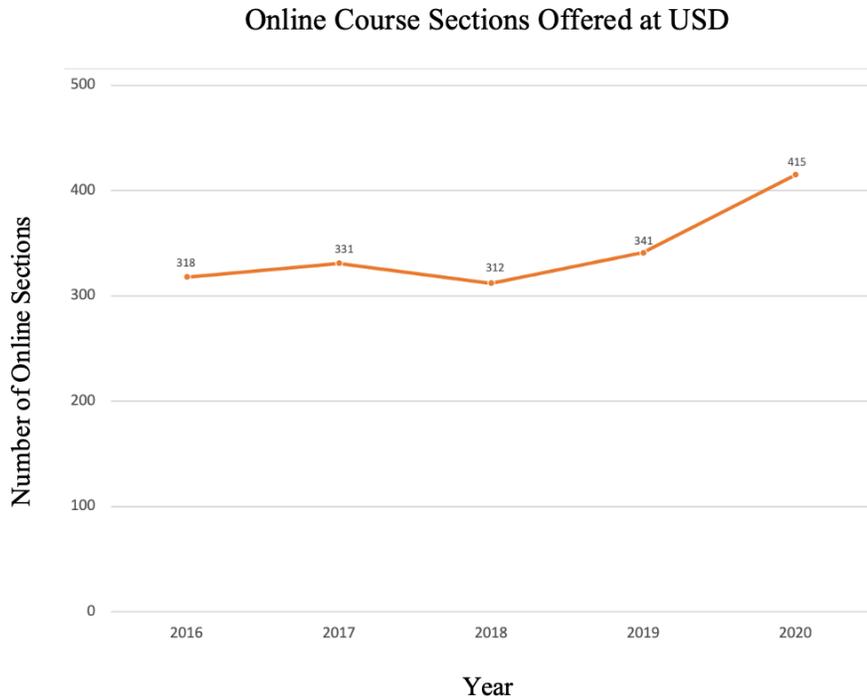
## CHAPTER ONE

### Introduction

#### Literature Review

In recent years, data shows a significant growth in the prevalence of online classes within institutions of higher education and a rise in demand (Toven-Lindsey et al., 2015). As of 2015, 28% of students in the US enrolled in at least one online learning course (Allen et al., 2016). At the University of South Dakota (USD) specifically, the number of courses offered online rose from 318 to 415 in just five years (Figure 1 & 2). Therefore, from 2016 to 2020 USD increased the number of online courses from 13% to 18% of total courses offered (Figure 2). Additionally, in the wake of the COVID-19 pandemic, there was a substantial spike in the number of hybrid courses (courses with face-to-face and online components) offered from 18 in 2019 to 533 in 2020 (Figures 2 & 3). With this considerable growth in online or partially online learning, there is also a growing number of studies aimed toward investigating whether online platforms are less, as, or more effective than the traditional face-to-face model of education. Nevertheless, all this investigation has still yielded inconsistent results (Moore, 2005; Nemetz et al., 2017; Xu & Jaggars, 2013). Now with the rise of COVID-19 and thereby distanced learning, it is essential to further explore this developing research area further.

**Figure 1.** Online Course Sections Offered at USD from 2016-2020



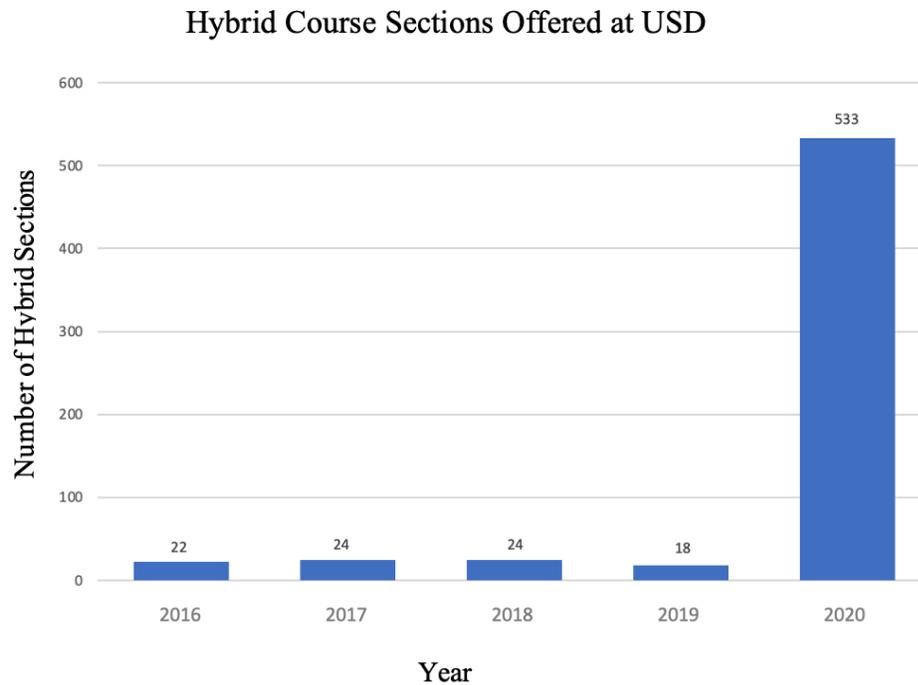
**Figure 2.** Breakdown of number of courses offered in each modality from 2016-2020

	2016	2017	2018	2019	2020
Face-to-Face	1996 83%	1928 84%	1950 84%	1944 84%	1367 58%
Online	318 13%	331 14%	312 14%	341 14%	415 18%
Hybrid	22 1%	24 1%	24 1%	18 1%	533 23%
Other	78 3%	23 1%	25 1%	19 1%	24 1%
<b>Total</b>	<b>2414</b> <b>100%</b>	<b>2306</b> <b>100%</b>	<b>2311</b> <b>100%</b>	<b>2322</b> <b>100%</b>	<b>2339</b> <b>100%</b>

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**Figure 3.** Hybrid Course Sections Offered at USD from 2016-2020

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Apart from the forced migration to online platforms due to the pandemic, for years the advantages of online course options have swayed students out of the traditional face-to-face class format. Some advantages of online learning include readily available content, building technical skills for future employment, and catering to students who prefer to learn according to their schedule (Lam, 2009; Means et al., 2010). Moreover, students are not the only ones to benefit from expanding the online course system. Online learning can monetarily benefit colleges and universities that otherwise could not expand their size in a physical sense due to lack of space. However, much of the controversy that exists in the literature is not centered on the practicality of online alternatives to face-to-face learning, but instead whether online learning platforms are equivalent to the traditional face-to-face format of instruction (Lawrence & Abel, 2013).

While researchers have attempted to evaluate both if and why a gap might exist in student performance across online and face-to-face learning platforms, the results are varied. For example, a study published in *Social Work Education* looked at performance differences among students enrolled in three sections of the same course. The same professor designed each course, but two of the sections took place face-to-face, and one utilized an online format. The study found that 51% of students enrolled in the online version received A's in the course, whereas the percentage of A's in the two face-to-face sections was 46% and 19%, respectively (Lawrence & Abel, 2013). While other studies have supported these results, they also found that online courses have higher withdrawal rates (Faulconer et al., 2018; Jaggars et al., 2013). However, not all studies report differences in student performance between the two learning platforms. Nemetz et al. (2017) found that neither group significantly outweighed the other in terms of student performance when a professor offered the same resources to both online and face-to-face students.

Some research suggests that these mixed results are due to online courses' varied structure. Overall, the typical online course does not provide a class structure centered on teaching students the skills they need to succeed in an online environment (Xu & Jaggars, 2014). The need for self-discipline becomes exacerbated when completing an online course due to a reportedly diminished instructor presence, and surveyed students are aware of this need for self-motivation (Bork & Rucks-Ahidiana, 2013; Jaggars, 2014). However, developing skills such as self-directed learning is not incorporated into the online learning model because the faculty expect students to enter the course with these skills (Bork & Rucks-Ahidiana, 2013).

On the other hand, some professors spend a lot of time developing their online courses and promoting student interaction throughout, which results in better student performance. Studies indicate that strong instructor presence in a course, apparent through feedback and discussion with students, leads to more effective online learning because students are more satisfied with the course and thereby more motivated (Dixson, 2012). A recent study published in the *Journal of Education for Business* (Nemetz et al., 2017) further demonstrates these findings. The study found self-discipline among students and instructor presence on the virtual platform to be significantly correlated with online course success. As such, online learning has the potential to benefit students in many ways academically, but only through a thoughtful course design and proper maintenance. Creating a well-structured online learning environment makes students feel empowered because they have more control over when and how they learn. They can also stay informed on important class information because it is readily available to them through their course homepage (Lawrence & Abel, 2013).

Further explanation for performance differences in face-to-face and online courses may include factors that neither institutions nor students can control. How a student performs in an online environment might rely on the degree to which they are familiar or can access particular technology (Lawrence & Abel, 2013). For example, low-income students may not have access to the devices required for specific assignments or reliable internet service. Additionally, it is important to consider that students may perform differently in the online version of a course due to the subject area. A recent study found that courses with the most profound gaps in performance were those in the

social sciences and the applied professions, including courses within disciplines such as business, law, and nursing (Xu & Jaggars, 2014).

While much research focuses on determining which factors impact the relationship between face-to-face and online student performance, few studies examine the role demographic factors play in this relationship. Furthermore, previous studies that have looked towards demographic factors to describe the performance difference between platforms report conflicting results.

One study conducted by Xu and Jaggars (2014) set out to look at 500,000 courses taken by 40,000 college students in Washington state. They examined the performance gap between face-to-face and online courses and how that gap changed when looking at specific demographic based subgroups. This study found that overall, students performed more poorly in the online class format of a course for all courses; however, there were disparities in how much poorer different subsets of students performed. In particular, the analysis showed that males and students with less academic preparation had more significant gaps in performance between online and face-to-face course formats than other student subsets.

However, when Lam (2009) conducted a study to evaluate the effects of GPA, gender, and ethnicity on student performance in face-to-face and online courses, the results were slightly different. Lam did find that GPA had the most decisive impact on student performance in both face-to-face and online courses. While these findings were in line with those of the previous study, Lam did not find any evidence that males performed significantly worse than females in online courses.

## Hypothesis

The varied results reported above regarding both the effectiveness of face-to-face and online courses and the role demographic factors play in this relationship demonstrate a need for further research on the topic. As such, the current study focused on the overarching research question, ‘After controlling for instructor, gender, ethnicity, and ACT, will a performance gap still exist between students completing face-to-face and online versions of the same course?’ For analysis, this question was converted to a hypothesis as follows:

$H_0$ : After controlling for instructor, gender, ethnicity, and ACT score, there will be no gap in student performance between face-to-face and online platforms of the same course.

$H_A$ : After controlling for instructor, gender, ethnicity, and ACT score, there will be a gap in student performance between face-to-face and online platforms of the same course.

A potential reason for the difference between delivery methods is that the study includes two different student populations. For this reason, it was necessary to control for gender, ethnicity, and ACT.

## CHAPTER TWO

### Materials and Methods

#### Course Information

The course used to test this hypothesis was entitled Human Anatomy and Integrated Physiology (PHGY 220). It is an undergraduate-level course at the University of South Dakota (USD). Although USD offers the course through various instructors, the scope of this study focused on student outcomes from only two of these instructors. Each of the two instructors included in the study taught both face-to-face and online course sections. The instructors also followed similar course designs centered around the same course objectives and student learning outcomes. The similarity in course design reduces the likelihood that differences in student performance across the learning platforms were due to variations in the course structure. Furthermore, the professors utilized similar grading mechanisms (homework assignments, quizzes, and exams) for student evaluation. The only significant difference between the two courses was the number of points offered and thereby the number of assignments, quizzes, and exams completed throughout the semester. The difference in total points between the two instructors was around 300.

#### Sample

The research conducted used demographic data collected from USD's Office of Institutional Research and student performance data collected from the course professors. Before receiving the data, the committee requested and gained permission to work with

human subjects through USD's Institutional Review Board (IRB-21-37). The data was de-identified prior to beginning analysis. The data included information from students completing multiple online and face-to-face sections of PHGY 220 either at the University of South Dakota Community College of Sioux Falls or the Vermillion main campus from fall 2018 through summer 2020.

The current study evaluated the performance difference between face-to-face and online courses while controlling for as many variables as possible. Data obtained included each student's instructor, delivery method (face-to-face or online), final grade in the course, grade for each exam, ACT score, gender, and ethnicity (White, American Indian, Asian, Black, Hispanic/Latino, international, or multiracial). Of the 821 students for which performance data was available and the 958 students for which demographic information was available, only a certain amount of data successfully matched. Therefore, the final sample contained only 553 students (N=553).

As summarized in Tables 1 and 2, within the overall sample (N=553), about 79% of students were female and students identifying as white made up the majority (85%), followed by Hispanic/Latino (4%), Black (3%), multiracial (3%), international (2%), Asian (2%), and American Indian (1%). Of the total 553 students, 475 took the face-to-face version of the course, and 78 took the online version. Equivalent proportions of females were present in both the face-to-face and online formats (79%). Additionally, the proportions of students identifying as white and most other ethnicities remained constant across both platforms. However, there was a noticeably higher proportion of American Indian students enrolled in the online course (5%) than the face-to-face (<0.5%), and there were zero Asian students enrolled in the online version of the course (Table 2).

**Table 1.** Breakdown of gender within the sample with percentages

Gender	Delivery		Total
	Face-to-Face	Online	
Female	373 78.53%	62 79.49%	435 78.66%
Male	102 21.47%	16 20.51%	118 21.34%
<b>Total</b>	<b>475</b>	<b>78</b>	<b>553</b>

**Table 2.** Breakdown of ethnicity within the sample with percentages

Ethnicity	Delivery		Total
	Face-to-Face	Online	
American Indian	1 0.21%	4 5.13%	5 0.90%
Asian	11 2.32%	0 0.00%	11 1.99%
Black	13 2.74%	2 2.56%	15 2.71%
Hispanic/Latino	20 4.21%	4 5.13%	24 4.34%
International	9 1.89%	1 1.28	10 1.81%
Multi-Racial	14 2.95%	3 3.85	17 3.07%
White	407 85.68%	64 82.05%	471 85.17%
<b>Total</b>	<b>475</b>	<b>78</b>	<b>553</b>

Key
Frequency
Column Percentage

Furthermore, the sample contained a broad range of ACT scores. Effective examination of the scores required moving them into five distinct groups. Table 3 demonstrates the groups and frequency of students scoring in each. By looking at the frequencies for the total sample, it is clear that this variable follows a near-perfect normal distribution, with the majority of observations falling in the 22 to 25 category.

**Table 3.** ACT score distributions

ACT Score	Face-to-Face	Online	Total
17 or Less	18	5	23
18 to 21	114	24	138
22 to 25	195	20	215
26 to 29	98	13	111
30 or More	17	2	19
<b>Total</b>	<b>442</b>	<b>64</b>	<b>506</b>

### Procedure

To begin the analysis, I checked for any violation of assumptions. Then, I performed a series of two-sample difference of means t-tests ( $\alpha = .05$ ). These tests compared average final course grade for face-to-face versus online students (N= 821), white versus non-white students (N= 553), and male versus female students (N= 553). Again, due to an inability to match certain pieces of data, sample sizes for these tests varied.

Next, I used a regression analysis model to evaluate the research hypothesis. Within this analysis, final course grade was the dependent variable representing student performance, delivery method (face-to-face or online) was the independent variable, and

instructor, gender, ethnicity, and ACT scores were all controlled variables. Because the regression analysis required data on student ACT scores, I excluded 47 students for whom data on ACT scores was not available from the model. Therefore, the regression had a total sample size of N=506. I completed the analysis through the use of the STATA 11 software program.

## CHAPTER THREE

### Results

As summarized in Tables 4 and 5, the t-tests showed a significant difference ( $p < .05$ ) between the average grade for face-to-face versus online students ( $p = 0.000$ ) and white versus non-white students ( $p = 0.002$ ). However, as shown in Table 6, the difference between the average final course grade for males and females was not significant ( $p = 0.532$ ).

**Table 4.** Two-sample t-test comparing differences in average final course grade for each delivery method

	Observations	Mean	Standard Deviation
Face-to-Face	686	.8208799	.1235934
Online	135	.7582404	.163033

t=4.2313  
p=0.000\*\*\*

Significance Key:  
\*\*\*p < .01

**Table 5.** Two-sample t-test comparing differences in average final course grade for white and non-white students

	Observations	Mean	Standard Deviation
White	471	.8124541	.1250928
Non-White	82	.7652561	.1370158

t=3.1079  
p=0.0020\*\*\*

Significance Key:  
\*\*\*p < .01

**Table 6.** Two-sample t-test comparing differences in average final course grade for female and male students

	Observations	Mean	Standard Deviation
Female	435	.8072301	.1286919
Male	118	.7989136	.1252932

t=0.6261  
p=0.5315

Table 7 summarizes the results of the linear regression. Overall, the model was statistically significant ( $F=0$ ), and approximately 21% of the variance in final grade was explained by the variation in the independent variables in the model ( $\text{adj. } R^2=0.214$ ).

Additionally, the model provides evidence of a statistically significant relationship between delivery method and final grade ( $t=-2.07$ ,  $p<0.05$ ). A student's ACT score also had a statistically significant positive relationship with final grade ( $t=10.46$ ,  $p<0.01$ ). Based on the results, holding all other variables constant, the face-to-face students achieved a final score 4.03 points higher than students completing the course online. For each step up on the ACT score scale (ex: moving from the 17 and below to the 18 to 22 category), the expected final grade increased by 6.12 points. The model suggested a significant relationship between gender and final grade as well but at a lower significance level ( $t=-1.74$ ,  $p<0.10$ ). This relationship indicates that on average males scored 2.15 points lower than females when controlling for the other variables. Nevertheless, when comparing the standardized coefficients as shown in Table 8, ACT is the strongest predictor of final grade ( $\beta=0.44$ ) followed by delivery method ( $\beta=-0.11$ ) and gender ( $\beta=-0.07$ ).

**Table 7.** Results of linear regression (N=506) with delivery method as independent variable and final course grade as dependent variable

	Coefficient	Standard Error	t	P> t
Instructor	.007495	.0156973	0.48	0.633
Delivery	-.040266	.0194097	-2.07	0.039**
Gender	-.021535	.0123835	-1.74	0.083*
Ethnicity				
American Indian	-.0191665	.0575289	-0.33	0.739
Asian	.0053867	.0401845	0.13	0.893
Black	-.0174055	.0368019	-0.47	0.636
Hispanic/Latino	.0380904	.026517	1.44	0.152
International	-.0067651	.1120602	-0.06	0.952
Multiracial	-.0147304	.028544	-0.52	0.606
ACT Score	.0612324	.005856	10.46	0.000***

Significance Key:

\*\*\*p < .01

\*\*p < .05

\*p < .10

**Table 8.** Standardized coefficients from linear regression in Table 4

	Standardized Coefficient
<b>Instructor</b>	.0248721
<b>Delivery</b>	-.106313
<b>Gender</b>	-.0693678
<b>Ethnicity</b>	
<b>American Indian</b>	-.0134825
<b>Asian</b>	.0053374
<b>Black</b>	-.0192431
<b>Hispanic/Latino</b>	.0575178
<b>International</b>	-.0023865
<b>Multiracial</b>	-.0204748
<b>ACT Score</b>	.4402568

Overall, the significant relationship between delivery method and final course grade allows for rejection of the null hypothesis ( $H_0$ ). Further, the model supports the alternative hypothesis ( $H_A$ ) that even after controlling for instructor, gender, ethnicity, and ACT score, there is a significant gap in student performance between face-to-face and online platforms of the same course.

## CHAPTER FOUR

### Discussion and Conclusion

#### Discussion

The statistical analysis in this study supported the alternative hypothesis. Overall, students in online courses had a lower expected final grade than students in face-to-face sections, even after controlling for instructor, gender, ethnicity, and ACT score. Additionally, lower ACT scores and being male demonstrated a negative impact on student performance.

The results of this study oppose previous research that found students performed equivalently or better in online courses when looking strictly at final course grades (Faulconer et al., 2018; Jaggars et al., 2013; Nemetz et al., 2017; Lawrence & Abel, 2013). However, compared to past studies that examined the role of demographic factors in overall student performance, the results are very similar. These previous studies found that students scored worse in online courses (Xu and Jaggars, 2014). Further, GPA and general academic preparedness were two of the strongest predictors of student performance (Xu & Jaggars, 2014; Lam, 2009). The current study reflects this trend through ACT score strength in predicting student outcomes.

While the relationship between less academic preparedness and lower student performance makes intuitive sense, the link between delivery method and poor student performance is less direct. As mentioned in the literature review, the reason for this relationship may be anything from professor presence to device accessibility. This study attempted to evaluate if ethnicity played a role in this relationship but found no

significant results. These findings are not to say that ethnicity plays no role in student performance but instead lead to this study's first limitation.

### Limitations

Perhaps the most confining limitation of this study was the sample size. Despite an initially large pool of data, difficulties in matching student performance factors (i.e., exam grades and final course grades) and demographic factors (i.e., gender and ethnicity) diminished the final sample size to N=553. Further, 47 of these students did not have ACT data and therefore had to be excluded from the linear regression model, leaving a sample size of only N=506. There was also no data for students that withdrew from the course, contributing to a smaller sample and fewer analysis possibilities.

The sample itself included a higher percentage of females than males and a much higher percentage of whites than any other ethnicity. There are a few explanations for this disproportionality in the data. The most likely reason for the higher percentage of women is that PHGY 220 is a prerequisite for nursing and dental hygiene, two majors predominately pursued by women. For example, of the 222 nursing degrees awarded by USD in 2019, 197 went to women, and 25 went to men (Data USA). Furthermore, the university's make-up as a whole explains the disproportionality of ethnicity within the sample. As of 2019, students identifying as white made up 82.8% of the student population at USD while every other ethnicity made up less than 4% apiece (Data USA).

Another limitation within this study was the number of variables examined. Although the variables used provided various perspectives, some other variables that would provide insight might include student age, financial aid status, and whether the student has completed an online course in the past. Age and previous online courses

might indicate which students are non-traditional or more experienced in taking college-level courses. Financial aid reception might indicate the student comes from an underserved population with less academic resources.

The final limitation of this study is its generalizability. The data analyzed included student grades from only one STEM course at one institution. Some variation did come from including one traditional college campus and one community college and having two professors. However, as mentioned previously, the courses evaluated in the study used the same course design, limiting the variability. Also, the University of South Dakota Community College of Sioux Falls (CCSF) is better qualified as an additional USD location rather than a traditional community college. USD offers many 4-year programs through CCSF. Additionally, admission requirements, resources, programs, and tuition at CCSF are similar to that of the Vermillion main campus. Furthermore, CCSF and the Vermillion main campus have the same president, the same provost, and are financially connected, meaning CCSF is not an autonomous branch of USD. Therefore, the most variation produced in the study was probably from student subpopulations at each location.

### Conclusion

Despite its limitations, this study has significant implications for institutions of higher education. This research aimed to identify if face-to-face and online methods of instruction were equivalent when controlling for instructor, gender, ethnicity, and ACT score. The evidence provided by the linear regression model supports the conclusion that delivery method and final grade have a significant relationship even when controlling for

these variables. Therefore, the results indicate that a gap exists between the studied face-to-face and online course sections of PHGY 220.

The process used in this study could have many implications for universities going forward. Although this study could not explain why performance discrepancies exist, it is an integral tool for monitoring face-to-face and online course equivalence. When considering the advantages of online learning, it would benefit colleges, professors, and students to ensure equivalence for all courses across both modalities. By repeating the process used in this study, institutions could catch and address issues disturbing the effectiveness of either platform early on. Also, the use of this method would allow instructors and academic counselors to follow performance trends within courses such that they could predict which students may need extra resources and advise them accordingly.

While these findings are an important contribution to the existing literature, the equivalence of face-to-face and online courses is still a topic with great potential. Suggestions for future studies include using a larger and more diversified sample, exploring more variables, and evaluating a broader range of courses to search for significant differences across subject areas. Additionally, although the face-to-face course sections in this study did not move online abruptly in response to COVID-19, many other courses did. Future research may want to explore COVID-19 and the forced migration of courses to the online platform as a possible reason for student performance differences. Research into that topic could provide valuable insight into the importance of online course structure being as many institutions did not have adequate time to prepare an online curriculum.

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