# An Interdisciplinary Analysis of Course Meeting Frequency, Attendance and Performance

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*Abstract: Using data from economics and history courses taught across multiple semesters, the authors show that a triweekly meeting frequency improves student performance relative to a biweekly meeting frequency. There is evidence that this effect operates through two channels. First, there is an indirect effect that operates through attendance. While greater attendance improves course score, this effect is less in a triweekly course. Second, there is a direct positive effect to more frequent course meetings on student performance. These two effects combine to increase student performance by 3 to 9 percentage points when meeting triweekly instead of biweekly. While students perform better overall on a triweekly meeting schedule, there are more absences and less consistent attendance.*

*Keywords: Attendance, Meeting Frequency, Course Performance*

## Introduction

This study investigates the relationship between course meeting frequency, attendance, and course performance in introductory level courses. This analysis is interdisciplinary, featuring data from courses in both economics and history at Indiana University Northwest, a medium-sized non-residential public university (approximate enrollment of 6,000 students). The idea for this research stemmed from an administrative change to incorporate more classes that meet on a three-days-per-week (triweekly) schedule, for 50 minutes each meeting, over the more traditional two-days-per-week (biweekly) schedule, for 75 minutes each meeting. Between the Fall of 2013 and the Spring of 2015, both authors each taught the same introductory survey class in both the triweekly format and the biweekly format. Using course scores and attendance data based on instructor observation, attendance and performance are compared across the different course formats to determine the effect of course meeting frequency on attendance and performance. After a brief review of related literature, we discuss the nature of the data, the relationship between meeting frequency and attendance, and the relationship between meeting frequency and course performance.

This topic is deserving of attention because the impact of more frequent and shorter class meetings on attendance is not immediately obvious. On one hand, a larger number of total class meetings during the semester may mean that the perceived cost of missing a single class meeting is lower, resulting in students missing more class meetings. On the other hand, if students think about absences in absolute terms (i.e. "I should not miss more than two class meetings in a semester"), then adding more class meetings may result in a higher attendance rate. We show that that the former occurs and the proportion of class meetings attended is similar between

triweekly and biweekly schedules. The same attendance rate in a triweekly section results in a larger number of class meetings attended as well as more class absences.

The effect of more frequent and shorter class meetings on student performance is also not immediately obvious. There is some research suggesting that more frequent and shorter sessions lead to better performance (Devadoss & Foltz, 1996; Reardon, Leierer, & Lee, 2012); however, if more frequent class meetings also result in more total absences, the overall effect may be diminished or reversed. We show that while a triweekly schedule does increase number of absences, the effect of this increase on course performance is mitigated by half, as each absence has a smaller effect than in a biweekly schedule. When controlling for this indirect attendance effect, there is also a significant direct effect that increases course performance by 10 to 15 percentage points. The combination of the direct performance effect with the indirect attendance effect results in a smaller 3 to 9 percentage point increase in total score. Overall, a triweekly class schedule is associated with better total course performance. This study is one of the first to identify, separate, and measure (1) the indirect effect course meeting frequency has on performance through changes in the pattern of attendance and absences and (2) the direct effect on student performance due to the frequency of meeting itself.

**Related Literature**

Broadly speaking, the individual components of this study have a large related literature, while the combination of all three components (meeting frequency, attendance, and performance) into a single study has not been thoroughly investigated before. Educators have been interested for decades in how frequently courses should meet. For example, Paul (1937) conducted a study of introductory courses at Iowa State Teachers College (now the University of Northern Iowa) and argued that a five-days-per-week format was preferable to the three-days-per-week (Monday, Wednesday & Friday) format, although some important details, such as the duration of class meetings in each format, are unclear. By the 21st century, the argument revolved more around whether three-days-per-week was preferable to two- or even one-day-per-week formats (Vernick, Reardon, & Sampson, 2004). Carrington (2010) even found that in intermediate accounting courses, students performed better in two-day- and one-day-per-week courses than in three-day-per-week classes. Conversely, Reardon, Leierer and Lee (2012) found that student success was higher in compressed summer schedules of four-days-per-week and lowest in one-day-per-week. The comparison of meeting frequency and performance is also directly related to the spacing effect, or the theory that learning is improved by study sessions spread out over time rather than concentrated in a shorter period (Ebbinghaus, 1885). Numerous studies (Dempster 1989, Budé et al 2011) have found that the spacing effect has verifiable implications for educational practice. For example, Budé found that "distributed practice will lead to better conceptual understanding compared to massed practice" (p. 75). However, these studies tend to focus more on comparing abbreviated courses (e.g., summer courses) with standard semester-long courses rather than on comparing meeting frequency among semester-long courses (Anastasi 2007). So, the debate over the optimal course frequency in a standard semester continues with no generally agreed upon rule in sight.

Similarly, there is quite a bit of literature about the correlation between attendance and course performance. In a very brief article that was more exhortatory than analytical, Goggio (1943) urged that attendance be compulsory for first year students of Modern Language courses. Subsequent studies were much more rigorous and based in data analysis. Wyatt (1992) analyzed

absenteeism according to nine variables: liking or disliking the class, living arrangements, time spent studying, frequency of alcohol consumption, time spent working, gender, age, parental income, and previous semester's GPA. Wyatt's data set included 110 surveyed students, but the argument is limited by the nature of the survey: students self-reported their rate of attendance. Durden and Ellis (1995) found that absenteeism plays a significant role in performance in Principles of Economics courses, but that an average of 3.5 absences reduces a student's course grade only by 1.1 percentage points. Similar to Wyatt's data, Durden and Ellis use self-reported absentee rates. Romer (1993) found the absentee rate to be about one third, but his data came from a single 'typical' day rather than an entire, or even multiple, semesters. Romer also argued that the rate of absenteeism seemed to reflect a mixture of some students missing most classes and many students missing a smaller number of classes. Not all studies rely on self-reported attendance. For example, Marburger (2001) combines actual attendance data with an end of semester survey and finds consistently higher levels of absenteeism in class sessions meeting on Friday. An alternative approach was taken by Chen and Lin (2008) who constructed a random experiment on attendance and exam performance and found that attendance improved performance on exams by as much as 18 percent. Credé, Roch and Kieszczynka (2010) sought to address this topic and avoid the problem of a very small data set by conducting a meta-analytic review of 68 previous studies. They found that class attendance was a better predictor of college grades than any other known predictor, including SAT scores, GPA, studying skills, and the amount of time spent studying. The authors showed through the studies they examined that improvement in attendance resulted in dramatic improvements in average grades and in the reduction of failure rates.

So there has been little consensus on the importance of course meeting frequency, but general consensus that attendance correlates positively with course performance. Finally, there is very little examination of all three issues together: meeting frequency, attendance, and performance. Considering the three issues together is important because meeting frequency may affect performance directly, as well as indirectly through changes to attendance. Devadoss and Foltz (1996) have made one of the few studies to combine these issues. They considered effects of student characteristics (such as age, aptitude, and financial support), teacher attributes (such as teaching style and whether the teacher received awards), and course features (such as whether there was an attendance requirement and what frequency of course meetings) on both attendance and performance. The authors found that courses with required attendance policies increased attendance by 12.7%. In terms of frequency, they found that classes meeting triweekly (Monday, Wednesday & Friday) had 6.4% higher attendance than classes meeting biweekly (Tuesday & Thursday). They argued that even controlling for students who were better motivated and who had higher prior GPA, additional attendance correlated with higher course grades. The authors did not examine the correlation of grades and course frequency, but the presence of all three issues in one article is unusual. Some limitations of the study are that it examined only one subject, agricultural economics, that it combined data from courses offered at different universities taught by different instructors, and that the majority of classes were upper-level (junior/senior) courses.

In short, there has been little to no attempt to seek connections between course meeting frequency, attendance, and performance in the extant literature, especially across multiple disciplines. In an era in which online education is becoming commonplace and class schedules are becoming more flexible, a study like this one is important to maximize the educational impact of courses for students who are still taking traditional, face-to-face courses. By using data

from both economics and history courses, this study provides an interdisciplinary approach to this problem, with an aim of showing how course meeting frequency affects both attendance and course performance.

## Data and Results

*Summary of Data*

Our data come from seven course sections in the subjects of economics and history taught during the Fall and Spring semesters over the 2013-2014 and 2014-2015 academic years at Indiana University Northwest. This dataset includes three sections of ECON-E 103, Introduction to Microeconomics and four sections of HIST-H 113, History of Western Civilization I. Of these seven sections, four (two in each subject) were taught on a triweekly 50-minute session schedule (meeting Monday, Wednesday & Friday). The remaining three were taught on a biweekly 75-minute session schedule (meeting either Monday & Wednesday or Tuesday & Thursday). The differences in meeting frequency and subject are evenly distributed across academic years, minimizing any semester-specific or inter-academic-year effects. The sections in our data also coincide with the first significant course offerings on a triweekly frequency at the school in at least a decade. As a result, students had no prior experience with a triweekly meeting frequency, making them less likely to choose one section over another due to its meeting frequency rather than based on other exogenous factors (such as which section fits more appropriately in their schedule), which helps to limit selection bias.

Within each subject, all course sections were taught by the same instructor with minimal variations in course content, graded assignment difficulty, and instruction method each semester. All of the courses had a graded attendance policy. Students received points for attendance and instructors took attendance during regular instructional class meetings.[1] Thus, the data on attendance rate are based on instructor observation, not self-reporting by the students. Because the data are not self-reported, this increases the trustworthiness of the attendance data compared to the data that is common in previous studies. Because attendance is a required course component, total course scores and attendance rate will be directly correlated. To address this correlation, the attendance component from each student's total course score is excluded. Whenever the term "total score" is used, it refers to the total course score excluding the attendance component with the remaining components re-weighted.

These data include attendance observations of 165 students divided roughly equally across subject and meeting frequency. Each observation represents one student (performance, attendance, rank, etc.) in one class section. No student appeared more than once in the data, either across semesters or disciplines. The two primary outcome variables of interest are each student's total course score, as a percent excluding the graded attendance portion, and attendance rate for the course. In addition to these course-specific variables, some student-specific control variables of class rank (freshman, sophomore, junior, senior), gender, and age are also included.

One final and significant factor in the performance of a student is inherent student quality (that is, capacity for and likelihood of success), which we cannot observe directly but attempt to capture with each student's career GPA. Career GPA is defined as the average GPA of each student for all courses, excluding the course section included in our data, as observed in the Fall

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[1] Attendance comprised 5% of the total course score in all courses and was taken during the first part of the class by the instructor.

of 2016. While GPA when entering a course is often used to control for student quality, because these two courses are introductory 100-level courses, they have a very high proportion of freshman (41%) and sophomores (31%) who have completed few, and in some cases no, courses prior to these. Instead, career GPA is measured more than a year after completing the course, based on an average of 75 total units or 25 three-credit courses per student.

Table 1 shows mean and standard deviations for each variable in these data by all sections combined as well as separated by meeting frequency and subject. Across all sections, the mean total score is 78.7% and the mean attendance rate is 80.3% (as a percent of class meetings). By subject, both mean total score and attendance rate is higher for history than economics. By number of meetings per week, mean total score is higher for triweekly sections while attendance rate is higher for biweekly sections. While none of these differences are statistically significant as simple means,[2] statistically significant differences will emerge when we control for other factors in the following sections. The standard deviation for total score is lower for triweekly sections, while the standard deviation for attendance rate is higher for triweekly sections. These differences in standard deviation suggest that in triweekly sections, the total course score may be more consistent across students while attendance is less consistent.

The rest of Table 1 summarizes the other control variables. Across all sections, the average student career GPA is 2.65, the average age is 22.7 years, 40.6% of students are freshman, 71.5% are either freshmen or sophomores, and observations are roughly equally divided between male and female students. The total number of observations is 165, distributed approximately equally by course meeting frequency and subject.[3]

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[2] The p-values associated with a difference of means test by subject are 0.31 for total score and 0.79 for attendance rate and by number of meetings are 0.50 and 0.52, respectively.

[3] Five observations were dropped for students that were either non-degree seeking, graduate or of unknown rank. The factors behind the performance and attendance of these students are likely to be very different from the rest of the sample, and their limited number makes drawing any inference difficult.

### Table 1 - Summary Statistics

| | | All sections combined | By meeting frequency | | By Subject | |
|---|---|---|---|---|---|---|
| | | | **Triweekly** | **Biweekly** | **Economics** | **History** |
| Total Score % | *Mean:* | 78.7% | 79.4% | 78.1% | 77.7% | 79.7% |
| | *SD:* | 0.124 | 0.119 | 0.128 | 0.116 | 0.131 |
| Attendance % | *Mean:* | 80.3% | 79.2% | 81.2% | 79.9% | 80.7% |
| | *SD:* | 0.192 | 0.224 | 0.163 | 0.213 | 0.169 |
| GPA | *Mean:* | 2.65 | 2.63 | 2.68 | 2.71 | 2.59 |
| | *SD:* | 0.807 | 0.816 | 0.804 | 0.815 | 0.800 |
| Age in years | *Mean:* | 22.7 | 22.4 | 22.9 | 22.2 | 23.1 |
| | *SD:* | 7.14 | 7.61 | 6.76 | 7.21 | 7.08 |
| % Freshmen | | 40.6% | 47.3% | 35.2% | 37.6% | 43.8% |
| % Sophomore | | 30.9% | 31.1% | 30.8% | 40.0% | 21.3% |
| % Junior | | 18.2% | 10.8% | 24.2% | 14.1% | 22.5% |
| % Senior | | 10.3% | 10.8% | 9.9% | 8.2% | 12.5% |
| % Female | | 47.9% | 48.6% | 47.3% | 45.9% | 50.0% |
| Observations | | 165 | 74 | 91 | 85 | 80 |

While the attendance rate, as a percent of class meetings, is similar across biweekly and triweekly meeting frequencies, this necessarily implies that the number of class meetings the typical student attends, as well as the number of absences, must be different. In a typical semester that meets for 15 weeks, an 80% attendance rate would imply the average student attends 24 out of 30 potential meetings on a biweekly meeting schedule (missing 6) or attends 36 out of 45 meetings on a triweekly meeting schedule (missing 9). Missing one course meeting in a biweekly section will have a larger effect on attendance rate than missing one meeting in a triweekly section. While a 15-week biweekly section could potentially meet as many as 30 times and a triweekly section as many as 45 times, the actual number of observations in our data varies by class based on semester schedule, holidays, meeting cancellations (weather-related and otherwise) and number of exams. The average number of observations for biweekly sections was 22 and for triweekly was 34. While attendance rates are similar across sections, there is a significant difference in the number of absences by both subject and section schedule.

Table 2 shows the average number of class absences. Because it is not immediately clear if the proportion or total number of meetings attended is a more important factor in performance, it is necessary to consider the proportion of total course meetings attended, the number of course meetings attended, as well as the number of class absences.

**Table 2 – Class Absences**

| | Combined Subjects | | Economics | | History | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| All sections combined | 5.24 | 5.55 | 5.27 | 6.26 | 5.21 | 4.71 |
| Biweekly sections | 4.14 | 3.78 | 2.73 | 2.50 | 4.98 | 4.16 |
| Triweekly sections | 6.59 | 6.94 | 6.96 | 7.38 | 5.78 | 5.93 |

For the combined subjects, students missed on average two meetings more in triweekly sections than biweekly sections (p-value of 0.008). This increase in absences (about 60% more) is similar in size to the increase in number of class meetings as a result of a triweekly schedule. There was greater variation in economics (with an average difference of almost four more absences, p-value of <0.001) than history (with an average of less than one more absence, p-value of 0.56) between biweekly and triweekly schedules. The standard deviation for absences was higher both in economics compared to history and triweekly sections compared to biweekly sections. This higher standard deviation means that there is greater variability, or less consistency, in the number of absences for students in economics than in history as well as in triweekly sections than in biweekly sections.

Because the number of class absences differs between biweekly and triweekly sections, it may be useful to look at attendance rates by specific weekly class meetings, to see on which days absences are more likely to occur. Table 3 shows the mean and standard deviation of attendance rate for biweekly and triweekly sections by class meeting day.

**Table 3 – Attendance Rates by Class Meeting Day**

| | Biweekly Sections | | Triweekly Sections | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| 1st weekly class meeting | 81.0% | 0.176 | 79.9% | 0.236 |
| 2nd weekly class meeting | 81.6% | 0.189 | 80.8% | 0.231 |
| 3rd weekly class meeting | - | - | 76.9% | 0.265 |

The first weekly class meeting is typically Monday (Tuesday for one section in the data), the second weekly class meeting is typically Wednesday (Thursday for one section in the data) and the third weekly class meeting is Friday. Attendance rates by meeting day are higher for biweekly than triweekly and for both biweekly and triweekly sections the second weekly class meeting is the highest attended. For triweekly sections the lowest attended class meeting is the third weekly meeting on Friday, which is consistent with the findings of Marburger (2001). The standard deviation is consistently larger for triweekly sections suggesting that student attendance is less consistent in triweekly sections. This difference in attendance consistency between triweekly and biweekly course sections plays an important role in our estimation technique as it results in significant heteroscedasticity (explained below) by course meeting frequency.

*Empirical Methods*

To investigate the significance of the relationship between the variables of interest in our data we use weighted least squares (WLS) regression. Weighted least squares regression is closely related to ordinary least squares (OLS) regression but allows us to correct for a predictable

pattern in the error term. One of the primary concerns with using an OLS estimation technique is that of heteroscedasticity, or that the variance of error terms is not the same across the groups within the sample. Because data is pooled from course sections in different subjects and with different scheduled meeting frequencies, there is likely to be significant heteroscedasticity. In the presence of heteroscedasticity, regression estimates continue to be unbiased but are no longer efficient; also, standard errors and inference based on these standard errors may not be correct. We find there is evidence of significant heteroscedasticity, and we can consistently reject the OLS assumption of homoscedasticity. The approach we adopt to correct this heteroscedasticity is with WLS. [4] We use this approach because we have knowledge about the source of heteroscedasticity, namely the heterogeneity in course sections mentioned above. Our main regression results in the following sections are based on WLS regressions with weights inversely related to the estimated covariance of residuals grouped by course meeting frequency. [5] While the steps are omitted here, the investigation of the variance of OLS residuals determined that heteroscedasticity is introduced primarily by pooling course meeting frequency (biweekly and triweekly). The residuals grouped in other ways (including by section, subject, year, etc.) do not differ significantly in variance.

Two other empirical concerns are temporal trends and selection issues. If the triweekly sections were all taught either earlier or later in the sample compared to biweekly sections, then course meeting frequencies might be affected by a temporal trend (such as grade inflation). However, the different course meeting frequencies and subjects are evenly distributed across academic years (two triweekly courses taught in each academic year, with one in each subject), minimizing any inter-academic-year effects. While the ideal way to investigate a change of class meeting frequency is with a randomly controlled treatment, randomly assigning students to course sections is not feasible. While we do not have the luxury of a randomly controlled experiment, there are several reasons to believe that selection issues between triweekly and biweekly course sections may be minimal. First, our sample begins in Fall 2013, which was the first semester in which there were significant offerings of triweekly (Monday-Wednesday-Friday) courses. To the best of our knowledge, triweekly courses had not previously been offered in at least a decade. Because of the sudden introduction, students had limited information ex-ante about their preferences between triweekly and biweekly meeting frequencies, reducing selection. Second, as a commuter campus where most students work full or part time, our students have limited flexibility in choosing their class schedules, and class schedules are often determined by students' work schedules. We believe these two effects limit the potential student selection issues between triweekly and biweekly course schedules.

Finally, in addition to the regression results presented below, we have investigated several alternative specifications, including controlling for academic year, semester, and calendar year as well as other approaches to heteroscedasticity correction. These alternative specifications did not significantly change our main results or alter our conclusions. The following two sections provide our main results. In the first we look at the determinants of attendance, while in the second we investigate the determinants of course performance.

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[4] An alternate approach would be to use a heteroscedasticity-corrected covariance based on White (1980) or Long and Ervin (2000). Using this alternate approach does not significantly change the value of our estimates, but does reduce their significance, in part because of the small sample size and because this approach fails to take advantage of our knowledge of the source of heterogeneity. Another alternate approach would be bootstrapping.

[5] Regression weights are $w_i = 1/\hat{\sigma}_i^2$ for $i = 1,2$ corresponding to biweekly and triweekly course sections.

*Determinants of Attendance*

In this section, we investigate how course meeting frequency (biweekly or triweekly meetings) affects attendance rate, measured as the proportion of class meetings attended, the number of class meetings attended, and the number of class absences. As outlined in the previous section, our primary empirical method is weighted least squares regression using weights reflecting the heteroscedasticity introduced by course meeting frequency.[6] The original OLS regressions on which homoscedasticity tests were performed and from which weights were constructed can be found in the appendix. Each regression controls for student quality, subject, other student characteristics, and includes an indicator variable for course meeting frequency. In the regression results, the coefficient on this indicator captures the effect and significance of meeting frequency on attendance rates. For example, if the coefficient on the triweekly meeting frequency indicator is positive and significant, then more frequent class meetings has a positive and statistically significant effect on attendance (or absences). Regression results are presented in Table 4.

Regression (i) uses the percent of class meetings attended as the dependent variable. In this regression, the coefficient on triweekly meetings (coefficient 2) is negative but not significant, which suggests that a class section meeting biweekly or triweekly does not have a significant effect on the percent of class meetings attended. Student quality, as measured by career GPA, is significant (coefficient 3). A hypothetical student with a one-point increase in career GPA attends an additional 11 percent of class meetings. There is no significant difference by subject in attendance, either directly (coefficient 4) or indirectly interacted with triweekly sections (coefficient 5). While all student rank coefficients are negative (suggesting freshmen are more likely to have higher attendance), the only significant effect is for juniors (coefficient 6). The coefficients on gender and age suggest that female students and older students have higher attendance, but neither estimate is significant.

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[6] For regressions (ii) and (iii) in Table 4 we can reject the assumption of homoscedasticity at the 5% significance level with the Breusch-Pagan on the equivalent OLS regression. While regression (i) fails to reject homoscedasticity with p-value 0.16, we still use weighted least squares for this regression due to the marginal significance of the test and the limited drawbacks to weighted least squares. Results for regression (i) do not differ substantially from an OLS regression.

**Table 4 – Weighted Least Squares Regression Results for Attendance**

| Dependent Variable | (i) Attendance % | (ii) Attendance # | (iii) Absences # |
|---|---|---|---|
| 1. *(Intercept)* | **0.506***** | **6.63***** | **10.7***** |
| | (7.47) | (4.07) | (6.42) |
| 2. Triweekly sessions | -0.0578 | **8.05***** | **3.72***** |
| | (-1.56) | (8.01) | (3.64) |
| 3. GPA | **0.113***** | **2.87***** | **-2.68***** |
| | (7.15) | (7.4) | (-6.72) |
| 4. History | -0.0184 | **4.51***** | **1.34*** |
| | (-0.567) | (6.16) | (1.77) |
| 5. History × Triweekly sections | 0.0802 | **4.38***** | -2.05 |
| | (1.36) | (2.64) | (-1.21) |
| *Other Controls* | | | |
| 6. Sophomore | -0.0327 | -0.764 | 0.878 |
| | (-1.07) | (-1.03) | (1.15) |
| 7. Junior | **-0.0979***** | **-2.39***** | **2.67***** |
| | (-2.71) | (-2.78) | (3.02) |
| 8. Senior | -0.0386 | -0.66 | 1.0 |
| | (-0.809) | (-0.57) | (0.843) |
| 9. Gender | 0.0357 | 0.824 | -0.929 |
| | (1.41) | (1.34) | (-1.47) |
| 10. Age | 0.0015 | 0.0372 | -0.0375 |
| | (0.786) | (0.803) | (-0.788) |
| Adj-$R^2$ | 0.266 | 0.597 | 0.296 |
| F | 7.61 | 28 | 8.67 |
| d.f. | 155 | 155 | 155 |

*$p < 0.1$; **$p<0.05$; *** $<0.01$; t-statistics in parentheses.

Regression (ii) in Table 4 uses the number of class meetings attended as the dependent variable. Here the coefficient on triweekly sessions (coefficient 2) is positive and significant. A course that meets triweekly results in students attending approximately eight more class meetings than one that meets biweekly. This is consistent with a triweekly meeting schedule having more class meetings but retaining a similar proportion of class meetings attended compared to a biweekly schedule. Consistent with regression (i), there is a significant student quality effect and a hypothetical student with a one point increase in career GPA attends an additional 3 class meetings in the course. Unlike regression (i), there is now a significant subject effect. Students in biweekly history course sections generally attend four to five additional class meetings than their economics course counterparts (coefficient 4). This effect is stronger for history sections that meet triweekly (coefficient 5) with these students attending a further additional four class

meetings. The remaining coefficients have a similar pattern of significance and magnitude as in regression (i).

Finally, regression (iii) uses the number of absences from regular class meetings as the dependent variable. There is again a significant triweekly meeting effect (coefficient 2). Students attending on a triweekly meeting schedule miss approximately four additional class meetings during the semester. There is also a significant subject effect with students in history course sections having just over one additional absence then their economics course counterparts, but unlike (ii) course meeting frequency does not substantially alter this subject effect. The other significant coefficients, on GPA and Junior, are similar in magnitude to (ii) but with an appropriately reversed sign. While regression (iii) may appear redundant with regression (ii), it is not. Regression (ii) shows that students attend a greater number of class meetings in a biweekly class, however this information alone is not sufficient to conclude whether the number of absences is also statistically different. Regression (iii) confirms that a triweekly class meeting frequency does indeed result in a statistically significant increase in absences of about four.

The results in Table 4 suggest that offering a section that meets three times per week instead of two does not significantly affect the proportion of class meetings students attend. However, consequently, it will affect the total number of class meetings students attend as well as the total number of class absences. Student quality, as measured by career GPA, is a significant factor in all three regressions and increases student attendance and subsequently decreases absences. The course subject affects the number of class meetings attended but not the percent of meetings attended. Non-freshmen generally attend fewer class meetings and have more absences; however, this effect is only significant for juniors.

These results suggest that there is a trade-off in attendance between biweekly and triweekly meeting frequencies. In terms of the attendance rate, measured by proportion of class meetings attended, both biweekly and triweekly schedules are similar. However, triweekly class schedules result in both a larger number of total class meetings attended as well as total class absences. Thus, if an instructor's priority is to minimize the absolute number of class absences, for example in a discussion-based class where a more consistent level of student presence may be important, then a biweekly format achieves a lower absolute number of class absences. On the other hand, if a greater number of class meetings attended is desirable, say in a section taught according to the principles of a "flipped" classroom or in an independent projects-based class where a greater number of opportunities to interact with the instructor is important, then a triweekly schedule may serve better.

*Determinants of Performance*

In this section, we consider two potential mechanisms through which the frequency of class meetings may affect student course performance. The first mechanism is an indirect effect through attendance and absences. In the summary of data section, we showed that the pattern of total attendance and total absences differs between biweekly and triweekly meeting schedules. Differences in attendance and absences may indirectly explain potential differences in course performance. While the same proportion of class meetings attended in triweekly and biweekly schedules means students are likely to be exposed to the same proportions of course material, under a triweekly schedule this means students attend a larger absolute number of class meetings and may have more opportunities to ask questions and interact with the instructor.

The second mechanism is a direct effect that results from class meeting frequency itself. There is evidence that student performance is better in more frequent and shorter sessions (Devadoss and Foltz 1996; Reardon, Leierer and Lee 2012) potentially in part due to a spacing effect (Dempster 1989, Budé et al 2011). By controlling for differences in attendance as well as student quality and other student characteristics, it is possible to separate and measure this direct effect from the indirect effect.

Our identification strategy is again weighted least squares regressions as outlined in the empirical methods section, using weights reflecting the heteroscedasticity introduced by course meeting frequency.[7] The original OLS regressions on which homoscedasticity tests were performed and from which weights were constructed can be found in the appendix. Table 5 presents the main regression results with two different measures of attendance. Regressions (i) and (ii) use the proportion of class meetings attended as the primary explanatory variable while regressions (iii) and (iv) use total number of class meetings attended instead. The effect of class absences is captured in the second set of regressions as an additional class absence is equivalent to one less class meeting attended. Regressions (i) and (iii) provide baseline results without controlling for course meeting frequency. Regressions (ii) and (iv) are the main regressions of interest and control for course meeting frequency. All four regressions in Table 5 show that student quality (as measured by career GPA) consistently has a positive and significant effect on course performance (coefficient 3). A hypothetical one-point increase in career GPA results in an approximate 7.5 percentage point increase in total course performance. All four regressions show that attendance (measured in different ways) also consistently has a significant and positive effect on course performance (coefficients 4 and 6). To investigate both the indirect effect of course meeting frequency, as it operates through attendance, and the direct effect of course meeting frequency on performance, let us begin by focusing on regression (ii).

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[7] For all four regressions in Table 5 we can reject the assumption of homoscedasticity at the 1% significance level with the Breusch-Pagan on the equivalent OLS regression.

**Table 5 – Weighted Least Squares Regression Results for Course Performance**

| | **Total Course Score % as Dependent Variable** | | | |
|---|---|---|---|---|
| | (i) | (ii) | (iii) | (iv) |
| 1. *(Intercept)* | **0.486***** | **0.379***** | **0.495***** | **0.41***** |
| | (11.7) | (5.83) | (13.1) | (6.99) |
| 2. Triweekly sections | - | **0.145**** | - | 0.0997 |
| | | (2.04) | | (1.63) |
| 3. GPA | **0.076***** | **0.075***** | **0.078***** | **0.0722***** |
| | (6.89) | (6.88) | (7.76) | (6.54) |
| 4. Attendance (%) | **0.105**** | **0.213***** | - | - |
| | (2.33) | (2.79) | | |
| 5. Attendance (%) × Triweekly sections | - | **-0.141*** | - | - |
| | | (-1.66) | | |
| 6. Attendance (N) | - | - | **0.00332***** | **0.00956***** |
| | | | (3.02) | (2.95) |
| 7. Attendance (N) × Triweekly sections | - | - | - | **-0.00621*** |
| | | | | (-1.96) |
| 8. History | 0.0228 | **0.0361**** | 0.0136 | 0.000898 |
| | (1.46) | (2.21) | (0.86) | (0.0458) |
| *Other Controls* | | | | |
| 9. Sophomore | -0.024 | -0.022 | -0.02 | -0.021 |
| | (-1.3) | (-1.2) | (-1.1) | (-1.2) |
| 10. Junior | -0.00015 | 0.0081 | 0.0081 | 0.011 |
| | (-0.0063) | (0.34) | (0.34) | (0.45) |
| 11. Senior | 0.021 | 0.021 | 0.025 | 0.015 |
| | (0.74) | (0.76) | (0.89) | (0.54) |
| 12. Gender | 0.0057 | 0.0016 | 0.0042 | 0.0018 |
| | (0.37) | (0.11) | (0.27) | (0.12) |
| 13. Age | 0.00043 | 0.00032 | 0.00034 | 0.00048 |
| | (0.38) | (0.28) | (0.3) | (0.43) |
| Adj-$R^2$ | 0.386 | 0.402 | 0.404 | 0.406 |
| F | 13.9 | 12 | 14.9 | 12.2 |
| d.f. | 156 | 154 | 156 | 154 |

$*p < 0.1$; $**p<0.05$; $*** <0.01$; t-statistics in parentheses.

We first consider the indirect effect of course meeting frequency on total course score, as it operates through attendance. When controlling for course meeting frequency, attending an additional 20% of all course meetings in a biweekly course increases total course performance by

about 4.3 percentage points (coefficient 4).[8] For a triweekly meeting schedule, the same additional 20% attendance increases total course performance by only 1.4 percentage points (coefficients 4 and 5), which means that the value of attendance in a triweekly course is about one third. This suggests that there exists a significant and positive relationship between the proportion of class meetings attended and course performance, and this relationship is weaker for courses that meet triweekly.

Regression (ii) also has a significant subject effect (coefficient 8): students in history course sections tend to earn a total course score 3.6 percentage points higher than those in economics course sections. The coefficients for the remaining controls suggest that juniors and seniors have better course performance than freshman and sophomores (coefficients 9-11) and that female and older students also perform better (coefficients 12 and 13); however, none of these estimates is statistically significant.

Finally, the direct effect of course meeting frequency is captured by coefficient 2, which is significant and positive. After controlling for the indirect effect on course score from changes in attendance, the quality of students, as well as other student characteristics, the direct effect of a triweekly class meeting frequency compared to a biweekly class meeting frequency on total course score is 14.5 percentage points (coefficient 2). That is, students in sections meeting on a triweekly frequency should be expected to score significantly higher than their peers in a biweekly section provided both student attendance and the value of attendance remains the same. To control for the differences in both attendance rates and the implied value of attendance on a triweekly meeting frequency, it is possible to combine coefficient 2 with coefficient 5 (evaluated at the average attendance rate for triweekly sections) to find that the net effect of a triweekly meeting frequency on student performance is approximately a 3.2 percentage point increase in total course score.

In regression (iv), attendance is measured as the total number of class meetings attended. We again begin by considering the indirect effect of course meeting frequency on total course score, as it operates through attendance. The results are similar to (ii). In a biweekly course, attending an additional five course meetings, or an approximate additional 20%, increases total course performance by about 4.8 percentage points (coefficient 6). For a triweekly meeting schedule, the value of attendance is about half to one third and attending the same additional 5 course meetings increases total course performance by only 1.7 percentage points (coefficients 6 and 7). The rest of the estimates are similar to regression (ii) except that the subject control for history course sections is no longer significant.

The direct effect of a triweekly meeting schedule (coefficient 2) is smaller than in regression (ii) but not significant at the 10% level. The p-value associated with the estimate for coefficient 2 is 0.1061 or slightly above the 10% level of significance. This estimate does become significant at the 10% level when dropping some of the non-significant controls (such as the rank controls). This borderline significance may suggest that we are reaching the level of identification possible with our sample size. While the direct effect is not statistically significant at the 10% level, the estimate for coefficient 2 implies that after controlling for the indirect effect of meeting frequency through attendance on course score, for the quality of the student, as well as other student controls, the direct effect of a triweekly class meeting frequency compared to a biweekly class meeting frequency is 10 percentage points, provided both student attendance and

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[8] If this effect appears small, recall that total course score is excluding any graded attendance components. The increase in total course score with attendance, which was a graded component in every course section in our data, would be larger.

the value of attendance remains the same. As in regression (ii), to control for the differences in both attendance rates and the implied value of attendance on a triweekly meeting frequency, combine coefficient 2 with coefficient 5 (evaluated at the average attendance for triweekly sections) to find that the net effect of a triweekly meeting frequency on student performance is approximately a 9.3 percentage point increase in total course score.

The estimates in regression (iv) also makes it possible to consider the effect of absences (i.e. attending fewer course meetings) on course performance. For a course that meets biweekly, the effect of missing one additional class meeting on total course score is a decrease of one percentage point (coefficient 6). For a course that meets triweekly, missing one additional class meeting decreases total course score by just 0.33 percentage points (coefficients 6 and 7). Thus, the larger number of class meetings on a triweekly schedule mitigates the effect of each class absence by two thirds.

There are two main conclusions that can be drawn from the regressions in Table 5. First, that offering a course on a triweekly schedule instead of a biweekly schedule decreases the benefit of attending (or the cost of being absent from) an individual class meeting by as much as two thirds. As a result, while the proportion of class meetings attended remains the same, students attend more course meetings as well as have more absences. This finding is consistent with the results of previous studies on the subject such as Romer (1993), Devadoss and Foltz (1996), and Credé, Roch and Kieszczynka (2010).

The second conclusion is that there is a significant direct effect to offering a course on a triweekly instead of a biweekly schedule. When controlling for the indirect effect discussed above, as well as student quality and other student characteristics, scheduling a course on a triweekly meeting frequency directly results in a 10 to 15 percentage point increase in total course scores. While by itself this increase appears substantial, it is in part offset by the indirect effect as attendance patterns change in a section meeting on a triweekly schedule. Controlling for how a triweekly meeting frequency also changes the pattern and benefits of attendance, the combined overall effect of scheduling a course on a triweekly schedule is approximately a 3 to 9 percentage point increase in total course score.

## Conclusion

In this study, we use an interdisciplinary dataset including total course scores and instructor-observed attendance information for introductory courses in economics and history taught on both biweekly and triweekly meeting frequencies and collected over a period of three calendar years. While the ideal experimental design would allow for the random assignment of students to class meeting frequencies, unfortunately this is generally not possible in a college environment. Despite this, there are reasons to believe any selection issues introduced are relatively minimal[9] and the results are robust. We find a number of significant effects of biweekly and triweekly scheduling on student attendance and performance.

First, triweekly scheduling does not have a significant effect on the proportion of class meetings attended, but does increase the number of missed classes by about two to three and reduces the consistency of attendance. When a third class meeting is added on a Friday, this class meeting is more likely to be missed by students than the first two of the week. Instructors scheduling important discussions or projects on Fridays should be aware of this difference.

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[9] See the summary of data section for details on selection issues.

Second, attendance has a significant and positive effect on total course score. Higher attendance rates (or a lower number of class absences) improve total course score. This finding is consistent with the literature in Credé, Roch and Kieszczynka (2010), Durden and Garey (1995), and others.

Third, meeting on a triweekly schedule improves student performance, but this effect operates through two mechanisms. The first mechanism operates indirectly through attendance. Meeting on a triweekly schedule changes the pattern of attendance. When there are a larger number of class meetings, the cost, both real and perceived, of missing a class is lower and students have more total absences. The relative value of attendance is roughly half in a section meeting on a triweekly frequency compared to one meeting biweekly.

The second mechanism operates directly from the class meeting frequency. Controlling for the indirect effect mentioned above as well as other factors, a class meeting on a triweekly schedule directly increases student course scores substantially. The matter is complicated as the estimate of this second mechanism is just above the 10% significance level (p-value 0.1061) when attendance is measured in terms of the number course meetings attended, as opposed to the proportion of course meetings attended. The marginal nature of the significance of this particular estimate is a result of the sample size. Taken together, the regression results suggest that scheduling a course on a triweekly meeting schedule results in a direct increase of total student scores by as much as 10 to 15 percentage points, provided attendance remains the same. While this overall increase is large, it is partially offset by the indirect effect discussed above. When controlling for differences in attendance as a result of course meeting frequency, the combined effect of a triweekly meeting schedule on student performance is a 3 to 9 percentage point increase in total course score.

The main conclusion from these results is that a triweekly schedule has an overall positive effect on student performance. Total course scores tend to be higher and with lower variation in triweekly sections compared with biweekly sections. While attendance rates in sections meeting on triweekly and biweekly schedules are very similar, the additional number of class meetings in a triweekly schedule contributes to more class absences. If the primary concern of an instructor is to maintain a high attendance rate, there is little difference between a triweekly and biweekly schedule and a triweekly schedule may contribute to higher student performance. If, however, the primary concern of an instructor is to minimize the number of class absences and maintain consistent attendance from meeting to meeting then a biweekly schedule is more likely to achieve this goal. For example, if the course is primarily based on discussions or project work in class, a biweekly schedule may be preferred to decrease total number of absences.

One application of the relationship between course meeting frequency and student attendance and performance is to help instructors better tailor the frequency of class meetings to the method of instruction. For example, in a more traditional course, based primarily on lecture or discussion, a biweekly schedule may be better suited to discouraging students from missing class sections. On the other hand, a course taught along the principles of a "flipped" classroom might be better suited to a triweekly schedule, in which the consequences of missing an individual class may be less severe, and resources outside the classroom more plentiful. If neither issue strikes an instructor as important and all other considerations are equal, then a triweekly schedule should be favored because of the potential boost to student learning and performance.

In the future, we hope to extend these results in several ways. First, one area in which we hope to expand is in sample size, which we believe is currently limiting the significance of some of our results. Unfortunately, since these data were collected, the use of courses that meet on a

triweekly schedule on our campus has been reduced for administrative reasons, which makes collecting additional data difficult. Another approach to increasing our sample size would be to treat observations in our existing data at the assignment or exam level rather than the course section-student level. This modification would increase our sample size and allow us to use fixed effects panel estimation to determine if the effect of absenteeism leading up to an exam is different by class meeting frequency.

A second extension we would like to investigate in the future is the effect of other course meeting schedules besides biweekly and triweekly. We have both taught these same courses in several other formats including once-weekly meetings and as 100% online courses. While these offerings are currently infrequent with few observations, in the future it may be possible to expand our results to include a larger variety of scheduling formats.

## Appendix

The data used in this study were collected primarily by the authors from their own courses taught in the semesters between the fall of 2013 and the spring of 2015 at Indiana University Northwest. Course collected data was then augmented from student records provided by the Office of the Registrar at Indiana University Northwest.

The following two tables show the results of the ordinary least squares regressions used to test for heteroscedasticity and for constructing the weights used in the weighted least squares regressions shown in Table 4 and Table 5. Correcting for this heteroscedasticity does decrease both the magnitudes and significance of most estimates but does not alter the fundamental conclusions.

## Appendix 1. Table 6 – Ordinary Least Squares Regression Results for Attendance

| | | (i) | (ii) | (iii) |
|---|---|---|---|---|
| Dependent Variable | | *Attendance %* | *Attendance #* | *Absences #* |
| 1. | *(Intercept)* | **0.503*** | **5.8*** | **11.9*** |
| | | (7.01) | (2.9) | (5.84) |
| 2. | Triweekly sessions | -0.0579 | **8.12*** | **3.64*** |
| | | (-1.53) | (7.71) | (3.4) |
| 3. | GPA | **0.119*** | **3.36*** | **-3.22*** |
| | | (7.22) | (7.35) | (-6.9) |
| 4. | History | -0.0174 | **4.67*** | 1.17 |
| | | (-0.465) | (4.49) | (1.1) |
| 5. | History × Triweekly sections | 0.0778 | **4.14** | -1.73 |
| | | (1.36) | (2.6) | (-1.07) |
| *Other Controls* | | | | |
| 6. | Sophomore | -0.0417 | -1.15 | 1.44 |
| | | (-1.32) | (-1.32) | (1.6) |
| 7. | Junior | **-0.109*** | **-3.03*** | **3.5*** |
| | | (-2.82) | (-2.81) | (3.19) |
| 8. | Senior | -0.0452 | -1.08 | 1.54 |
| | | (-0.907) | (-0.78) | (1.09) |
| 9. | Gender | 0.0333 | 0.738 | -0.833 |
| | | (1.26) | (1) | (-1.11) |
| 10. | Age | 0.00134 | 0.0274 | -0.041 |
| | | (0.675) | (0.495) | (-0.727) |
| Adj-$R^2$ | | 0.271 | 0.617 | 0.293 |
| F | | 7.77 | 30.3 | 8.54 |
| d.f. | | 155 | 155 | 155 |

$*p < 0.1$; $**p<0.05$; $*** <0.01$; t-statistics in parentheses.

## Appendix 2. Table 7 – Ordinary Least Squares Regression Results for Course Performance

*Total Course Score % as Dependent Variable*

| | | (i) | (ii) | (iii) | (iv) |
|---|---|---|---|---|---|
| 1. | *(Intercept)* | **0.476*** (10.8) | **0.382*** (6.26) | **0.494*** (12.3) | **0.413*** (7.48) |
| 2. | Triweekly sections | - | **0.147** (2.1) | - | **0.101*** (1.66) |
| 3. | GPA | **0.0705*** (6.14) | **0.0697*** (6.14) | **0.0745*** (7.13) | **0.0667*** (5.82) |
| 4. | Attendance (%) | **0.132*** (2.74) | **0.228*** (3.21) | - | - |
| 5. | Attendance (%) × Triweekly sections | - | **-0.143*** (-1.71) | - | - |
| 6. | Attendance (N) | - | - | **0.00381*** (3.21) | **0.0105*** (3.43) |
| 7. | Attendance (N) × Triweekly sections | - | - | - | **-0.00664** (-2.18) |
| 8. | History | 0.0223 (1.39) | **0.0364** (2.16) | 0.0131 (0.803) | -0.00508 (-0.253) |
| *Other Controls* | | | | | |
| 9. | Sophomore | -0.02 (-1) | -0.018 (-0.97) | -0.015 (-0.79) | -0.018 (-0.93) |
| 10. | Junior | 0.0018 (0.077) | 0.0096 (0.4) | 0.0093 (0.39) | 0.012 (0.53) |
| 11. | Senior | 0.014 (0.48) | 0.013 (0.44) | 0.016 (0.53) | 0.007 (0.24) |
| 12. | Gender | 0.0073 (0.45) | 0.0031 (0.19) | 0.0066 (0.41) | 0.0031 (0.2) |
| 13. | Age | 0.00034 (0.28) | 0.00026 (0.22) | 0.00029 (0.24) | 0.00041 (0.35) |
| Adj-$R^2$ | | 0.352 | 0.37 | 0.363 | 0.378 |
| F | | 12.2 | 10.6 | 12.7 | 10.9 |
| d.f. | | 156 | 154 | 156 | 154 |

$*p < 0.1$; $**p<0.05$; $*** <0.01$; t-statistics in parentheses.

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