You May be Able to Teach Early Classes, but Students May Not be Awake Yet!

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Abstract

Academic success of first-year students is one of the primary concerns of higher education institutes. A factor that may influence students' success in a course and has been ignored is the effect of time of class on students' performance. The goal of this study is to investigate the relationship between class time and students' performance in a course to verify whether or not students enrolled in early morning sections have lower performance compared to those who enrolled in sections that meet at other times of the day. The research team analyzed students' attendance and performance in a course with an enrollment of 1651 students spread across 15 different sections. Early morning sections and one late Friday section performed significantly lower than the other sections. However, one of the early morning sections showed similar behavior to the non-early morning sections, which is likely due to this section instructor's teaching style.

I. Introduction

Academic success of first-year students is one of the primary concerns of higher education institutes. A large number of research studies have investigated a variety of factors that influence first-year academic success such as demographics[1], high school performance[2], family status[3], financial status[4], health status[5], social support[6], and individual beliefs[7], abilities[8], and habits[9]. A factor that may influence students' success in a course, and which has been largely ignored in the research literature, is the effect of time of class. Prior research on sleep habits of college students indicates that over 20% of college students have poor sleep quality and over half feel tired in the morning [10,11]. In addition, anecdotal evidence indicates students in early morning classes have lower performance than those at other times of the day, yet systematic research is scarce.

More attention has been paid to start time of schools and academic performance of K-12 students than college students. In a review study, Wolfson and Craskadon [12] relate early school start time to daytime sleepiness, attention problems, and poor academic performance. In addition, they conclude an early school start time has a negative relation to sleep duration and quality [12]. Furthermore, the results of a meta-analysis study reveals that sleep duration and sleepiness have a significant negative relation to school performance [13]. Another review study also concludes that students' sleep duration and quality is related to students' academic performance and learning capacity [14].

Chronotype, a biological attribute of human beings, reflecting the time of the day their functions are active or reach a certain level and its relationship to preferred time to wake up, study, retire, etc. is well studied [15]. Individuals vary from extremely early types to extremely late types [16, 17]. Early chronotype individuals tend to get up early in the morning and have difficulty staying up late at night. On the contrary, late chronotype individuals tend to get up late in the morning (or afternoon) and sleep late at night (or early morning) and have difficulty getting up early in the morning.

Most individuals fall into late chronotypes, from moderate to extreme [17]. In addition, adolescents tend to be later types than other age groups [17]. Recent research on chronotype shows that the majority of college students fall into late types [18], which results in students' attention problems and tendency to fall asleep in morning classes [19]. Thus, it would not be surprising to have low functioning students in early morning classes.

Unlike K-12 students, college students are – within constraints (e.g., conflicts with other courses, preferred sections filling up very quickly, and the overall course schedule) – able to choose their preferred sections for multi-section courses. In online learning courses, where students have more autonomy over their study schedule, there is a strong correlation between chronotypes and students' preferred time to do online learning [18, 20]. Since the majority of students in these studies fell into late chronotypes, students access online learning material and join discussions more often later in the day compared to early mornings. That – given the choice to access material later in the day, students will – additionally suggests that early morning classes are not students preferred time of class.

II. Research Purpose and Questions

Anecdotal evidence indicates early morning sections of a course are the least favorite sections for students, and students in these sections have lower performance than other times of the day. The goal of this study is to investigate the relationship between class time and students' performance in a course to verify this hypothesis by asking the following questions:

- Do students prefer later sections in the day than early morning sections of a course?
- Do students' attendance and final grades differ significantly in early morning sections than other sections of a course?

III. Methods

A. Participants and Settings

Participants were the 1651 first-year engineering (FYE) students enrolled in ENGR 132 in Spring 2012. ENGR 132, Transforming Ideas to Innovation II, is a required second semester, 2-credit hour course for all FYE students. In this course, students learn how to use computer tools to solve fundamental engineering problems, how to make evidence-based engineering decisions, develop problem-solving, modeling, and design skills, and develop teaming and communication skills. The students were enrolled in 15 sections run over four days. Each section had a maximum capacity of 120 students. Sections met every two hours starting from 7:30 am and ending at 5:20 pm (Table 1). Students in each section met twice a week at the same time.

Table 1 – Time and days of sections

	7:30-9:20am	**9:30-11:20am**	**11:30am-1:20pm**	**1:30-3:20pm**	**3:30-5:20pm**
Tuesday Thursday	7:30 Tu/Th a 7:30 Tu/Th b	9:30 Tu/Th a 9:30 Tu/Th b	11:30 Tu/Th a 11:30 Tu/Th b	1:30 Tu/Th a 1:30 Tu/Th b	3:30 Tu/Th a 3:30 Tu/Th b
Wednesday Friday	7:30 W/F	9:30 W/F	11:30 W/F	1:30 W/F	3:30 W/F

The thirteen instructors who taught the 15 sections of the course had different levels of experience with the FYE program and the course (Table 2). Eight of these instructors taught ENGR 131 course in the previous Fall semester, which is the prerequisite course for ENGR 132.

Table 2 - Instructors' experience
(High: 6 or more semesters; Medium: 3-5 semesters; Low: 1-2 semesters)

Section	FYE Teaching Experience	ENGR 132 Experience (Instructor, TA, Development Team)	FYE Related Teaching Award	Percent of Students from ENGR 131
7:30 Tu/Th a	High	High	Yes	NA
7:30 Tu/Th b	High	High	Yes	22%
7:30 W/F	Low	High	Yes	12% (Drawing from 2 sections as TA)
9:30 Tu/Th a	Low	Low	No	NA
9:30 Tu/Th b	Low	None	No	15%
9:30 W/F	Same as 7:30 W/F			24% (Drawing from 2 sections as TA)
11:30 Tu/Th a	High	Medium	No	12%
11:30 Tu/Th b	High	High	Yes	20%
11:30 W/F	Low	Low	Yes	NA
1:30 Tu/Th a*	Low	None	No	23% (Drawing from 3 sections)
1:30 Tu/Th b	Medium	Low	No	NA
1:30 W/F	Same as 11:30 W/F			NA
3:30 Tu/Th a	Low	Medium	No	NA
3:30 Tu/Th b	Same as 9:30 Tu/Th b			10%
3:30 W/F	Low	None	No	4%

* This section had two instructors co-teaching the course.

Due to an emphasis on in-class and team activities, attendance was very important for this course. According to the course syllabus, the first three absences did not directly impact a student's grade; however, starting with the fourth absence, the student's grade was reduced by 5% for each unexcused absence.

B. Data and Analysis Plan

The data for this study were comprised of information on the number of students who enrolled in the course, number of students who withdrew from the course, students' attendance records, and students' final grades in the course. The number of students who enrolled in the course and withdrew from the course were used as an indicator of students' preference for each section. The average of students' final grades in each section was calculated as an indicator of students' performance in the course. Students' average grades in each section and average attendance records were tested using ANOVA to determine if there is a significant difference between sections. In both cases, the ANOVA test result was significant ($p < 0.001$). Based on these findings, Tukey's Honestly Significant Difference (HSD) test was conducted to identify whether or not the three early morning sections were significantly different than the other sections. During the analysis, the 3:30 W/F section was identified as being similar to the 7:30 sections, thus comparisons to this section were added to the results.

IV. Results and Discussion

A. Enrollments and Withdraws

Enrollment records show the 7:30 sections were far less preferred than other sections (Figure 1). With the exception of four sections, the three 7:30 sections and the 3:30 W/F section, all sections reached their full capacity of 120 students at the beginning of the semester. The three 7:30 sections had much lower enrollments than other sections. The 7:30 W/F section had the lowest enrollment.

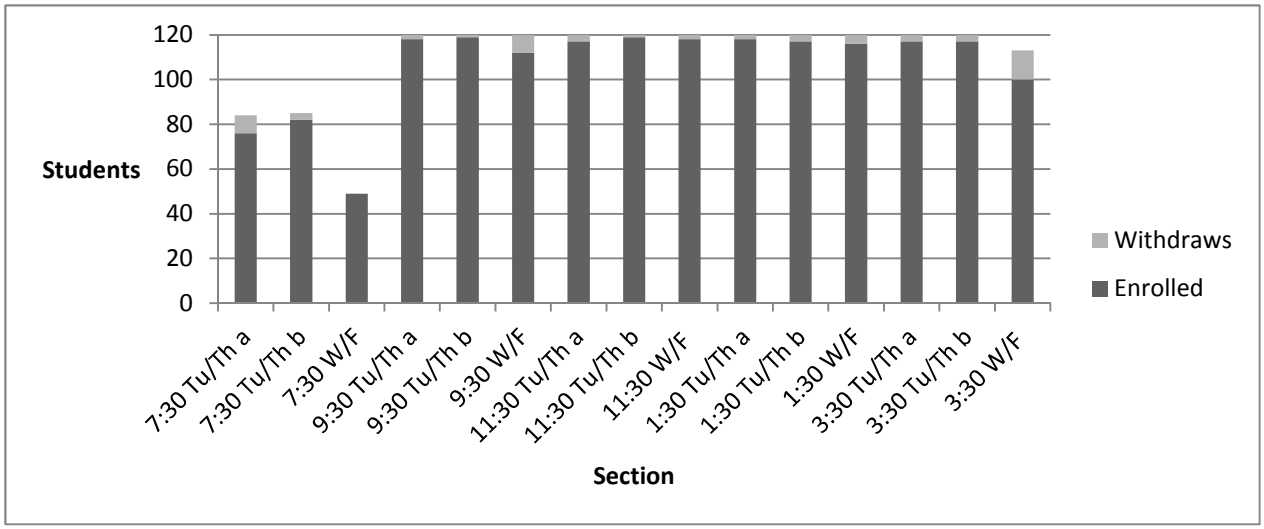

Figure 1 – Number of students enrolled in each section.

These results indicate that the time a section is offered is important in students' selection. In addition, the day a section is being offered is also important. While early morning classes are less preferred by students, a combination of Friday and 7:30 am seems to exacerbate this effect; the 7:30 W/F section had the lowest enrollment. In addition, the 3:30 W/F section, ending at 5:20 pm on Fridays, was the only afternoon section that did not reach the full 120 capacity at the beginning of the semester.

The 3:30 W/F section had the highest percentage of withdraws followed by the 7:30 Tu/Th a section (Figure 2). The number of withdraws in the 7:30 Tu/Th b section, which had the highest number of enrollments among the 7:30 sections, was low. The differences between the 7:30 sections' enrollments and withdraws might have been due to the instructors of these sections and their teaching style.

At the time of enrollment, instructors' names were posted for each section. While time of the section seems to be the most important factor, students' prior experience (from the ENGR 131 course) and assumptions about the instructors (given their name as posted on the course enrollment site) also may have played a role in low enrollments. Twenty two percent of students in the 7:30 Tu/Th b section, which had the highest enrollments among the 7:30 sections, had the same instructor in ENGR 131. This indicates positive prior experience with this instructor might have influenced students' decision. This instructor has high teaching experience as well as

experience with the course and received a teaching award. In addition, this was the only section offered by this instructor, thus students who wanted to take the course from that instructor, had no choice but to choose this 7:30 section.

Enrollments for the 7:30 W/F section were low. This instructor offered two sections, one 7:30 and one 9:30 section. Thus students who wanted to take the course with this instructor had two options. In these two sections, 36% of students had prior experience with the instructor, as their TA in ENGR 131. The enrollment in the 7:30 W/F section was much lower than the 9:30 W/F section. Since the instructor was the same for these two sections, the only factor that influenced students' decision was the section's time (and possibly other scheduling constraints). Despite low enrollments in the 7:30 W/F section, which partially might have been due to negative assumptions about this section's instructor, no one withdrew from this section, an indication that despite potential preliminary negative assumptions about this instructor, students felt confident enough to keep the course through the semester. In addition, students may have enjoyed the lower number of students in the section that results in more one-on-one interactions with the instructor and teaching assistants.

The 3:30 W/F section was the only afternoon section that did not reach the full capacity of 120 students and had the highest percentage of withdraws. The instructor of this section had low teaching experience and no experience with the course. In addition, only 4% of students who had ENGR 131 with this instructor took the course with him. Thus in addition to the section ending at 5:20 pm on Fridays, instructor may have also played a role in low enrollments and high withdrawals from the course.

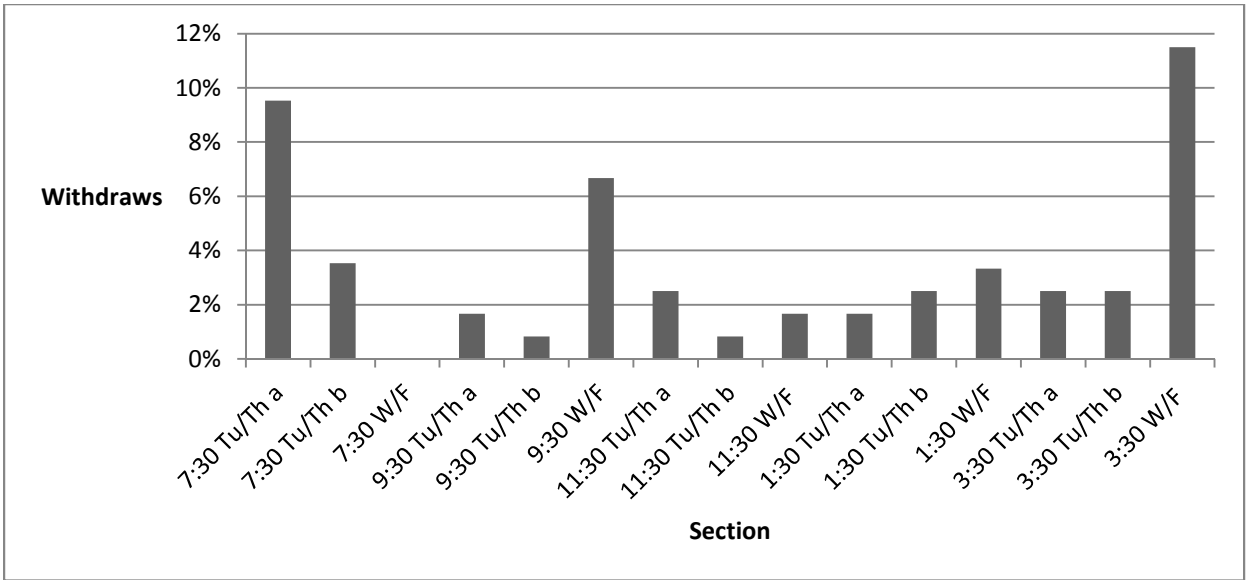

Figure 2 – Percentage of withdraws in each section.

B. Attendance

In total, attendance was recorded for 30 classes during the semester. The 7:30 sections as well as the 3:30 W/F section on average had the lowest number of recorded attendances (Figure 3). Among these sections, the 7:30 Tu/Th a section and the 7:30 W/F had a lower average followed

by the 3:30 W/F section. Attendance of the 7:30 Tu/Th b section was much higher than the other two 7:30 sections. Interestingly, the median of the 9:30 sections was also lower than the later sections in the day. The ANOVA showed significant differences ($p < 0.001$) between the attendance records of different sections. Tukey's HSD test was used to identify which sections were significantly different than the four low attendance sections (Table 3).

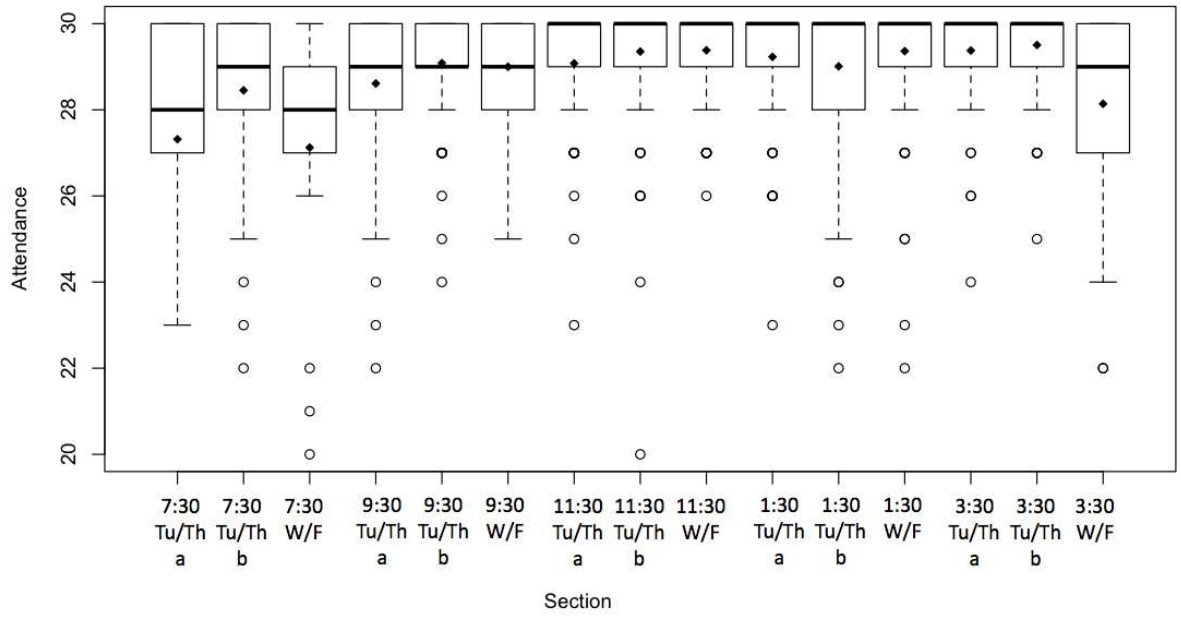

Figure 3 – Distribution and average of attendance for sections.
Horizontal lines indicates median and illustrates average of each section.

Table 3 – Significance level (*p* value) of attendance for the three 7:30 and the 3:30 W/F sections compared to other sections. Empty cells illustrate non-significant sections.

Section	$p <$ (7:30 Tu/Th a)	$p <$ (7:30 Tu/Th b)	$p <$ (7:30 W/F)	$p <$ (3:30 W/F)
7:30 Tu/Th a	----	0.001		
7:30 Tu/Th b	0.001	----	0.005	
7:30 W/F		0.005	----	
9:30 Tu/Th a	0.001		0.001	
9:30 Tu/Th b	0.001		0.001	0.05
9:30 W/F	0.001		0.001	0.05
11:30 Tu/Th a	0.001		0.001	0.05
11:30 Tu/Th b	0.001	0.05	0.001	0.001
11:30 W/F	0.001	0.05	0.001	0.001
1:30 Tu/Th a	0.001		0.001	0.005
1:30 Tu/Th b	0.001		0.001	0.05
1:30 W/F	0.001	0.05	0.001	0.001
3:30 Tu/Th a	0.001	0.05	0.001	0.001
3:30 Tu/Th b	0.001	0.01	0.001	0.001
3:30 W/F				----

The 7:30 Tu/Th a section had a significantly lower attendance average than all other sections except the 7:30 W/F and 3:30 W/F sections. Similarly, the 7:30 W/F section had a significantly

lower attendance record than all other sections except the 7:30 Tu/Th a and the 3:30 W/F sections. These results show the negative influence of 7:30 classes on students' attendance. Student's low attendance in 7:30 sections is likely linked to students' chronotypes. The majority of students, who fall into late chronotypes, have a hard time waking up early in the morning, thus they are more likely to be late or miss the class. In addition, the 9:30 am sections also had lower median attendance than sections later in the day. This means students are more likely to miss the 9:30 classes than sections later in the day.

Interestingly, the 7:30 Tu/Th b section, which had the highest enrollment among the 7:30 sections, had a significantly better attendance record than the other 7:30 sections. However, it was still significantly lower than five of the other sections. The higher attendance record might be due to the instructor effect.

The 3:30 W/F section was very similar to the 7:30 sections, and had a significantly lower attendance record than all but the 7:30 sections and the 9:30 Tu/Th a section. Low attendance in the 3:30 W/F section might be caused by reasons other than chronotype. For example, students' who commute weekly to other cities may just skip the late Friday class to leave town early to avoid traffic on Friday afternoons.

C. Final Grade

The distribution and average final grade was calculated for each section (Figure 4). The 7:30 Tu/Th a, the 7:30 W/F, and the 3:30 W/F sections had the lowest average among all sections. ANOVA showed significant difference ($p < 0.001$) between the average final grades in different sections. Tukey's HSD test was used to identify which sections were significantly different than the early morning and late Wed/Fri sections (Table 4).

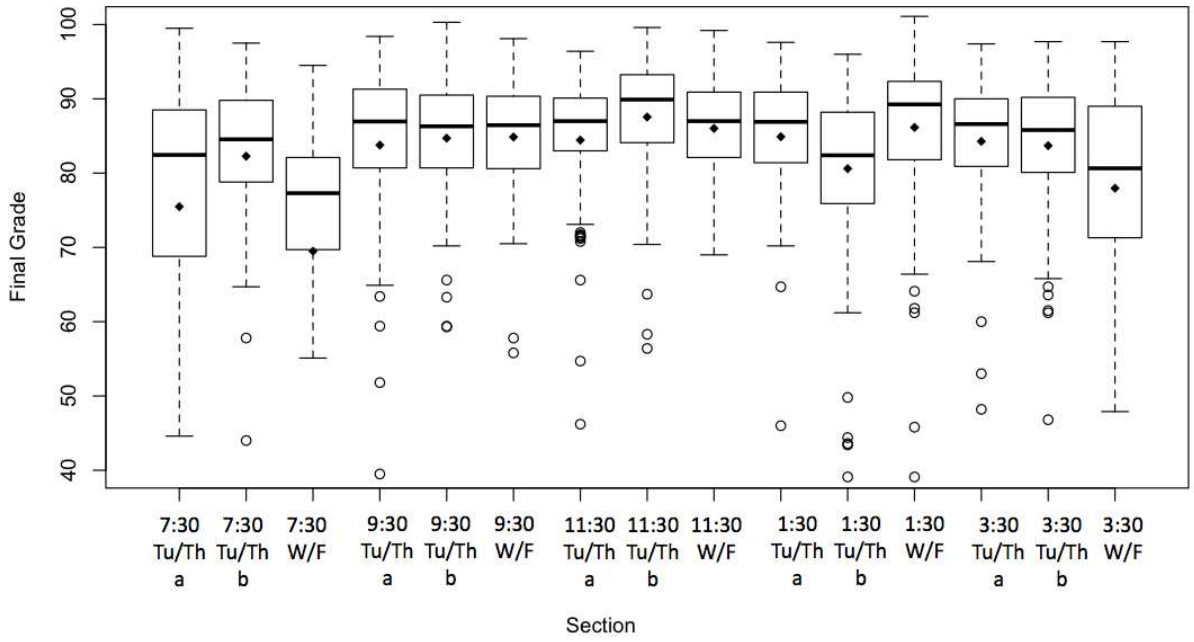

Figure 4 – Distribution and average of final grades for each section. Horizontal lines indicates median and illustrates average of each section.

Table 4 – Significance level (*p* value) of final grade for the three 7:30 and the 3:30 W/F sections compared to other sections. Empty cells illustrate non-significant sections.

Section	*p* < (7:30 Tu/Th a)	*p* < (7:30 Tu/Th b)	*p* < (7:30 W/F)	*p* < (3:30 W/F)
7:30 Tu/Th a	----	0.05		
7:30 Tu/Th b	0.05	----	0.001	
7:30 W/F		0.001	----	0.01
9:30 Tu/Th a	0.001		0.001	0.05
9:30 Tu/Th b	0.001		0.001	0.005
9:30 W/F	0.001		0.001	0.005
11:30 Tu/Th a	0.001		0.001	0.005
11:30 Tu/Th b	0.001		0.001	0.001
11:30 W/F	0.001		0.001	0.001
1:30 Tu/Th a	0.001		0.001	0.005
1:30 Tu/Th b			0.001	
1:30 W/F	0.001		0.001	0.001
3:30 Tu/Th a	0.001		0.001	0.05
3:30 Tu/Th b	0.001		0.001	0.05
3:30 W/F			0.01	----

The 7:30 Tu/Th a section had significantly lower final grade average than other sections except the 7:30 W/F, 3:30 W/F, 1:30 Tu/Th b sections. The 7:30 W/F section, which had the lowest final grade average, had significantly lower final grade average than the other sections except the 7:30 Tu/Th a section. Interestingly, this section had a significantly lower final grade average even than the 7:30 Tu/Th b and the 3:30 W/F sections. The 3:30 W/F section had a significantly lower final grade average than all sections except the two 7:30 Tu/Th sections and the 1:30 Tu/Th b section.

These results indicate the negative consequences of 7:30 sections as well as the 3:30 W/F section, though to a lesser extent, on students' performance in the course. Due to students' chronotypes, it is more likely to have low functioning students in the 7:30 classes. Missing more classes than the other sections also can exacerbate the problem for students in the 7:30 sections. While the students miss their 3:30 W/F section most likely for different reasons than their 7:30 sections, it also influences their performance.

Students in the 7:30 Tu/Th b section, which had higher enrollment and attendance among 7:30 sections, had a significantly higher final grade average compared to the other two 7:30 sections. This section was similar to other non-7:30 sections. As explained earlier, this might be to the instructor's teaching style.

V. Conclusion

A. Summary of Results

In summary, two of the three 7:30 sections had significantly lower attendance records and average final grades compared to later sections. In addition, fewer students enrolled in the 7:30 sections. The performance in the 3:30 W/F section (ending at 5:20 pm) showed similarly low student attendance and performance. These results illustrate an academic problem in students' performance in early morning and late Friday sections. However, this might be due to different reasons. Students' low performance in the 7:30 sections is likely linked to students'

chronotypes (i.e. low functioning students and more absences in the morning classes). Students' low performance in the 3:30 W/F section is probably due to other reasons such as leaving town early to avoid Friday afternoon traffic. In addition, one of the early morning sections had higher attendance and a better final grade average than the other early morning sections. This finding illustrates that there might be possible means to reduce the negative consequences of early morning sections, yet further research is needed to capture instructional differences.

B. Implications for Practice

One possible solution to reduce the effect of early morning and late Friday sections is to eliminate these sections and add sections in more preferred times/days for students. However, several constraints may make this infeasible. For example, resources like staff and available classroom space prevent institutions from eliminating the 7:30 sections. However, if administrators and course coordinators are aware of the negative consequences of early morning and late Friday sections on students' learning, they might be able to find solutions that work within their context.

While rescheduling the classes to eliminate early morning sections may not be possible, institutions can use strategies to reduce the negative educational consequences. Students in one of the early morning sections performed similar to the later sections and significantly better than the other early morning ones, which might be partially attributed to the instructor, who is known for a very engaging teaching style. Findings in class differences indicate that the instructor and the teaching style may reduce the negative results of early morning sections. Thus, identifying teaching strategies that could be helpful for early morning classes might be one solution.

C. Limitations

Despite the large sample size (more than 1600 students), there were only three 7:30 sections. This limits the generalizability of the findings. In addition, different sections had different instructors, which may have influenced the students' attendance and performance in the course. Furthermore, based on anecdotal evidence, students who enroll in early morning classes may have lower academic ability than the other sections, thus they had performed poorly.

D. Future work

To improve the generalizability of this research, in the next study we will increase the students' sample size from one semester (~1650) to three semesters (+5000). This will increase the number of early morning sections from three to nine, which can help differentiate these sections from later ones more clearly. In addition, we will investigate grade components (e.g., homework, exam, project) to identify where the differences in students' performance occur.

Comparing students' previous semester GPA or final grades in a previous course (e.g., ENGR 131) can clarify whether or not students with lower academic ability enroll in the morning sections or the lower performance is directly a result of taking the early morning section.

Identifying the instructors' teaching styles and other characteristics that may decrease the consequences of early morning sections is another way to continue this research. These teaching

styles and characteristics can be shared/promoted among faculty members (e.g., via professional development workshops).

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