Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #45767

BOARD #113: Circadian Rhythm and Sleep Effect on Undergraduate Engineering Students

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Circadian Rhythm and Sleep Effect on Undergraduate Construction and Engineering Students

Various non-educational factors impact the educational performance of students. While these factors span a broad spectrum, including social, cultural, economic, and other domains, sleep norms and routines account for a significant portion of the effect. Despite this, the importance of proper sleep norms is often overlooked. The physical resilience of students can also mask the issue. Thus, it is imperative to explore the impact of sleep habits and norms on construction and engineering students' performance and perceptions. This paper reports on the second phase of a study investigating the effects of circadian rhythm and sleep routines on students. In this phase, conducted in Fall 2023 and 2024, construction and engineering students were recruited to participate in the study at Mississippi State University. An instrument was developed to gather quantitative data, and statistical analysis was conducted to discern similarities and differences between students. While the major-based groups showed different response scores for impacting factors, the overarching results highlight a misalignment between sleep routines and students' educational activities. This paper also details similarities and differences among students from various majors. This research illuminates a relatively underexplored potential area for construction and engineering education, emphasizing the impact of proper sleep routines on student performance. It encourages education scholars and administrators to recognize the significance of healthy sleep in educational system planning and design.

Keywords: Engineering, Education, Sleep Routine, Circadian Rhythm, Performance

Introduction

Sleep deprivation is a common and widespread problem that affects both personal and professional life. Many people of different ages struggle with sleep issues and seek remedies through various means. These issues, however, are associated with a set of determinants, stimuli, and catalysts. Many of these factors are controllable to some extent, and individuals can cope with their sleep issues by managing them. These stimuli and catalysts are often neglected particularly during college years, as students may feel pressured by their educational responsibilities and physiologically capable of dealing with the consequences of sleep deprivation. Numerous studies have been conducted to investigate sleep issues among college students from different perspectives.

Construction students and professionals are among the groups prone to sleep issues; however, there is inadequate research focusing on construction students specifically. Therefore, a study concentrating on students' perceptions about different aspects of sleep requirements and effects was defined and developed at Mississippi State University. After finalizing the structure of the study, prior research was reviewed, and common themes and factors in sleep deprivation were extracted. A quantitative research methodology was employed to gather the data. Students from construction and engineering programs were recruited to participate in the study. This allowed a comparison between construction and engineering programs and highlighted similarities and differences between these two areas. The current paper reports on the results of data analysis of these two groups in the first phase of the study. The findings of this study contribute to the body

of knowledge by providing associations and patterns in students' perceptions about external stimuli that can be taken into account by educational administrators.

Literature Review

As the demand for modern-day college degrees increases, colleges are asking more students every year. This comes in the form of increased time commitments, greater effort required, and numerous sacrifices made. Among these sacrifices, one in particular stands out: sleep. Young adults in college are getting poorer sleep now than at any other time in history. With more young adults attending colleges than ever, trends among students have become more pronounced and easier to observe. A disturbing trend has been noticed: the quality of sleep amongst college students is vastly lower than that of the general population. At an urban midwestern university in the United States, research showed a staggering 60 percent of students participating in a sleep quality study were found to have poor sleep quality. This group also reported later bedtimes and rise times, as well as prescription drug use to alter sleep and wake times [1]. A 2018 study involving over 7,000 students across six different U.S. universities indicated a slight difference in sleep quality between genders. 64 percent of females in the study were defined as poor sleepers, compared to 57 percent of males [2]. Another similar U.S. study recorded that female students typically went to sleep and rose earlier, had longer sleep latency, and more awakenings than males [3]. Sleep quality, rise time, sleep efficiency, and time spent in bed were better among male students than female students. The sleep epidemic in colleges is not confined to the United States and has taken root worldwide. A study of 4,318 college students in Taiwan examined the prevalence of poor sleep among the group. The results were strikingly similar to those of the U.S. studies, with over 54 percent of students classified as poor sleepers. The study also revealed that poor sleep was significantly associated with being female, an undergraduate student, skipping breakfast, and having poor social support. These alarming statistics have garnered the attention of many researchers [4]. Factors such as gender, academic level, and lifestyle habits can help shed light on this issue and provide some much-needed clarification on the poor sleep quality that so many college students are facing today.

While college offers many opportunities for students to connect and have fun, it is also a very stressful environment. This can be attributed to factors such as heightened responsibility and a more challenging curriculum than students are accustomed to. Due to this environment, stress seems to be very prevalent among college attendees. Stress is a significant issue when it comes to the quality of sleep that students are getting. In a sample of 549 college students from 2018, sleep difficulties were largely associated with perceived stress [5]. Due to modern-day technology, students are constantly receiving assignments and due date reminders that keep them on edge and focused on school. This results in students seeing the creation of announcements and assignments even when they are trying to relax and enjoy their free time. Students feel like they cannot escape school no matter where they are is not conducive to quality sleep. While stress is a major issue among students, it is not the only factor affecting their sleep. Researchers have also investigated other contributing factors. A systematic review conducted by Pakpour et al. in 2020 found that addiction to the internet was highly associated with poor sleep and sleep disturbance [6]. This leads to staying up later and prolonged exposure to blue light, which can cause headaches and eye strain. To fight the urge to sleep, students are also using multiple forms of stimulants, including prescription drugs and energy drinks. Drugs are becoming more available

in college settings and are making a significant impact on the sleep that college attendees are getting. Stimulants increase sleep latency and worsen a person's ability to enter REM sleep. Research also suggests that students who use stimulant medications experience worse sleep quality than those without it [7].A study of 2,854 Thai college students in 2012 reported that approximately 50 percent of said students had poor sleep quality. The research also showed that a staggering 58 percent of those same students used some sort of stimulant drug or beverage [8]. This number is alarmingly high and certainly appears to be a significant contributor to the poor sleep quality among students. Although all these factors contribute to poor sleep in college students, research indicates that the effects of poor sleep may be even more troubling.

The lack of quality sleep among college attendees has become a serious problem in higher education. Students are underperforming in their studies and not realizing their potential. In 2010, a research group of 44 students participated in a study where half of the study group stayed awake for 24 hours. After this, the entire group tested their academic ability. The sleep-deprived group performed significantly worse than those who got sleep and rated their effort as higher [9]. Interestingly, the sleep-deprived group also rated their estimated performance higher than those who had slept. According to this research, sleep-deprived students are doing significantly worse than others while they are not even aware of it. Along with lower academic performance, students with poor sleep quality are also facing a higher risk of health issues. A literature review spanning from 1978-2016, which reviewed hundreds of sources on college students and sleep, reported that students have a heightened risk of stress, hypertension, weight gain, and diabetes [10]. These health issues can have a huge effect on somebody's life and cause many other problems to arise. Going through college is challenging for many people, and having to do it with health issues can make matters even worse. Research indicates that students with poor sleep quality also have a less robust social life than those who experienced quality sleep. This can lead to further problems. Loneliness, sadness, and depression can all arise from the lack of a social life [11]. All of these factors, paired with the fact that most college students are away from their family and support system, have the potential to spawn suicidal thoughts. A study of 1,700 college students conducted in 2018 yielded concerning results. Over four-fifths of the students who presented suicidal thoughts also met the criteria to be classified as poor sleepers [12]. This is a staggering number that needs to be addressed. While studies in the area of sleep issues in construction and engineering fields are limited, project-based work models of the construction industry and the high-intensity academic pressure in engineering may uniquely affect students' sleep patterns. Students are suffering in their daily lives because of the poor sleep they are getting. Young adults in college need to be educated on the consequences of poor sleep and the benefits of getting good quality sleep. This awareness could potentially improve their academic performance, health, social life, and overall well-being during their college years.

There are not many classes on the importance of sleep and how it pertains to the human body in modern-day colleges. However, some institutions are trying to educate students on this subject and are seeing encouraging results. The benefits of a quality night's sleep are irreplaceable and form the foundation for successful careers in all fields of work. In 2018, a midwestern university enrolled 254 students in a class to educate them on sleep and encourage more rest. This class spanned eight weeks and required students to increase their sleep duration by an hour and keep a nightly log. After eight weeks, the researchers overseeing the course observed lower depression on average, improved sleep behaviors, and higher sleep quality [13]. Such benefits set a platform

for all colleges to investigate the addition of a course on sleep education. College students are not known for making healthy lifestyle choices. Excessive drinking is extremely common among students in many major colleges, highlighting a need for better intervention strategies. An experimental online intervention class was sent out to a group of college students in 2017 to help combat alcohol abuse. This class comprised four modules completed in four weeks. In such a short time, this intervention was able to reduce drinking, report better sleep quality, and improve sleep-related impairment ratings [14]. The benefits of quality sleep cover a multitude of areas in a person's life. In addition to better mental health and reduced substance abuse, quality sleep also boosts cardiovascular health. A study published in 2020 researched healthy undergraduate students and the improvement of their cardiometabolic health. This study required students to start sleeping for one hour longer per night for a period of one week. While the study yielded better systolic blood pressure in the students, it also saw that over 60 percent of students increased their average sleep time by more than 30 minutes [15]. This statistic shows the large number of students that accepted the study and continued the routine. If colleges start incorporating sleep education into their curriculum, they will see a multitude of benefits. In summary, research indicates that most college students are poor sleepers. This is due to factors such as stress, stimulants, drug abuse, and internet addiction. All these factors are commonly found in colleges all over the world and pose a significant problem for college students' health. Due to the poor sleep students are getting, they are experiencing effects such as lower academic ability, a smaller social life, and depression. Colleges around the world need to recognize the positive results being achieved and implement sleep education programs of their own.

Methodology

The main research question in the study was to explore how students in construction and engineering majors perceive various factors or causal conditions impacting their sleep. While there were common themes and perceptions among students, two groups from construction and engineering programs were selected for participation to show similarities and differences. This approach helped highlight the status of the construction program.

After defining the structure of the study, a literature review was conducted to extract themes, factors, causal conditions, and effects of sleep issues. A survey was then designed and developed to explore a series of subjects and items related to the research objective. The study was reviewed and approved by the Institutional Review Board at Mississippi State University (IRB-21-418). In the next step, students from target programs were recruited and asked to participate in an online survey in Fall 2023-24. An asymptotic z-test for a single proportion (one-sample test) was conducted to determine the required sample size. The calculation used the following parameters: probability under the null hypothesis of 0.5, probability under the alternative hypothesis of 0.7, two-sided alpha level of 0.05, and desired power of 0.8. Based on these inputs, the required sample size was determined to be 47 subjects. This sample size ensures an 80% chance of detecting a true difference between the null and alternative hypotheses, with a 5% risk of a Type I error (false positive). It's worth noting that this calculation assumes an asymptotic approximation, which is generally appropriate for large sample sizes.

The obtained data was then collected, cleaned, and coded in a data model. Descriptive analysis was performed to show potential associations and frequencies among data parameters. A

common approach for quantification of perception was to use a five-level Likert scale (1: Very Low – 5: Very High). In addition to visualizing the magnitude of each level, an average score was used to compare questions in matrix format (factors impacting sleep deprivation and effects of sleepiness). The results were grouped by construction (CON) and engineering (ENG) groups. Also, to facilitate comparison between groups, a percentage measure was used.

Results

To better analyze the potential impact of the major, participants were categorized into two groups: Construction (CON) and Engineering (ENG). In the first phase of the study, conducted in Spring and Fall 2024, 155 students from construction programs and 53 students from engineering programs participated. The Construction group comprised 88% male and 12% female students, while these numbers in the Engineering group were 64% and 36%, respectively.

In the next section, the educational status of students was assessed. In the first question, students were asked to report their current GPA. Figure 1 shows the GPA comparison between the two groups. As shown, Engineering students reported a higher GPA than Construction students.

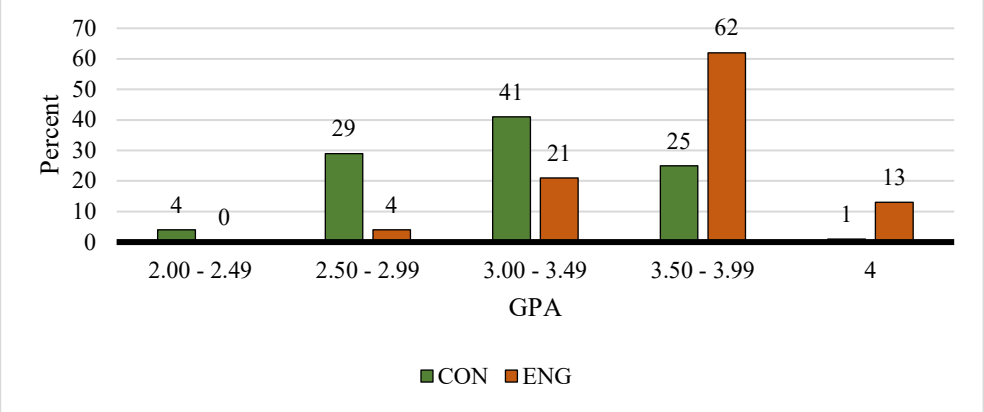

Figure 1. GPA comparison

In the next question, students reported their professional work experience in months. Five categories of work experience were provided. Figure 2 illustrates the percentage of students in each category for both groups.

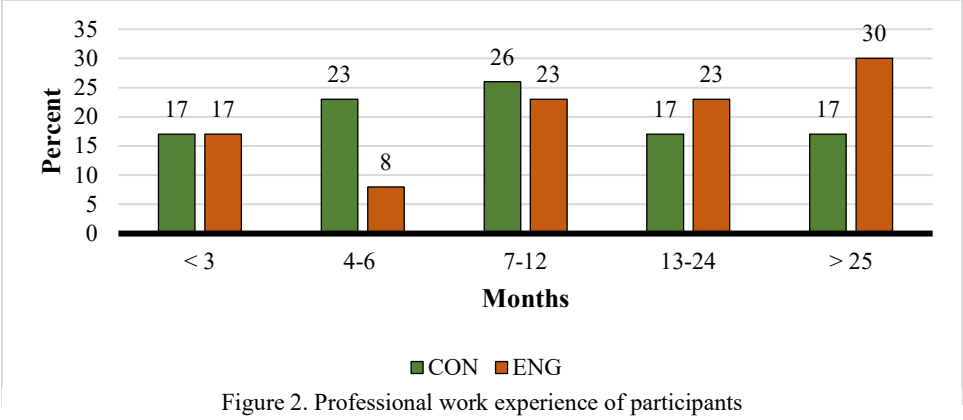

Figure 2. Professional work experience of participants

In the next question, students were asked how many hours they spend inside and outside class (total) for their courses per week, and five options were provided to select. Table 1 shows the percentage of each category.

Table 1. Study hours for both groups

Category	CON (%)	ENG (%)
< 12 hr	12	21
13-20 hr	36	28
21-28 hr	30	25
29-36 hr	17	17
37+ hr	5	9

In the next two questions, students were asked to specify their favorite and most efficient class time period during the day. Five intervals were provided for selection. The percentage of each interval for both groups is shown in Table 2. Interestingly, the 5-7 pm interval was the least favorite time for both groups.

Table 2. Preferred and efficient class time

Interval	Preferred		Efficient	
	CON (%)	ENG (%)	CON (%)	ENG (%)
8am - 10 am	32	28	28	25
10am - 12pm	59	42	57	57
1pm - 3pm	8	23	12	15
3pm - 5pm	1	8	3	2
5pm - 7pm	0	0	0	2

In the next two questions, participants were asked to specify in which time interval they preferred to have their Individual (e.g., reading, individual assignments, etc.) and Group learning activities (e.g., group assignments, interacting with your peers, etc.). Six four-hour intervals were provided for students to choose. Figures 3 and 4 show the percentage of each group in both situations.

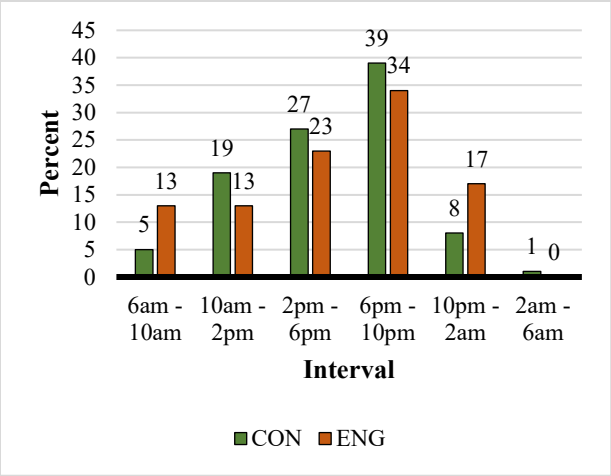

Figure 3. Individual learning time

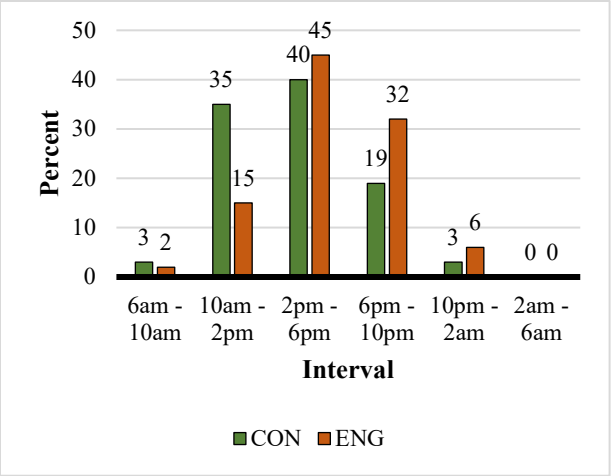

Figure 4. Group learning time

The next section of the survey explored the amount of sleep that students get during weekdays and weekends. Five options were provided to students, and they were asked to choose their sleep hours during working days and weekends. The percentage of each category in both groups and both situations is shown in Figures 5 and 6.

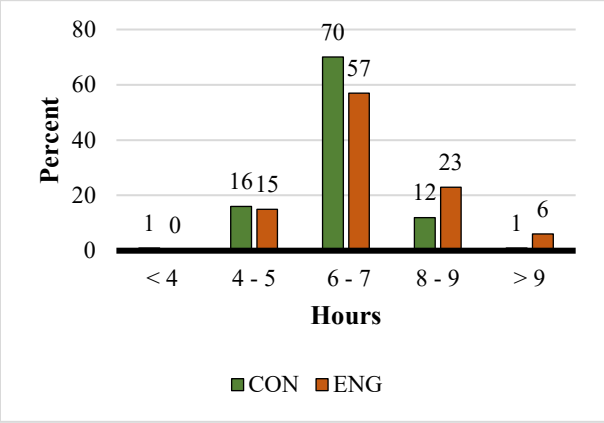

Figure 5. Sleep hours during working days

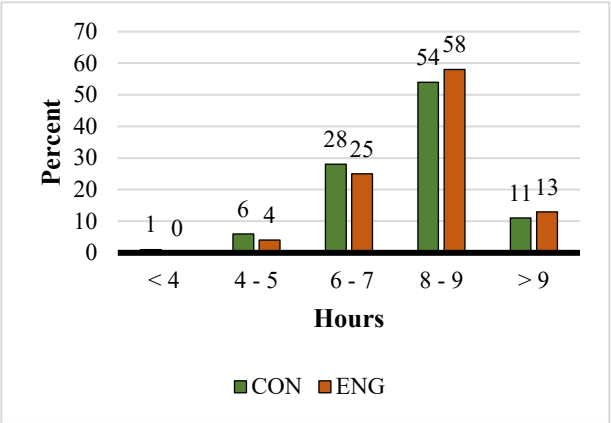

Figure 6. Sleep hours during weekends

Students were also asked about the likelihood of changing their sleep time to achieve an ideal schedule if external factors and conditions allowed. A five-level Likert scale was provided to quantify their opinions. The percentage of each level is shown in Table 3.

Table 3. Likelihood of change in sleep time

Category	CON (%)	ENG (%)
Very Low	3	13
Low	12	8
Moderate	56	51
High	25	9
Very High	4	19

In addition, students were asked how many hours a fresh graduate of their major at the beginning of their professional career should expect to spend for their work per week. Five categories were provided to students. The percentage of each category for both groups is shown in Figure 7.

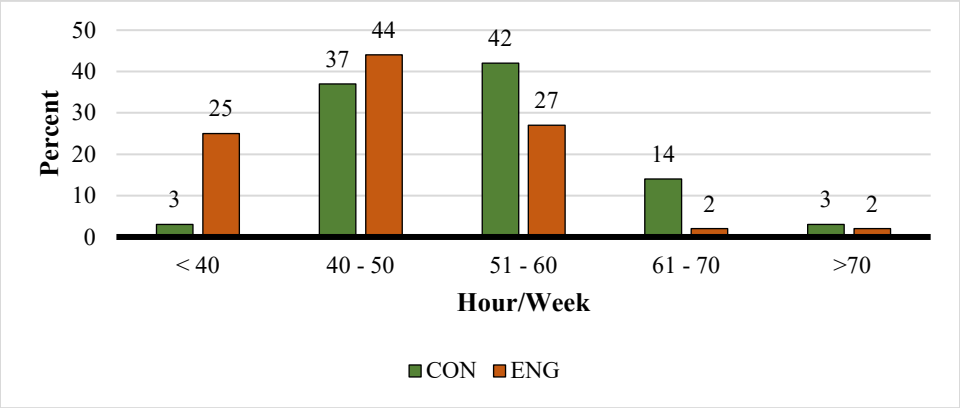

Figure 7. Professional work hour per week

Students were asked to express their opinion on the average sleeping hours that a fresh graduate of their major should expect to get in a 24-hour interval on working days at the beginning of their professional career. Additionally, they were asked to specify an ideal sleeping time for a professional in a 24-hour interval on working days. The percentage of each sleeping time category is shown in Table 4.

Table 4. Perceived required sleep time

Sleeping Hours	Fresh Graduate		Ideal	
	CON (%)	ENG (%)	CON (%)	ENG (%)
< 4	0	2	0	0
4 - 5	12	4	4	2
6 - 7	63	52	43	28
8 - 9	25	42	53	68
> 9	1	0	1	2

In the next section, students were asked to specify the sleeping time level for employees in their majors compared to other industries. A five-level Likert scale was provided to quantify the perception. The percentage of each level is shown in Figure 8.

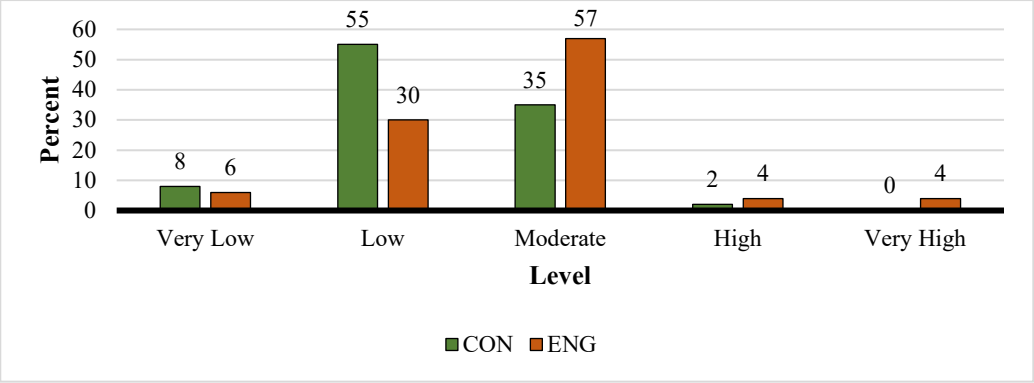

Figure 8. Sleep time in comparison with other industries

The next section of the survey explored factors that impact sleep deprivation. Participants were asked to rate the importance of a series of factors in depriving professionals (employees) in their major of getting enough sleep time, using a five-level Likert scale. The average score of each factor (out of 5) is shown in Figure 9.

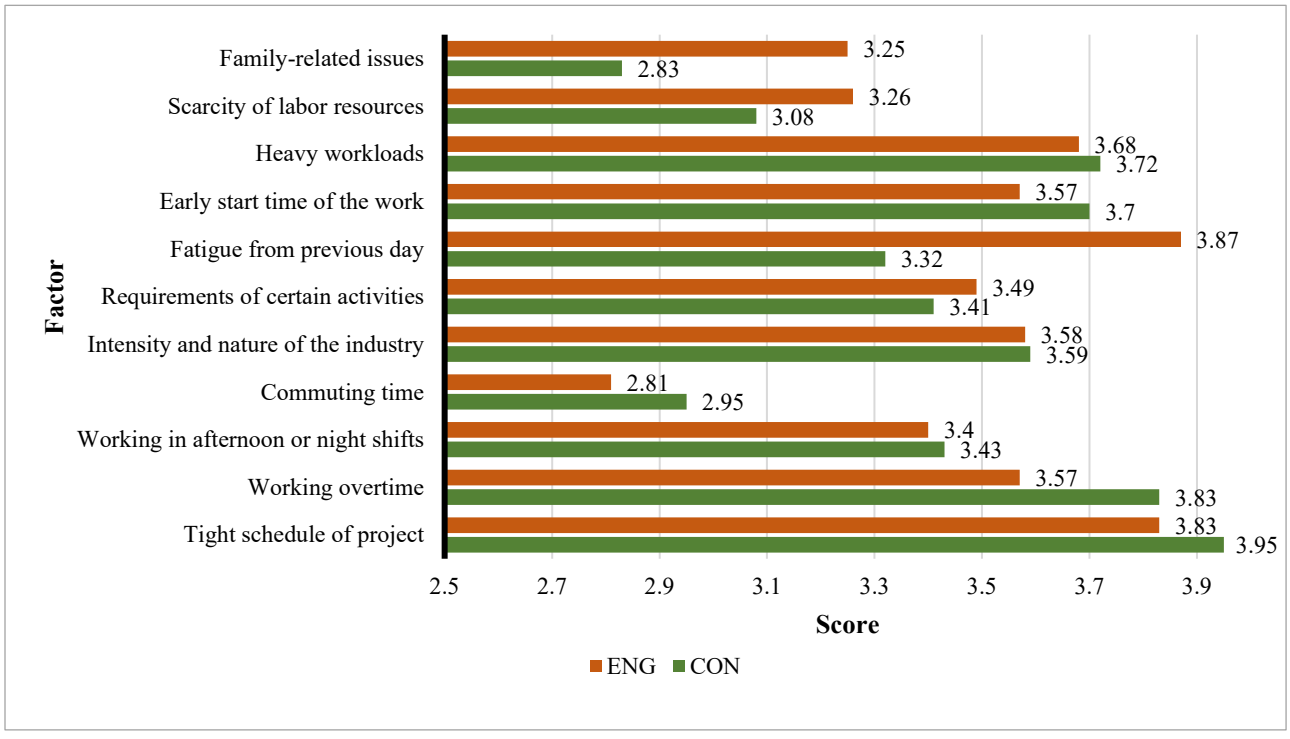

Figure 9. Sleep deprivation factors

Similarly, students rated the effect level of sleepiness on a list of items among their major professionals, as shown in Figure 10.

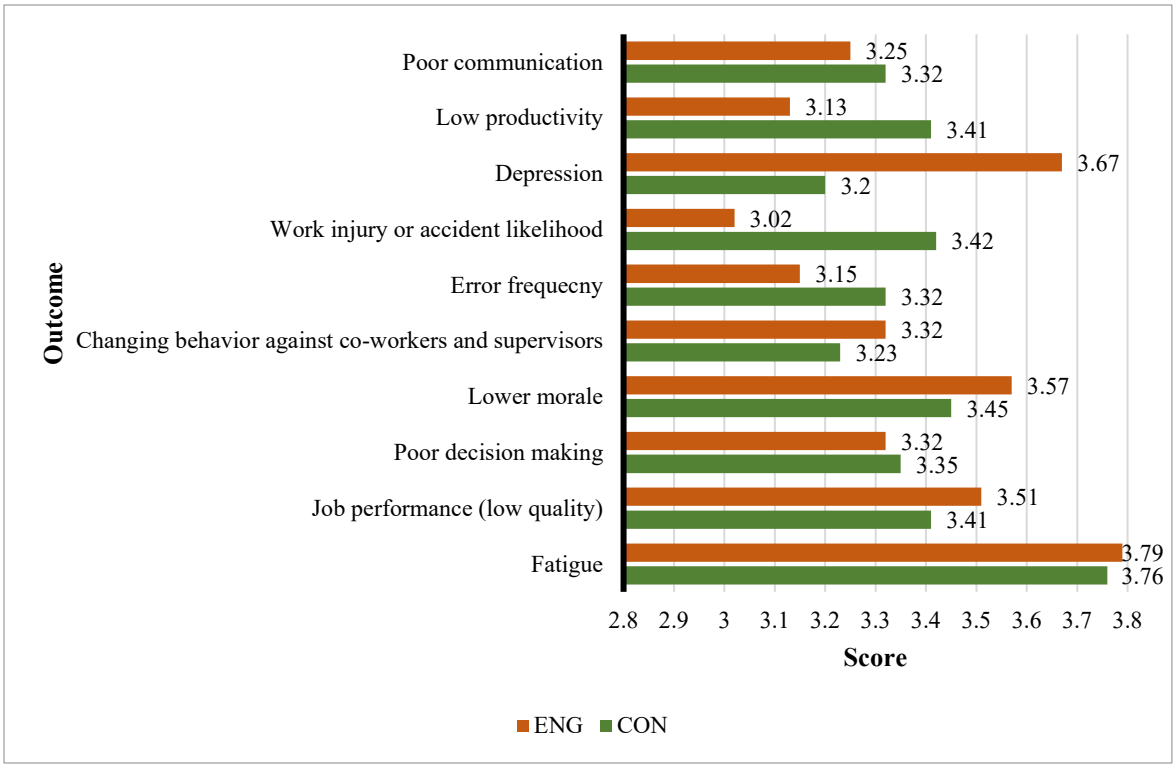

Figure 10. Sleepiness effect

Finally, students were asked to specify to what extent they believed their required courses were available and offered in different time slots so that they could register for sections they prefer most. A five-level Likert scale was used to quantify the responses. The percentage of each level is shown in Table 5.

Table 5. Required courses availability

Category	CON (%)	ENG (%)
Very Low	19	11
Low	26	17
Moderate	43	45
High	11	19
Very High	1	8

Discussion

The analysis of the survey results reveals several interesting insights into the perceptions and experiences of Construction (CON) and Engineering (ENG) students regarding work, study habits, and sleep patterns. The engineering group reported higher overall work experience, with a more even distribution across experience categories, suggesting that engineering students may have more opportunities for internships or part-time work in their field during their studies. Notably, construction students reported expecting significantly higher work hours for fresh graduates in their field compared to engineering students, indicating that construction students are mentally prepared to spend more time in their careers, which could be attributed to the nature of the construction industry and its project-based work structure.

Both groups reported similar average study hours outside of class. However, the engineering group showed a higher variance in study hours, suggesting a more diverse range of study habits among engineering students. This could be due to differences in course structures or individual learning preferences within engineering disciplines. Both construction and engineering students expressed that their required courses are not widely available in their preferred time slots, highlighting a potential area for improvement in course scheduling that could better accommodate student preferences and potentially impact on their sleep patterns and overall well-being.

A significant finding was the discrepancy between expected and ideal sleep hours for fresh graduates in both groups. Students acknowledged that the reality of sleep time in their professions did not align with ideal situations. This awareness could be valuable for preparing students for the challenges they may face in maintaining a work-life balance in their future careers. Construction students, in particular, perceived that employees in their field have considerably lower sleep time compared to other industries, aligning with the demanding nature of the construction industry and its often-irregular work hours.

Both groups identified similar top factors impacting sleep deprivation, including tight schedules, heavy workloads, and fatigue from previous days. However, construction students perceived family-related issues as less impactful on sleep deprivation compared to engineering students, potentially reflecting varying perceptions of work-life balance between the two fields. An important observation was the difference in perceived impact of sleepiness on depression. Construction students rated this impact considerably lower than engineering students, which is particularly noteworthy given that the construction industry has one of the highest suicide rates among industries. This suggests a potential gap in awareness or acknowledgment of mental health issues within the construction field, which could be an important area for future education and intervention programs.

In summary, these findings provide valuable insights into the perceptions and experiences of construction and engineering students regarding work, study, and sleep patterns. They highlight areas where educational institutions and industries could potentially improve support for students and young professionals, particularly in managing workloads, sleep patterns, and mental health awareness.

Conclusion

This paper reports on a study to explore the perceptions and experiences of construction and engineering students regarding work habits, study patterns, and sleep behaviors. Despite similarities in a portion of patterns, the findings highlight significant differences between the two groups in their expectations of work hours and perceptions of sleep deprivation in their respective industries. Construction students appear to anticipate longer work hours and less sleep time compared to their engineering counterparts, reflecting the demanding nature of the construction industry. The study also reveals a concerning gap in awareness of mental health issues, particularly among construction students, despite the high suicide rates in the industry. This underscores the need for targeted educational programs and interventions to address mental health awareness and promote a better work-life balance in both fields. Furthermore, the discrepancy between expected and ideal sleep hours across both groups suggests a need for better preparation of students for the realities of their future careers.

While the study employed a statistically sufficient sample size, the generalization of the findings is not warranted. Additional studies can support the reliability of the results. Further studies can include additional students from both groups, conducting the study in other higher education institutions, and addition of non-construction/engineering students. These potential studies can confirm current findings and/or reveal additional patterns.

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