

Sleep Routine among Grade 10 Learners in the Science Curriculum: Its Influence on Academic Performance in Biology, Chemistry, and Physics

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Received: 30 Jul 2025 Revised: 5 Mar 2026 Accepted: 6 Mar 2026

Abstract

Sleep is a crucial physiological phenomenon in the cognitive process yet most adolescents have chronic sleep deprivation. This research examined the sleeping habits of 66 Grade 10 students attending a Science Curriculum and how they affect their performance in Biology, Chemistry and Physics in a period of five months. They were using a daily self-reported sleep diary to guarantee the credibility of the data, whereby they kept track of their bedtime, their wake time and sleep duration. The findings showed that the average sleep time of the students was only 6 hours and 18 minutes of sleep which is way short of the recommended time taken by adolescents. The multiple linear regression analysis revealed that although sleep patterns were not a significant predictor of performance in Chemistry, they portrayed significant predictive association with performance in Biology and Physics. Specifically, the later the bedtime the higher the grades in Biology which is an indicator of a complex relationship between the time of sleep and the demands of the academic performance of the specialized subjects. These findings show that parents need to be educated and advised on concepts that can be used to maximize the quality of sleep and enhance academic performance among students in highly-science programs.

Keywords: Sleeping routine, academic achievement, biology, chemistry, physics

1. Introduction

Sleep is a vital biological activity that is necessary in cognitive performance as well as the physical well-being. Its importance is further intensified when an individual is an adolescent, because it is the period of development that is marked by significant changes in body functionality (National Sleep Foundation, 2015). Sleep has been demonstrated to be important in terms of attention, learning, memory and emotional regulation, processes that are of importance in the achievement of success in academics (Carskadon, 2006). However, adolescents, particularly Grade 10 learners, often experience chronic tiredness because of social obligations, biological changes, and academic demands (Crowley et al., 2018).

The cognitive performance in relation to sleep has been an established concept in educational psychology (Fonseca and Genzel, 2020). According to a study done by David

et al. (2014), poor sleeping pattern adversely affects cognitive abilities and academic achievements. At the same time, Toyong (2020) has stated that students who undergo intellectual studies like Biology, Chemistry, and Physics need enough rest in order to facilitate meaningful learning. This is an indication that any study of the sleeping patterns of Grade 10 Learners would be in a position to open up ideas on how their sleeping hygiene can be promoted- which can likely improve their academic performance (David, 2014).

Moreover, science based curriculums pose distinct intellectual difficulty as compared to other common curriculums. Courses such as Biology, Chemistry and Physics cannot just involve simple memorization but instead involve higher order thinking skills of students using such tasks like solving their problems, being able to analyze them critically and abstract thinking (Osborne et al., 2003). Therefore, giving all disciplines where such students might find doing this sort of study extra care might be especially wise in such cases. It is thus imperative and opportune to carry out such an investigation to determine the extent to which there is relationship between the way students manage their sleeping hours and their performance in these subjects.

In fact, several studies have been found to have a strong correlation between college and high school academic performance and the quality of sleep in adolescents. By employing a meta-analytic review, Dewald et al. (2010) reached a conclusion that the quality and length of sleep have a serious impact on school performance, especially in the case of secondary education. The information can be compared with the results of the work by Wolfson and Carskadon (2003), who pointed out that the lack and inconsistency in sleep patterns adversely influenced the cognitive performance of adolescents and their ability to learn. This trend is further evidenced by other studies conducted in different contexts. Gaultney (2010) established that prevalence of sleep disorders has been associated with decreasing academic performance amongst college students whereas Hayley et al. (2017) mentioned that comparison of the Norwegian university students who have had their sleep issues and those students with regular sleep schedules showed poor academic performance amongst the former. Orzech, Salafsky and Hamilton (2011) have shown that even small decreases in the hours of sleep will adversely affect GPA in undergraduates. In the same context, Thabit and Alsulami (2023) established the fact that the abnormal sleep-wake schedules of pharmacy students demoralized their academic performance.

Hershner (2020) has also emphasized the need to come to terms with sleep or make it a measurable variable in assessing the performance outcomes of the students and asked educational stakeholders to consider making sleep education part of the student wellness curriculums. Sharman and Illingworth (2020) set an emphasis on the fact that delayed sleep schedules and excessive daytime somnolence are particularly a problem in adolescence, which requires systemic changes, including later school openings. Wang and Biro (2021) provided evidence that accrued through a comprehensive literature review, there are several potential determinants of poor sleep quality among college populations that could be disregarded during administering interventions in academic support: stress, screen use, and academic pressure.

Although a growing body of literature has explored adolescent sleep patterns and their effects on academic performance, few studies have examined this issue within specific academic tracks, such as science education (O'Malley & O'Connor, 2014). In addition to this, very minimal focus has been on the effect of specific components of sleep patterns including sleep duration, bedtime and wake up time on the performance of students in specific science subjects. This difference is particularly apparent when it comes to the example of Philippine high schools, where science tracks are characterized by the excessive workload and intellectual challenges. To fill this gap, the current paper is devoted to sleep habits of Grade 10 students who take up the science curriculum, and

explores the relationship between sleep patterns of these students and their performance in Biology, Chemistry, and Physics.

This paper is based on the Circadian Rhythms Theory, as it is stated that the biological processes, such as sleep-wake cycle, are controlled by the inner clocks that work in 24-hour cycle. The awareness of the interface between these internal rhythm and external requirements, including that of school is a reason that educational practices need to be adjusted to the natural sleep patterns of students to facilitate cognitive functioning and academic achievement (Moore-Ede et al., 1982). Hence, this research examined the correlation between the sleep habits of Grade 10 students taking the science curriculum and the duration of sleep, the time they fall asleep and the time they wake up and the performance of these students in three key science subjects, which include Biology, Chemistry and Physics. Through this connection, the research paper can make a contribution towards the emerging body of evidence that emphasizes the importance of sleep in cognitive and academic performance especially in education programs that are intellectually challenging.

2. Methodology

2.1 Research Design

This research design was correlational research since it was used to examine the relationships between naturally occurring sleep patterns and academic performance of learners in Grade 10. The method of non-experiment was chosen because it guarantees ecological validity since data were collected in the condition of a complete academic semester under natural conditions of the educational setting.

2.2 Participants and Setting

The researchers used 66 Grade 10 students in the Mindanao State University at Naawan Integrated Developmental School. The participants were chosen by their overall average grades in the past school year i.e. those between 80.00 and 89.99.

2.3 Research Instruments and Collection of the research data

The study took two main data collection tools to ascertain the credibility of the data. The monitoring of sleep routines was conducted through a self-reported Daily Sleep Diary, which obliges the respondents to provide data referring to bedtime (sleep onset), wake time, and duration of total sleep per weekday during a five-month period (August to December). Second, Academic Records gave the dependent variables which were the semestral average performance scores in three core science subjects which include Biology Course 2, High School Organic Chemistry and Physics Course 2. These were the academic scores that are directly obtained in terms of the official records of school grading to monitor the reliability and validity of the performance data.

2.4 Data Analysis

All the data were analyzed with the help of SPSS version 20 in order to provide statistical rigor and answer the research goals. The descriptive statistics were used as the first stage of statistical treatment; the means and standard deviations have been computed to describe both variables of sleep and the academic grades in the sample. To test the relationship between variables, Pearson product-moment correlation was employed in order to state the magnitude and direction of individual sleep pattern and subject specific performance. Finally, multiple linear regression was performed to determine the combined predictive value of bedtime, wake time and total sleep duration on academic performance. This model was imperative because essential predictors could be identified and simultaneously control over the overlapping variables.

3. Results and Discussion

This study analyzed the correlation between sleep routines and the academic performance of Grade 10 science curriculum students. Sleep routines were defined by sleep duration, bedtime, and wake time. The results explore this relationship across three core disciplines: Biology, Chemistry, and Physics.

3.1 Sleep Routines and Performance in Biology

Table 1 below shows a regression analysis that investigates how the sleeping variables predict academic performance in Biology. The average grade in Biology after semester was 83.59 (SD = 3.455). Even though Pearson correlation did not produce any important associations, the multiple linear regression analysis indicated that some variables of sleep were highly predictive of Biology performance. Precisely, sleep time turned out to be a positive predictor of Biology grades with significant values ($B = 0.864$, $t(4, 61) = 2.11$, $p = 0.031$). This implies that on average, students would get 0.864 points on Biology with each hour of lengthened sleep. This finding indicates that bedtime became a prominent predictor that may be attributed to the deep and thorough preparation needed at late time of the night of the more complicated conceptual task that the Course 2 of Biology entails. Although this might seem to be counter intuitive, there is a chance that the students who sleep later take longer evenings of concentration in their studies, which leads to better grades. Similar to this Eliasson et al. in 2010 equally reported that timing of sleep as opposed to total amount of sleep was more predictive of academic success and therefore individual adjustment to later bed time may nonetheless be conducive to high academic functioning provided there is optimization of sleep.

In contrast, wake time was identified as a significant negative predictor of Biology grades ($B = -3.421$, $t(4, 61) = -2.733$, $p = 0.008$). This suggests that for every additional hour of delayed waking, Biology scores decreased by about 3.421 points. This result is consistent with the results reported by Alfonsi et al. (2020) who have observed that academic performance might be impaired by late wake times and disrupted circadian rhythm, at least in those academic disciplines that necessitate higher-order thinking (i.e., the sciences). The implication of this finding is that early wake times can be beneficial to students since it would make them more alert and would enable them to do their morning activities and would make them have a better preparation of their study activities in the day.

Table 1. Linear Regression Analysis and Significant Predictors in Biology

Predictor	B	t	df	p	Remarks
Sleep Time	0.864	2.11	4.61	0.031	Positive predictor: each additional hour of sleep increases the average Biology grade by 0.864 points.
Wake Time	-3.421	-2.733	4.61	0.008	Negative predictor: each additional hour later waking up decreases the average Biology grade by 3.421 points.

Although each sleep and wake time is highly indicative of each other, the effect of the combined measure of regression was not significant. This is indicative of the fact that individual parts of sleep behavior, especially wake time, are likely to affect academic performance but is not collectively enough to determine differences in Biology grades among students. These results signal the beginning of additional set of findings to prove that developed and properly practiced sleep habits can produce meaningful effects on the academic results of individuals who approach to the so-called hard-to-study subjects. They

emphasize the necessity to rise earlier and facilitate cognitive vigilance and self-regulation grounded on evidence and accept the fact that in the modern world, some students can be assisted with efficient night time studying cycle.

3.2 Sleep Routines and Performance in Chemistry

The overall grade in Organic Chemistry over a semester was 83.55 (SD = 4.499). Pearson correlation analysis showed that the correlation between total sleep hours and academic performance in Organic Chemistry is statistically significant ($r = 0.263$, $p = 0.016$). This implies that there was no high but significant relationship: students that got more sleep were likely to get higher grades. Although the correlation is not high, the magnitude of the correlation indicates that the slightest growth in the sleeping time is likely to be determined accordingly to academic performance.

They did not reveal any sleep related variables, in the linear regression model that include: total sleep, bedtime or wake time as significant performance predictors in Chemistry. This means that on one hand, there is a relationship between sleep duration and academic achievement that is bivariate, but which on the other hand may not be as strong when many variables are put into consideration. The given conforms to the previous studies that emphasize the importance of sleep in terms of academic performance. In the study among the Iranian adolescents, Jalilolghadr et al. (2021) discovered the significant correlations between sleep duration and improved academic outcomes. In the same context, Lin et al. (2020) have shown that weekday sleep durations were associated with academic performance in mathematics, a cognitively intensive course, similar to chemistry, in its use of abstract thinking and recalling. Collectively, these findings highlight the cognitive effects of getting adequate sleep especially in complicated topics which need sustained consideration and solving issues. Although there was not enough predictive strength in regression analysis, the strong indication indicates the need to conduct educational interventions to ensure high school learners have sufficient sleep hygiene.

Table 2. Pearson Correlation Analysis Between Sleep and Organic Chemistry Average

Variable	r	p	M	SD	Remarks
Sleep Hours vs. Organic Chemistry Average	0.263	0.016	83.55	4.499	Moderate positive relationship: more sleep is associated with higher grades.

3.3 Sleep Routines and Performance in Physics

The average semestral grade in Physics for the sample was 83.03 (SD = 4.671). Linear regression analysis revealed that both wake time and total sleep duration were significant predictors of Physics academic performance. As shown in table 3 below, wake time was found to be a statistically significant negative predictor, $B = -4.478$, $t(4, 61) = -2.656$, $p = 0.010$. This indicates that every hour later a student wakes up, their Physics grade decreases by approximately 4.478 points. By comparison, the total sleep duration was identified as an important positive predictor, $B = 1.990$, $t(4, 61) = 2.15$, $p = 0.035$, which indicates that every additional hour of sleep per night is related to an average Physics grade of nearly 2 points. Such a direct correlation implies that sleep is an important determinant in Physics performance, which may be one way of demonstrating that cognitive recovery is very much a necessity, mathematical rationality, and ability to solve complex problems demanded by this subject.

Interestingly, results of Pearson correlation analysis failed to produce any statistically significant relationships, which underscores the fact that even though one may not find any directly linear relationships when considering the two variables individually in the bivariate analysis, the predictive value of the variables surrounding sleep can be realized as the overall influence of the other variables in the regression equation. These results

indicate that the sleeping habit especially the time of waking up and total time of sleep has a significant involvement in student performance in Physics. Scheduled wake up times can be more in touch with natural circadian rhythms and school schedules and thus make mornings more alert and ready to jump into abstract and quantitative learning. In the meantime, the proper amount of sleep time probably helps with cognitive processes that are important to Physics learning, e.g., memory consolidation, logical thinking and attention control.

Moreover, Shochat et al., in 2014 discovered that lack of sleep deteriorates the higher order thoughts that are required to achieve academic success especially in stressful courses. These findings support the value of encouraging sleep-appropriate behaviors among the students as a bigger approach to academic support.

Table 3. Linear Regression Analysis and Significant Predictors in Physics

Predictor	B	t	df	p	Remarks
Wake Time	-4.478	-2.656	4, 61	0.010	Negative predictor: each additional hour later waking up decreases the average Physics grade by 4.478 points.
Sleep Time	1.990	2.158	4, 61	0.035	Positive predictor. Each additional hour of sleep increases the average Physics grade by 1.990 points.

4. Conclusions

This paper explored the correlation between sleeping patterns of Grade 10 students in science curriculum high school and their performance in Biology, Chemistry and Physics. The results show that variables of sleep, including the total time and the circadian time (bedtime and wake time), have different magnitudes of influence on the outcomes of the subjects. While length of sleep was a crucial predictor of achievement in Physics, in Biology, the timing of sleep was more important, with early wakefulness times being linked with cognitive alertness, and late bedtime to intense study requirements. These findings are consistent with scientific studies on the contribution of sleep to memory formation and excessive cognitive load of the STEM fields. These results then support the notion that sleep hygiene, along with a regular pattern of sleep, should be given importance through educational policies and parental guidance. Schools are also advised to incorporate sleep health in the curriculum to facilitate academic success, and the research on the future should also consider the long-term effects of adapting to sleep timing on the well-being of students in various academic strands.

5. References

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