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Original research paper

WHEN ARE STUDENTS AT THEIR PEAK PERFORMANCE?

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Abstract: Previous studies focusing on students‘ productivity have shown that different times of the day impact students‘ productivity and efficiency. Psychology and biology explain that the circadian rhythm is a key factor influencing students‘ performance during lessons and exams in the morning hours. Additionally, small changes in scheduling can affect students‘ performance. This study tested several hypotheses in this regard and gathered the necessary data to provide valuable insights into how students are affected by the learning process and their schedules. The results revealed that students feel more productive during the late-morning and early-afternoon hours, and they prefer the most important university activities to be scheduled during this time. Furthermore, their alertness is higher in the afternoon compared to the morning. This study provides insights into university students‘ feelings regarding alertness, the influence of university schedules, sleeping patterns, preferences, and similar factors, from which several practical implications are derived.

Keywords: *productivity; schedule; alertness; morning; afternoon; university students*.

1. Introduction

Students' productivity has always been the main topic of discussion. Scholars have been trying to find out which factors influence students' productivity during lectures and how it can be improved. The period of day (morning or afternoon), motivation (internal or external), students' behavior (before school and while in school) are all important factors that influence the outcome of their productivity. As Cruz (2022) beautifully stated: "As the old saying goes, time is what we want most but what we use worst" (p. 22). Most of the students feel that they are short of time for sleeping, doing their homework, out of school activities etc. One of the concepts pertinent to this issue is the term "peak performance" which refers to the period when students are most alert, productive and get the best test results. Carrell et al. (2011) report that "survey evidence shows that over a quarter of high school students report falling asleep in class at least once per week" (p. 1). Sleep researchers support the finding that university students are less productive

during morning lessons due to changing patterns of sleep and the consequence of that is that they are sleep deprived (Carrell et al., 2011). On the other hand, Pope (2016) claims that students learn more in the morning than later in the school day and that "having a morning instead of afternoon math or English class increases a student's GPA by 0.072 (0.006) and 0.032 (0.006), respectively". In addition, he argued that "there are no clear systematic differences in the time-of-day effect between boys and girls, older and younger students, students with high- and low-educated parents, or low- and high-performing students" (p. 1). Pope (2016) hypothesized that the reasons behind different levels of productivity in different parts of the day may be because of "changes in teachers' teaching quality, changes in students' learning ability, or differential student attendance" (p. 1). He lists three main factors, such as "circadian rhythm; stamina effects, with decreasing productivity the longer a student is at school; or school structure effects such as lower productivity after a lunch break" (1). While some researchers claim that starting classes later will increase students' performance and test results, others argue that the hypothesis has not been tested empirically, adding that this tells us nothing about how the teaching and learning abilities change throughout the day.

One aspect which is strongly connected to the students' academic productivity during different parts of the day and needs to be further explained is the circadian rhythm, the crucial element of human alertness. Pope (2016) points out that the "secretion of melatonin starts around 9:00 p.m., peaks between 2:00 and 4:00 a.m., and stops around 7:30 a.m. In adolescents this time schedule is typically shifted two hours later in the day" (p. 2), therefore causing most adolescents to fall asleep later in the night causing them to feel sleep deprived during morning hours and influences their performance during lessons and tests. As previously mentioned, university students are in the late adolescent stage of their lives in terms of maturity. Studies show that during this stage, people develop different sleeping patterns compared to their teenage years, which influence their performance during morning and afternoon lessons and tests. This is because adolescent university students tend to fall asleep after midnight and are not as focused during morning lessons as they were in their teenage years. While many researchers argue about whether different results during the aforementioned periods of the day are due to: going to sleep late, the circadian rhythm, quality of teaching, students' motivation etc., we still do not have a clear picture. Evidence suggests that there is a difference in performance during morning and afternoon lessons and tests, therefore the goal of the present study is to open another perspective and to fill some gaps in the existing literature. This study will try to gain a perspective on how university students feel about morning and afternoon lessons, how they are affected, and which is their preference, therefore giving us the necessary insight into this issue from their point of view.

2. Literature review

There are many studies in the fields of medicine and psychology related to the topic of how sleeping and waking up early affects people and whether morning or afternoon classes are more beneficial for university students. Some of these

studies point out that the circadian rhythm is one of the key factors of why students go to bed late, which ultimately affects them during waking up and their morning performance during lectures, compared to afternoon lectures. The biological rhythm that governs our sleep-wake cycle is known as the circadian rhythm which is the main producer of a chemical element in the brain known as melatonin. Melatonin is a hormone in our bodies that plays a role in sleep. The production and release of melatonin in the brain is connected to the time of day, increasing when it is dark and decreasing when it is light. During adolescence there is a change in sleeping patterns, and more adolescents start having more owl-like tendencies, starting to fall asleep later and as a result waking up later (Carrell et al., 2011). As Carrell et al. (2011) point out, because of the changes of the time of secretion of melatonin in adolescents, there is an asynchronous relationship between their circadian rhythm and the time required for them to be alert. Adolescent university students cannot fall asleep easily until the melatonin starts producing (11 p.m.) and this is the main reason why they are more proactive during school activities which occur later in the day and also explains their late bedtime routines. The authors conclude that when classes start earlier than the usual schedule, students are greatly impacted by it, as for adolescent‘s alertness begins in “late morning, drops off mid-afternoon, and peaks again in the early evening” (p. 13). Jankowski (2015) carried out a study using the Composite Morningness Questionnaire to determine preferences related to productivity and sleeping habits in three groups: children, adults and university students. The participants who took part in the study were 952 Polish residents aged 13 to 46. The findings suggest that female participants wake up on average 23 minutes earlier compared to male participants. Furthermore, participants aged 16-18 reported their preferences for school activities later in the day and most of them identified themselves as evening persons. A noticeable pattern was found in this study, namely, younger participants were classified as morning persons, then there seems to be a change during puberty when they begin to show more eveningness tendencies and then in adulthood the participants once again begin to express more morningness preferences. Hansen et al. (2005) conducted a study with 60 high school students who were willing to keep sleep/wake diaries from August to September and then in November and February. They used computer-administered and paper-and-pencil tests, and the results led to a few conclusions. Namely, students lose an average of 120 minutes of sleep per school night during the first week of school. Additionally, weekend sleep time was significantly longer (by 30 minutes) than before the start of the school year (in August). Finally, all students reported performing better in the afternoon compared to the morning. Additionally, Hansen et al. (2005) stated that cognitive functions of adolescent university students are at their peak during afternoon hours, which supports the idea that adolescent university students are more productive during afternoon lessons. Another study was carried out by Paciello et al. (2022) to test the validity of several questionnaires, including the Composite Morningness Questionnaire, on 55 adolescents aged 13-16 years. The validity was found to be strong, and a few valuable conclusions were made, namely: participants who prefer to wake up later were associated with shorter sleep duration and poorer sleep quality; the

study also found that adolescents have disrupted sleep patterns due to academic and social demands; morning-type individuals are more aligned with conventional school schedules, while evening-type individuals face more difficulties with early morning schedules; morning-type individuals generally tend to have better and higher-quality sleep compared to evening types; and school-aged children tend to have more rigid schedules due to fixed start times, in contrast to university students.

The Composite Morningness Questionnaire was also used in a study carried out by Morales and López (2004) to determine the morningness and eveningness tendencies of adults and university students. The participants were 203 university students aged 19-30 and 125 working adults aged 31-60. The findings demonstrated that there were no significant differences between the male and female participants, the undergraduates showed greater tendencies for eveningness while adult participants showed greater tendencies for morningness and their peak alertness was earlier in the day compared to university students, which is in line with other studies. Another study demonstrated that university students perform significantly better on the tests and overall performance when the lectures are carried out at the time they prefer (Cruz, 2022). Additionally, in his study, Edwards (2012), used variations in starting time in school and claimed that his findings support the hormone hypothesis which claims that once students enter adolescence, they start to fall asleep later and cannot compensate for the lack of sleep during activities and as a consequence, their performance is affected. He points out that starting school an hour later increases test scores by 2 percent. Another study involving students‘ self-reports showed that students reported that they slept more hours, felt less daytime fatigue, and had less depressive feelings when lessons were carried out later in the day (Wolfson and Carskadon, 2005). The present study will try to gain insights from university students about how they feel about morning and afternoon lectures, how they are affected and which are their preferences regarding this issue. This information will serve as an example of whether morning or afternoon lectures are more beneficial for them, therefore contributing to the literature whether lessons and tests should be carried out later in the day.

2.1. Purpose of the study

This study will try to find answers to questions which will help us understand university students‘ productivity better. The research question are as follows:

1. In which period of the day university students feel at their peak performance?
2. Are the university students mostly morning or evening people?

Based on the literature covered on this topic and the studies carried out in the past we can formulate the following hypotheses:

H1. University students are more productive during the afternoon compared to morning hours.

H2. University students are mostly evening people.

3. Methodology

3.1 Participants

This study was carried out with 20 participants, of which 10 were male and 10 were female. They were all native speakers of Macedonian. Their English language proficiency level was determined by using the open source English language proficiency test retrieved from Cambridge University Press & Assessment. The test results were as follows: A2 (5%), B1 (10%), B2 (40%), C1 (35%), and C2 (10%). All participants were students enrolled at universities and their ages were: 18-20 (5%), 21-23 (45%), 24-26 (35%), and 27 and older (15%). This study used the snowball method as a means of gathering participants. Only those who reported that they were university students were included in the study.

3.2. Materials and instruments

The instrument which was used for eliciting information about participants' opinions on the topic is the questionnaire "Composite Morningness Questionnaire" consisting of 13 items (Smith et al., 1989). This questionnaire was chosen since it measures the variables we are interested in (sleeping patterns, alertness, productivity, evening-morning type, etc.). The questionnaire was validated by its creators and it has shown sufficient internal consistency of .82. This questionnaire was also used in a number of studies related to sleeping patterns, alertness, productivity etc. The questionnaire is structured and controlled and the participants could not give open-ended answers, rather they could choose only one of the given multiple-choice answers. The questions mainly focus on students' productive hours, their peak period, discovering their feelings and mindset during different parts of the day (morning and afternoon), as well as which part of the day they prefer to have tasks and activities based on their feeling of alertness and peak performance.

3.3. Procedure

The questionnaire was distributed through social media.. Before sending the questionnaire, the participants were informed about the study and only those who agreed to participate were included in the study. First the participants completed the English proficiency test, after which the questionnaire was distributed. The participants were given 24 hours to complete it. The average time needed for completing the questionnaire was 5 to 10 minutes.

3.4. Data analysis

Once the participants completed the questionnaire online, the results were immediately available to the researcher. The participants responded to a 13-item questionnaire with four or five response options. The multiple-choice answers included various options, such as the best time to fall asleep or wake up, preferences related to school activities, personal feelings about productivity during morning and evening lessons, and so on. The scores for each answer ranged from 1 to 4 or 5, with lower scores indicating evening preferences and higher scores indicating a greater degree of morningness. A score of 22 or below indicates an evening-

type person, while a score above 44 indicates a morning-type person. Scores between 22 and 44 are classified as intermediate. Additionally, a Chi-square test was used to calculate the results and test the hypothesis, with p-value set at 0.05. The previously stated directional hypotheses were first tested as null hypotheses.

4. Results

The results of the 13-item questionnaire known as "Composite Morningness Questionnaire" are summarized in the table below:

Table 1. Results of the questionnaire.

Questions	Score
1. Considering only your own "feeling best" rhythm, at what time would you get up if you were entirely free to plan your day?	2.05
2. Considering your only "feeling best" rhythm, at what time would you go to bed if you were entirely free to plan your evening?	1.45
3. Assuming normal circumstances, how easy do you find getting up in the morning?	1.4
4. How alert do you feel during the first half hour after having awakened in the morning?	1.65
5. During the first half hour after having awakened in the morning, how tired do you feel?	1.8
6. You have decided to engage in some physical exercise. A friend suggests that you do this one hour twice a week and the best time for him is 7:00 - 8:00 a.m. Bearing in mind nothing else but your own "feeling best" rhythm, how do you think you would perform?	2.3
7. At what time in the evening do you feel tired, as a result, in need of sleep?	1.3
8. You wish to be at your peak performance for a test which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day, and considering your own "feeling best" rhythm, which one of the four testing times would you choose?	3
9. One hears about "morning" and "evening" types of people. Which one of those types do you consider yourself to be?	1.65
10. When would you prefer to rise (provided you have a full day's work - 8 hours) if you were totally free to arrange your time?	1.1
11. If you always had to rise at 6:00 a.m., what do you think it would be like?	2.35
12. How long does it usually take before you "recover your senses" in the morning after rising from a night's sleep?	1.8
13. Please indicate to what extent you are a morning or evening active individual.	1.65
Total score:	23.5

Regarding the first research question, the questionnaire showed that the university students are far more alert and at their peak performance in the activities between late morning and early afternoon (11:00 a.m. - 1:00 p.m.) with 90% of the participants opting for that answer. Therefore, the first hypothesis was rejected. A chi-square goodness-of-fit test was conducted to examine whether students' peak performance time was evenly distributed across morning and afternoon periods. The results were significant, $\chi 2\ (1\ ,\ N = 20\ ) = 16.2,\ p < .001$.

In relation to the second research question, the total score of 23.5 suggests a tendency toward eveningness. This indicates that students reported a preference for evening hours regarding their alertness, interaction, and peak performance during university days. Specifically, 60% of university students classified themselves as evening-type individuals, while an additional 20% reported feeling more like evening than morning-type individuals. Morning wakefulness appears to be an issue, as 63.2% of university students expressed difficulties waking up early. Furthermore, 50% reported feeling very tired during the first half-hour after waking up, and 55% indicated experiencing very low alertness during the same period. Despite the majority of students identifying as evening-type individuals, many still chose to engage in university activities during late morning hours. For example, 90% of students opted to take exams in the early morning, even though these assessments are typically mentally exhausting and lengthy. Possible reasons and explanations for why university students prefer to schedule important activities, such as exams, in the morning despite their evening tendencies will be further discussed in the next section.

A chi-square goodness-of-fit test was performed to determine whether university students were more likely to identify as evening or morning types. The results were significant, $\chi 2\ (3\ ,\ N = 20\ ) = 14.0,\ p = .0029$ indicating that university students were significantly more likely to identify as evening types, thus supporting the second hypothesis.

5. Discussion

The 20 participants who took part in this study provided their responses to each of the 13-item questionnaires, and the total score was 23.5. Taking into account the previously mentioned criteria, it is concluded that they belong to the evening-type group. This means that they feel more alert and their peak performance happens later in the day. When comparing these results to the existing literature, there are many similarities. Specifically, a similar study conducted by Jankowski (2015) reported that students, after puberty, begin to show more evening tendencies and prefer lectures and tests to be conducted later in the day, which supports our findings. In our study, participants responded to a question about when they prefer to take a mentally exhausting test with a strong preference (90% of them) for the late-morning and early-afternoon (11:00 a.m. - 1:00 p.m.) option, compared to other time options. Interestingly, despite participants expressing a preference for morning tests, they reported difficulties related to waking up early. Specifically, 63.2% of participants stated that they find it difficult to wake up early. Furthermore, 50% reported feeling very tired during the first 30 minutes after waking up, which

may be linked to the fact that most of them (75%) usually fall asleep between 1:45 a.m. and 3:00 a.m. The sleep issues associated with evening-type individuals are supported by a study by Paciello et al. (2022), which found that evening-type individuals face more difficulties with early morning schedules and are associated with shorter sleep duration and poorer sleep quality. The reason why, despite their sleep issues, most participants still prefer morning tests may be linked to cultural norms. They have spent their lives taking lessons and exams during morning hours, and this routine has become so ingrained in their minds that they accept it as a "normal" practice, despite the psychological disadvantages associated with alertness, personal feelings, and performance. Another possible explanation is that university students prefer to complete their main tasks during the morning hours so they can be stress-free for the rest of the day. Additionally, some students may be employed or have other duties later in the day, which could lead them to prefer morning options. Despite different preferences regarding school activities, this study still supports the claim by Wolfson and Carskadon (2005), who stated that students sleep more, experience less daytime fatigue, and have fewer depressive feelings when lessons are conducted later in the day. In our study, the majority (85%) of university students reported that they prefer to wake up between 9:45 a.m. and 11:00 a.m., and that they need at least 21-40 minutes (or more) to feel fully awake in the morning after rising from sleep. Taking this information and previous statistics into account, this study supports Carrell et al.'s (2011) claim that adolescent alertness begins in the late morning.

On the other hand, the answers to the questionnaire support the second hypothesis that university students are mostly evening people, based on the responses of a significant number of university students (more than 60%) who feel that their performance is at its peak later in the day. This further supports the aforementioned possible explanation for why university students might choose early university activities, despite the majority of them being evening-type individuals. Similar findings were reported in a study conducted by Jankowski (2015), in which adolescent students classified themselves as evening-type individuals and expressed a preference for later school activities. This finding was further supported by Hansen et al. (2005), who conducted a study in which students reported performing better in the afternoon compared to the morning and their cognitive functions were found to peak during the afternoon hours. Furthermore, a study by Morales and López (2004) involving 203 university students identified a greater tendency toward eveningness and a preference for later university activities, providing additional support for the second hypothesis.

The practical implications of this study lie in understanding university students' perspectives and their routines concerning sleeping patterns and their own feelings about which times of day they are most productive, which seems to be later in the morning. Universities should consider adjusting their schedules to accommodate students' preferences, as a study by Cruz (2022) found that students perform significantly better in lessons and tests when these are conducted at times that align with their preferences. Therefore, finding a balance between university students' preferences and university activities in terms of time management is key to creating a successful learning environment.

6. Conclusion

This study aimed to address an issue related to university students' peak performance and its connection with the time of the day (morning and afternoon). The onset of melatonin production appears to change with age (child, adolescent, adult), which can affect students' performance during university activities at different times of the day. Based on our findings, gathered through a questionnaire to understand students' feelings about this issue, several conclusions can be made. University students tend to prefer having tests and important activities in the late morning hours. The majority of participants were classified as evening-type individuals. Many also reported issues with falling asleep late, often after midnight, which results in difficulties during morning hours and activities. Despite their late bedtimes, students' preference for late-morning tests and activities may be influenced by cultural norms, the need to alleviate stress as soon as possible, or responsibilities related to family or work. To better accommodate students' feelings and optimize their performance, the following practical implications should be considered: universities should adjust their schedules to schedule important lessons, activities, and tests during later morning hours or in the afternoon. Studies have shown that students perform significantly better during these times, and meeting their preferences can help them reach their peak performance.

7. Limitations

This study provides insights into participants' perspectives on the learning process and how they are affected by the challenges that education brings. It is important to note that this study has limitations that must be considered before drawing final conclusions. The study was conducted with a small number of participants (20), which is insufficient to draw general conclusions about the issue at hand. Additionally, since the survey was structured, participants could not fully express their opinions. Instead, they were limited to selecting the pre-defined options that most closely reflected their views. Furthermore, since the questionnaire was distributed online, the researcher was unable to observe the environmental factors that might have influenced the university students' responses. Additionally, it was not possible to determine whether participants took the time to carefully read and answer the questions or if they responded quickly just to complete the survey.

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