Proceedings of the 19th International Scientific and Practical Conference «Scientific Horizon in the Context of Social Crises»

(August 16-18, 2026). Tokyo, Japan

No 305

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School Scheduling, Cognitive Fatigue, and Perceived Academic Performance at a Nazarbayev Intellectual School: a Pilot Survey

Umarov Samir[1]

[1]11th-grade student;
Nazarbayev Intellectual School, Kazakhstan

Abstract. School timetables may influence students' alertness and perceived performance through the interaction of sleep, circadian timing, subject difficulty, and accumulated cognitive fatigue. This pilot study examined how 20 students in Grades 10-12 at one Nazarbayev Intellectual School perceived the organization of their school day. An anonymous online questionnaire was used, and the available responses were summarized with frequencies, percentages, and thematic grouping of an open-ended item. Nine students (45%) reported sleeping 6-7 hours on school nights, while another nine (45%) identified the third and fourth lessons as their most productive period. Eight students (40%) agreed that mathematics becomes more difficult in the afternoon, and ten students (50%) reported having performed worse on a test scheduled later in the school day. Open responses suggested placing difficult subjects earlier, considering a slightly later start, and reducing unnecessary gaps in the timetable. Because the sample was small and non-random, the data were self-reported, and no grades or test records were collected, the findings cannot establish causation or actual effects on academic achievement. They instead identify student-perceived patterns that may inform a larger study and cautious timetable pilots.
Keywords: *school schedule, cognitive fatigue, adolescent sleep, perceived academic performance, timetable optimization.*

Introduction

The organization of the school day is a practical factor that can influence how students experience learning. In academically intensive schools, students may attend several consecutive lessons, complete cognitively demanding work, and take assessments at different times of day. Even when total instructional time remains unchanged, the order of subjects, the timing of tests, and gaps between lessons may affect alertness, fatigue, and students' perceptions of their own performance.

This issue is especially relevant for adolescents because sleep timing changes during the teenage years while schools

often require early attendance. The relationship is not simple, however. Some students may be less alert during the first lesson, whereas accumulated mental effort may reduce concentration later in the day. An effective timetable may therefore need to balance early-morning sleepiness, mid-morning readiness, and late-day fatigue rather than assume that one period is optimal for every student and every subject.

The present study examines the self-reported experiences of students at a Nazarbayev Intellectual School (NIS). It focuses on sleep duration, perceived productivity during the school day, the perceived difficulty of demanding subjects in the afternoon, experiences with late-day tests, and proposed timetable changes. No grade-point averages, subject grades, or official test scores were collected. For this reason, the term perceived academic performance is used throughout, and the findings are not treated as evidence of a causal effect on actual academic achievement.

The study addressed four questions: how much sleep the surveyed students reported on school nights; during which lessons they felt most productive; whether they perceived demanding afternoon lessons and late-day assessments as more difficult; and what changes they suggested for the school timetable. The purpose was to identify patterns that could guide a larger investigation and low-risk pilot changes, not to make a definitive evaluation of the existing schedule.

Literature Review

Time of Day and Within-Day Scheduling

Research on time-of-day effects does not support a single simple rule. Pope analyzed a large panel of secondary-school students and found that morning classes were associated with stronger learning outcomes than afternoon classes, with a larger estimated effect for mathematics than for English [1]. This finding suggests that the placement of cognitively demanding subjects may matter even when the total number of instructional hours remains the same.

Williams and Shapiro reached a more complex conclusion using randomized schedules at the United States Air Force Academy. Their design separated the effect of clock time from fatigue caused by prior consecutive classes. All else being equal, students performed better in the afternoon than in the early morning, but multiple classes without sufficient breaks produced measurable fatigue and reduced performance [2]. Although that institutional setting differs from a secondary school, the study demonstrates why early-morning timing and

accumulated fatigue should be considered separately. A late class may occur at a biologically favorable time but still follow several demanding lessons, while an early class may avoid accumulated fatigue but occur before some adolescents reach full alertness.

Adolescent Sleep and School Start Times

Adolescent sleep research provides a biological explanation for morning difficulty. Crowley, Acebo, and Carskadon describe developmental changes that delay sleep timing during adolescence and can create conflict between biological rhythms and early social schedules [3]. Kelley and colleagues similarly argue that school timing should be considered in relation to adolescent sleep and circadian biology, while also recognizing the practical challenges of changing institutional schedules [4].

Educational studies of later start times report promising but uneven results. Edwards found that later daily start times were associated with gains in mathematics and reading scores among middle-school students [5]. Groen and Pabilonia reported that later high-school start times increased sleep and reading performance for female students in their data, while effects for male students were limited [6]. These differences indicate that schedule effects may vary by student group, outcome, and context.

A systematic review by Biller and colleagues is particularly important for interpreting this literature cautiously. Across 21 studies, the authors found a mixture of no association, mixed results, positive results, one negative result, and one unclear result for school start times and academic achievement [7]. In contrast, a smaller longitudinal study by Alfonsi and colleagues found that a one-hour delay in school start time was associated with longer sleep, better sustained attention, attendance, and improved academic performance [8]. Taken together, the evidence supports a plausible relationship between sleep-friendly schedules and student functioning, but it does not justify assuming that every later start or every earlier lesson will improve achievement.

Timetable Design as an Optimization Problem

Timetable construction must also satisfy practical constraints such as teacher availability, room capacity, subject requirements, and the distribution of lessons across the week. Chen and colleagues model educational scheduling as an optimization problem in which student and teacher preferences can be treated as soft constraints alongside non-

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negotiable operational requirements [9]. Their university-based model does not demonstrate that a specific school timetable improves learning, but it provides a useful conceptual point: student concentration and schedule preferences can be considered systematically rather than informally, provided that they are balanced against institutional constraints.

Overall, the literature suggests three relevant mechanisms: adolescent sleep timing may reduce early-morning alertness; demanding sequences of lessons may create cumulative cognitive fatigue; and the timing of particular subjects or assessments may interact with these conditions. Because published findings vary across settings, local evidence from NIS students can be informative, but it must be interpreted as exploratory rather than conclusive.

Methodology

Research Design

The study used a cross-sectional pilot survey. The final analysis was based on questionnaire data only; no interview data were included. This design was appropriate for describing students' perceptions and generating hypotheses, but it was not designed to determine causal effects or changes over time.

Participants and Sampling

Twenty students in Grades 10-12 at one Nazarbayev Intellectual School completed the online questionnaire. Participants were recruited through convenience sampling, meaning that respondents were selected from students who were accessible to the researcher. The questionnaire did not request names or other identifying information. Teachers were not included in the analyzed sample. Because the sample was small, non-random, and drawn from one academically selective school, it should be viewed as a pilot sample rather than a representative group of all NIS students or all students in Kazakhstan.

Instrument and Procedure

The online questionnaire included multiple-choice items, Likert-type items, and an open-ended question. It addressed school-night sleep, morning sleepiness, perceived productivity at different lesson periods, changes in focus across the day, mental fatigue, subjects requiring the most concentration, preferred timing of difficult subjects, perceived performance on late-day tests, the perceived influence of the timetable, and suggestions for improvement. Ten core questions available in the project documentation and discussed in this article are reproduced in Appendix A.

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The present report focuses on the summary figures available for five central indicators: school-night sleep duration, the lesson periods of highest perceived productivity, subjects requiring the most concentration, perceived afternoon difficulty in mathematics, and perceived performance on late-day tests. The open-ended timetable suggestions were grouped into broad themes. The wording of the questions asked respondents about their own experiences; therefore, the results represent perceptions rather than independently verified outcomes.

Data Analysis

Closed-ended responses were summarized with frequencies and percentages. Percentages were calculated using the full sample of 20 students. The open-ended answers were reviewed for recurring suggestions and grouped into descriptive themes. No inferential statistical tests were performed because only selected aggregate summaries were available and the sample was small. Accordingly, no claims of association, effect size, statistical significance, or causation are made from the survey findings.

Results

The analysis included 20 completed questionnaires. Table 1 presents the reported response categories for which numerical summary data were available. Because only selected categories were preserved in the project summary, the table does not display every response option. Percentages therefore describe the listed categories but should not be interpreted as a complete distribution for each question.

Table 1

Selected Survey Responses (N = 20)

Indicator	Reported response	n	%
School-night sleep duration	6-7 hours	9	45%
School-night sleep duration	7-8 hours	8	40%
Period of highest perceived productivity	3rd-4th lessons	9	45%
Period of highest perceived productivity	1st-2nd lessons	6	30%
Mathematics becomes harder in the afternoon	Agree	8	40%
Mathematics becomes harder in the afternoon	Unsure	7	35%
Performed worse on a late-day test	Yes	10	50%

Note. Only response categories reported in the available aggregate summary are shown; remaining responses were distributed among other options.

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Sleep Duration and Perceived Productivity

Nine students (45%) reported sleeping 6-7 hours on school nights, and eight students (40%) reported 7-8 hours. The 6-7-hour group was the largest single category, but it was not a majority. The survey summary does not show whether these sleep durations were stable across the week or how they related to bedtime, commuting time, extracurricular work, or screen use.

The largest group of respondents, nine students (45%), identified the third and fourth lessons as their most productive period. Six students (30%) selected the first and second lessons. This pattern suggests that many respondents did not perceive the very beginning of the day as their optimal period, while the available data do not identify how productivity changed after the fourth lesson for every student.

Subject Difficulty and Late-Day Assessment

In the available summary, students identified mathematics and science subjects, including physics and chemistry, as requiring the greatest concentration. Eight students (40%) agreed that mathematics becomes more difficult in the afternoon, while seven students (35%) were unsure. These responses show a substantial group reporting greater afternoon difficulty, but they do not constitute a majority and do not demonstrate an objective decline in mathematics performance.

Ten students (50%) reported that they had performed worse on a test scheduled later in the school day. This is exactly half of the sample, not a majority. The question captures students' retrospective judgment; it does not compare matched tests, control for test difficulty, or verify scores against school records.

Suggested Timetable Changes

The open-ended responses produced three recurring themes. Students suggested scheduling difficult subjects earlier in the day, considering a slightly later school start, and reducing unnecessary gaps or "windows" in the timetable. Because response-level counts were not retained in the aggregate summary, these themes indicate the types of suggestions made rather than their prevalence across the sample.

Discussion

A Possible Mid-Morning Productivity Window

The most notable descriptive pattern is a possible mid-morning productivity window. The third and fourth lessons

were selected more often than the first and second lessons, while respondents also described demanding subjects and tests as more difficult later in the day. This combination suggests that the students' preferred period may lie between early-morning sleepiness and late-day fatigue. The result is consistent with the idea that clock time and accumulated workload operate simultaneously rather than in isolation.

This interpretation should remain cautious. Pope's school-based evidence favors earlier placement of mathematics and English [1], whereas Williams and Shapiro found better afternoon performance after separating time-of-day from fatigue [2]. The NIS survey does not resolve this disagreement because it measures perception rather than standardized outcomes. It does, however, support examining the order of demanding lessons and the number of consecutive classes, rather than treating "morning" and "afternoon" as uniform categories.

Sleep, Alertness, and School Timing

The finding that 45% of respondents reported 6-7 hours of sleep is relevant to adolescent circadian research. Developmental changes can delay adolescents' preferred sleep timing [3], and early institutional schedules may reduce the time available for sleep [4]. However, the present survey did not measure bedtime, wake time, chronotype, sleep quality, or school start time as independent variables. It therefore cannot show that the timetable caused short sleep or that a later start would improve outcomes for this particular group.

Evidence from other settings suggests that later starts can improve some outcomes [5, 8], but effects are not uniform across students or studies [6, 7]. For NIS, a later start should therefore be considered as a testable option rather than an automatic solution. Any pilot should monitor sleep duration, attendance, punctuality, well-being, and objective academic measures before and after implementation.

Implications for Timetable Design

The survey supports several cautious planning principles. When operationally feasible, schools could place highly demanding subjects within the second to fourth lessons, avoid clustering several demanding lessons without a meaningful break, distribute major assessments across different periods, and reduce unnecessary timetable gaps that extend the school day. These are hypotheses for pilot testing, not final policy recommendations.

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Student preferences may be incorporated as soft constraints in timetable planning alongside teacher availability, room capacity, curriculum requirements, and fairness across classes [9]. A useful pilot would compare alternative schedules for a limited period and evaluate them with both student-reported indicators and objective outcomes. Such an approach would preserve administrative feasibility while testing whether schedule changes produce measurable benefits.

Limitations and Future Research

The study has several important limitations. First, the sample included only 20 students selected through convenience sampling at one academically selective school. The findings cannot be generalized to all NIS students, other school types, or adolescents in Kazakhstan. Second, all measures were self-reported and may be affected by recall error, current mood, expectations, or the desire to provide a particular answer. Third, the study did not collect GPA, subject grades, attendance records, or matched test scores, so it cannot evaluate actual academic achievement.

The cross-sectional design also prevents analysis of change over time and cannot establish cause and effect. Potential influences such as chronotype, screen use, stress, commuting time, caffeine consumption, extracurricular workload, mental health, and exact sleep timing were not controlled. In addition, the present analysis used aggregate response summaries, which prevented testing relationships between variables, such as whether students who slept less also reported lower productivity.

Future research should recruit a larger and more diverse sample, retain respondent-level data, use validated sleep and fatigue measures, and include objective academic indicators. Repeated measurements across several weeks would help distinguish stable patterns from temporary exam pressure or seasonal changes. A stronger design could compare the same subjects or assessment types at different lesson periods, or evaluate a timetable pilot before and after implementation. Teacher perspectives could also be added, because lesson timing may influence classroom participation, instructional pace, and teachers' observations of student alertness.

Conclusion

This pilot survey explored how 20 NIS students perceived the relationship between their school timetable, sleep, concentration, and academic performance. The largest single

sleep category was 6-7 hours, and the third and fourth lessons were the most frequently selected period of highest productivity. Forty percent of respondents agreed that mathematics becomes harder in the afternoon, and half reported having performed worse on a late-day test. Students also suggested earlier placement of difficult subjects, a slightly later start, and fewer unnecessary gaps.

These findings suggest that students perceive school timing as relevant to alertness and performance. However, no statistical significance was tested, and the data do not establish a causal effect on actual achievement. The most defensible conclusion is that the NIS timetable merits further study using larger samples, respondent-level data, and objective academic measures. Until such evidence is available, schedule changes should be introduced through limited, measurable pilots rather than broad claims that one timetable is universally optimal.

Funding Disclosure

No external financial funding was received for this study. The work was completed as part of school project work, with non-material academic supervision provided by the school.

Acknowledgment

The author thanks Zhanzhigitova Gulzada for academic supervision and the students who completed the questionnaire.

Conflict of Interest

The author declares no conflict of interest.

Appendix A. Selected Questionnaire Items

The following ten items are the core questions available in the original project documentation and discussed in this article. Response options are not reproduced because they were not available in the aggregate project summary.

1. How many hours do you usually sleep on school nights?
2. How often do you feel sleepy during morning classes?
3. During which lessons do you feel most productive?
4. Does your focus decline as the school day progresses?
5. After how many lessons do you begin to feel mentally tired?
6. Which subjects require the most concentration?
7. When should the most difficult subjects be scheduled?
8. Have you ever felt that a test scheduled later in the school day caused you to perform worse?
9. Do you think the school timetable affects your academic performance?
10. What changes would you propose for the school timetable?

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