Investigating the relationship of different amounts of sleep, homework and recreational technology use on academic performance

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International Baccalaureate (IB) students and parents at one school expressed concerns around curriculum workload and its effect on lack of sleep. This study aimed to identify how different amounts of sleep, homework and recreational technology use are associated with academic performance in a sample of female IB students. Grade 10, 11 and 12 students (n = 291) were surveyed to gather information about some of their sleep, homework and recreational technology habits. Report card grade averages were then cross-referenced for those same students to explore how grades might be influenced by different amounts of sleep. Further investigation examined time spent on homework and recreational technology activities and how they affected sleep. The study found that students who got 7 to 8 hours of sleep a night, did 2 to 3 hours of homework per night, and did not participate in recreational technology activities after 8pm, tended to have higher grades. This information has been used to inform and explore changes in school-wide practice: adding a weekly sleep-in morning, having guidance counsellors discuss sleep habits with students who are academically struggling, building instructional units on sleep into the Health and Physical Education curricu-

INTRODUCTION

In recent years, emerging research in adolescent sleep patterns has brought to light some important facts. Adolescents need 8.5 to 9.25 hour of sleep a night but only 15% of them are getting enough sleep (National Sleep Foundation, 2009). This is especially true of girls (National Sleep Foundation, 2010). Lack of sleep has serious consequences for developing brains. Academically, students who get enough sleep outperform students who are sleep deprived. Interestingly, sleep deprivation can be measured in minutes. Wahlstrom's study (as cited in Bronson, 2007) of 7,000 high school students in Minnesota found that students who scored "A"s averaged 15 minutes more sleep than students who scored "B"s, who got 11 more minutes of sleep than students who scored "C"s, who got 10 more minutes sleep than students who scored "D"s. This study replicated the results of Wolfson and Carskadon (1998) who studied 3,000 teenagers in Rhode Island. Interestingly, the difference between "A" and "D" students is only 36 minutes more sleep. Link and Ancoli-Israel (1995) support this with their finding that students with GPAs of 3.5 or greater reported 7.4 hours of sleep a night while students with GPAs of less than 3.5 reported only 7 hours. These studies show that

increasing sleep by as little as fifteen minutes is associated with significant academic pay-offs.

So why is sleep so important to adolescent academic performance? Sleep deprivation has been shown to affect a student's ability to think, compromising the functioning of the prefrontal cortex that controls executive functioning: planning, organization, initiation, time management, attention, short-term memory and emotional regulation. Owens and Mindell (2005) point out that the demands and pressures of high school make teens especially vulnerable if they are sleep deprived: "Students are expected to multitask, prioritize, sort through tons of information efficiently and accurately, and think creatively. Unfortunately, these are the very skills that research shows are most compromised by loss of sleep" (Owens and Mindell, 2005, p. 229). They further state that attitudes and motivation are also compromised: "Studies show that students who are well rested are more likely to be receptive to teachers, to have a more positive self-image and to report being more motivated to do their best in school than their sleepier peers" (Owens and Mindell, 2005, p. 229-230). Finally, sleep deprived students are more prone to tardiness and absenteeism, which results in a loss of instructional time.

Sleep is also important for consolidation and recall of learning: "Consolidation represents the processes by which a memory becomes stable" (Division of Sleep Medicine, 2007). In other words, sleep is when the brain reviews learning and permanently stores that information in memory. While researchers do not agree on how memory is consolidated, they do agree that this happens during sleep. However, stored information can be difficult to access or recall if a student is sleep deprived: "Without adequate sleep and rest, over-worked neurons can no longer function to coordinate information properly, and we lose our ability to access previously learned information" (Division of Sleep Medicine, 2007). Access to learned information is critical for academic performance.

While the focus of this study is the relationship between sleep and academic performance, our research was equally prompted by a concern for adolescents' emotional health. The Anxiety Disorders Association of America states that "sleep disruption is present in nearly

While schools are not positioned to offer specific medical advice on student health and well-being, a commitment to holistic education creates the responsibility for educators to reflect critically on the development of healthy learning environments. Students and their families need to be informed about and take responsible action with regard to their social, emotional and physical well-being. It is in this spirit that we undertook a focused research project into the relationship between sleep and academic achievement at our school.

Senior students (grades 10, 11 and 12) at the school examined in the current study reported that the IB workload was such that they spent hours doing homework nightly causing them to lose sleep. These students and their parents reported that they could not achieve "balance" as described in the IB learner profile, because there were not enough hours in the day to "do it all". Homework got pushed to the end of the evening, and as a result, many students reported that they were sleep deprived. A school-wide survey of the Middle Years

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all psychiatric disorders" (Anxiety Disorders Association of America, 2010). Research indicates that sleep-deprived teenagers are at risk for developing anxiety disorders and clinical depression. While it has long been understood that many anxiety disorders disrupt sleep, only recently has the reverse been studied, and there is now evidence to suggest that sleep deprivation may, in some cases, cause anxiety disorders, depression and even mimic ADHD. Those who work with students with special education needs are well aware that there is an increase in these disorders among high school populations.

While sleep has a strong effect on mood, it can also affect self-esteem. Sleep deprivation has been linked to weight gain, acne, irritability, substance abuse and accidents, especially accidents while driving (National Sleep Foundation, 2009). For these reasons, sleep deprived teens are prone to viewing themselves as unattractive and unlovable.

In all of the discussion about sleep, it is important to remember that in adolescence, the circadian clock changes. While adolescents still need to get a good night's sleep, most are not able to fall asleep until 11pm (National Sleep Foundation, 2009). Suggesting that teenagers go to bed before 11.00 may not be a universal solution to sleep deprivation.

Programme (MYP) and Diploma Programme (DP) students revealed deep concerns about the IB workload and lack of sleep. Anecdotally, the faculty reported receiving emails from students well after midnight, indicating a possibly serious sleep problem.

Given the gap between current sleep recommendations based on a brief literature review and the behaviour of students in the school community, three key goals emerged. This study aimed to determine whether students at our school were getting recommended amounts of sleep for adolescents, what effect the amount of sleep they report has on their academic performance and whether the amount of homework and recreational technology they used had some relationship to the amount of sleep they reported and their academic performance.

METHODS

Participants

Data acquired in this study were taken from a homogeneous community. Participants were students from a single independent girls' school in the metropolitan area of a large Canadian city. The social economic status of their families is generally upper middle to upper class. The parent community is university educated, and education is

a shared community value. All of the graduates go on to university. Culturally, the school is a diverse community with many international students, reflecting the rich cultural mix for which Canada is well known.

The school is an IB World School, from junior kindergarten (JK) to grade 12. The only curricula delivered at the school are the Primary Years Programme (PYP) (JK to grade 6), the MYP (grades 7 to 10) and the DP (grades 11 and 12). This makes the school an interesting laboratory from which to examine the relationship between grades and academic performance, especially in grades 10, 11 and 12, where academic performance is externally moderated and assessed (including external assessment) against established criteria. The greatest limitation in the general literature on sleep research and academic performance is that an "A" from one class does not necessarily mean the same as an "A" from another class. The IB assessment criteria offer some control by establishing greater reliability across a global, criterion-related assessment structure.

Of note is the IB assessment scale of 1 to 7. As this is a credentialed provincial school, we are required by the provincial government to report grades on transcripts in percentages. We use the agreed upon IB provincial scale to make these conversions. Student report cards show grades in both the IB scale of 1 to 7 and the provincial percentage conversion. For the purpose of this study, the percentage grades are used in order to provide greater differentiation of students' academic achievement.

Data collection

Data was gathered from grade 10, 11 and 12 girls (n = 291) by having them fill in an anonymous survey during a mid-week advisory period at the end of November in 2010. Grade 10 students (n = 99), grade 11 students (n = 102) and grade 12 students (n = 90) filled in the survey.

Of the eleven questions in the student survey, three were the target of this study. These three questions focused on the night before the survey to capture a snapshot of a typical school night in the life of the students. It should be noted that no special school events had been scheduled for the night before the survey.

The first question asked students how long they had slept the previous night. Multiple choice responses included 3 to 4 hours, 5 to 6 hours, 7 to 8 hours, and 8+ hours. The second question asked students how much time they had spent on homework the previous night. Multiple choice responses included 1 to 2 hours, 2 to 3 hours, 3 to 4 hours, and 4+ hours. The third question asked students if after 8pm they had engaged in any of the following activities: text messaging, email, Facebook, and/or YouTube. They were asked to check all that applied.

For all of these students, their December report card averages were recorded.

Data analysis

Survey results were compiled and analysed using SPSS Version 15 (IBM Corporation). Students from all grades were divided into groups based on number of hours of sleep per night, and number of hours of homework per night. Differences in grade average between groups were assessed using a one-way analysis of variance (ANOVA) and a Tukey post-hoc test with a correction for multiple comparisons ($\alpha = 0.05$).

Students were first examined as one group where hours of sleep and hours of homework were studied. Students were then divided by grade before being grouped based on number of hours of sleep per night. Trends in grade average and number of hours of homework per night were examined for these groups.

Finally, students were divided into groups by the number of technology activities they engaged in after 8pm per night. Trends in grade average and number of hours of sleep were assessed for each of these groups.

RESULTS

One of the most alarming findings was that of all of the students surveyed, 12.03% slept 3 to 4 hours, 43.64% slept 5 to 6 hours, and 38.49% slept 7 to 8 hours. Only 5.84% of the students slept 8+ hours, which means that according to the National Sleep Foundation's definition of sleep deprivation, 94.16% of the students surveyed were sleep-deprived.

For each of the students surveyed, December grade averages were recorded (Figure 1). It is interesting to note that grade averages improved from grades 10 to 11 and again from grades 11 to 12. This was valuable information for the school community and proof that the skills girls were learning needed practice and time to be consolidated. There was a trend across the grade levels for grade averages to be at their highest between 7 and 8 hours of sleep. This finding supported those of Link and Ancoli-Israel (1995). Grade averages were significantly higher for students who got 5–6 hours of sleep compared with students who got

3–4 hours of sleep. Likewise, students who got 7–8 hours of sleep had significantly higher grade averages than students who got only 3–4 hours of sleep. It is also interesting to note that the students who slept 8+ hours did not do as well as students who slept 7–8 hours.

Students who slept 5–6 hours per night and 7–8 hours per night had mean grade averages of 84.44% and 85.51%, respectively. Results from the ANOVA showed that these two groups had significantly higher grade averages than students who slept 3–4 hours per night (80.66%) ($p = 0.05$ and $p < 0.001$, respectively).

As expected, students who did 3–4 hours of homework per night had a significantly higher mean grade average (85.51%) than students who did 1–2 hours of homework a night (82.51%). However, no relationship was found between more hours of homework and fewer hours of sleep. It appears that students do not necessarily sacrifice hours of sleep for hours of homework—again, valuable information for the school community.

The number of hours students spent on homework was then compared to grade averages (Figure 1). The trend was for grade averages to improve as hours of homework increased, maxing out at 3–4 hours. Grades were lower when homework exceeded 4 hours. However, when the grade levels were teased apart comparing hours of sleep a night, grade averages and hours of homework per night (Figure 2) an important trend became apparent. It could be inferred that 7–8 hours of sleep seems to be optimal for the students for two reasons. This was where the highest grades tended to occurr (in two of the three grade levels) and where hours of homework dipped to 2 to 3 hours a night. Our school found this to be the most important correlation in the study, suggesting a balance of sleep, homework and recreational technology use that could lead to higher levels of academic success.

The third question surveyed the use of recreational technology after 8pm. Of all of the students surveyed, 73.20% were communicating by email after 8pm, 73.54% were on Facebook, 71.13% were sending text messages, 59.35% were watching YouTube videos and only 0.06% used no recreational technology at all after 8pm. When grade averages, number of recreational technology activities and hours of sleep were compared (Figure 3), it was found that students who refrained from recreational technology after 8pm had the highest grade averages and got 7–8 hours of sleep. It was also determined that students who limited their recreational technology activities also got 7–8 hours of sleep.
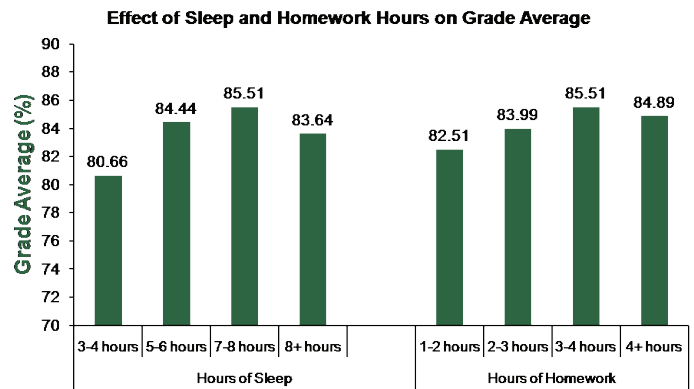

Figure 1: For all students surveyed, it was found that as hours of sleep and hours of homework increased, so did grade averages to an optimal point of 7–8 hours of sleep and 3–4 hours of homework. There was a statistically significant difference in grade average between students who got 3–4 hours of sleep and students who got 5–6 hours of sleep, and students who got 3–4 hours of sleep compared to students who get 7–8 hours of sleep.
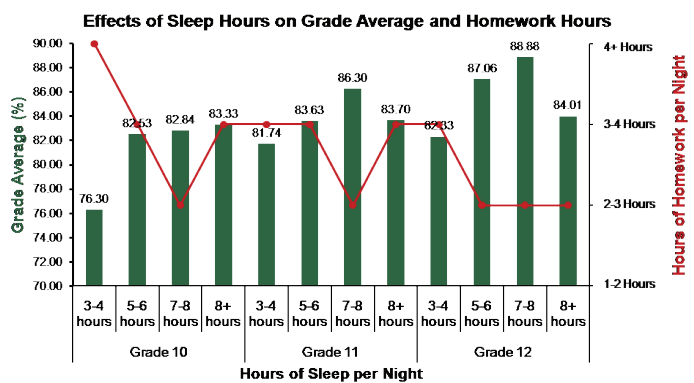

Figure 2: Students were divided by grade. Number of hours of homework per night was at a minimum when students got 7–8 hours of sleep per night. This also corresponded to a trend of optimal grade average.
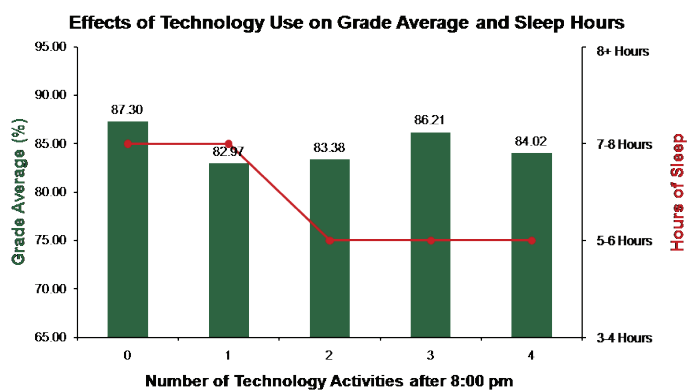

Figure 3: As the number of different recreational technology activities increased, the hours of sleep per night decreased. However, grade average was unaffected.

A trend emerged suggesting that as students increased the number of recreational technologies they used, the less they slept. (The study did not ask students how long they spent on any of these activities, as professional anecdotal observations indicated that students who multitask while doing homework were unable to estimate accurately how much time they spend on these activities.) It is also interesting to note that the number and selection of specific recreational technologies seems not to have had an effect on student grade averages.

DISCUSSION

The first research question asked whether students at our school were getting recommended amounts of sleep for adolescents. The findings of this study emphatically indicated that no, they did not. Only 5.84%, or 17 girls in the study, were meeting the sleep requirements for adolescent health and wellness as defined by the National Sleep Foundation. The next questions (what effect does sleep have on academic performance for the girls and how does homework and recreational technology activities affect their sleep and academic performance) were even more interesting. From this study, it is possible to observe that:

- girls who got 7–8 hours of sleep a night had the higher grades

- girls who did 2–3 hours of homework a night and got 7–8 hours of sleep a night tended to have the best grades

- girls who get less than optimal amounts of sleep are using time to engage in recreational technology that they could use for sleeping

- girls who devoted more than 4 hours each night to homework did not have higher grade averages.

These observations suggest that 7–8 hours of sleep a night might be optimal for the academic success of students attending this school.

However, this data must be interpreted cautiously. While this study found correlations between sleep, homework and recreational technology use on academic performance, there are many other variables that could have affected grade averages. These include and are not limited to the quality of sleep and the quality of attention while doing homework. It should also be noted that any study that relies on self-reporting is inherently subjective and not always reliable.

This study did not examine how sleep patterns affected physical and emotional health and well-being. Except for a very small percentage of the students, the girls were not getting enough sleep as recom-

mended by the National Sleep Foundation. However, 7 to 8 hours of sleep a night appears to be enough to protect their grades. Is it enough to protect their physical and emotional health? That question deserves further research.

OPERATIONALIZING THIS RESEARCH: TAKING ACTION

Now this school community is ready to test the hypothesis that reasonable homework loads, limited late-night use of recreational technology and a little more sleep are associated with academic success. Using Wolfson and Carskadon's clinical review (2003) as a guide, we offered the following recommendations:

1. Administrators should examine the academic curriculum and embed sleep education early and often into classroom instruction. Consideration should be given to including sleep education in Health and Physical Education curriculums during the MYP years.

2. The school should educate all stakeholders in the school community about the correlations found in this study and use the data to discuss how much sleep is enough, how much homework is too much, and the effect late-night recreational technological activities may have on academic success.

3. Student Services personnel should assess the sleep habits of students who are academically struggling or habitually late or absent from school. This should be a conversation with both the student and the parents.

4. Parents should be encouraged to talk to their adolescent children about their hours of sleep, hours of homework and their use of recreational technology. Good guidelines for parents to follow in these discussions as inferred from this study are 7–8 hours of sleep, 2–3 hours of homework, and limited use of recreational technology after 8pm.

Finally, in the quest to provide students with more sleep balance, the school in this study has altered its timetable to include a mid-week late start day, changing their start time on Wednesdays from 8.30 to 9.30. As it is clear from the sleep research literature that teenagers' circadian clocks change, making it difficult to fall asleep before 11 pm, the only time to catch up on sleep is in the morning. This kind of schedule adjustment gives MYP and DP students a mid-week sleep recovery, particularly important for over-tired students.
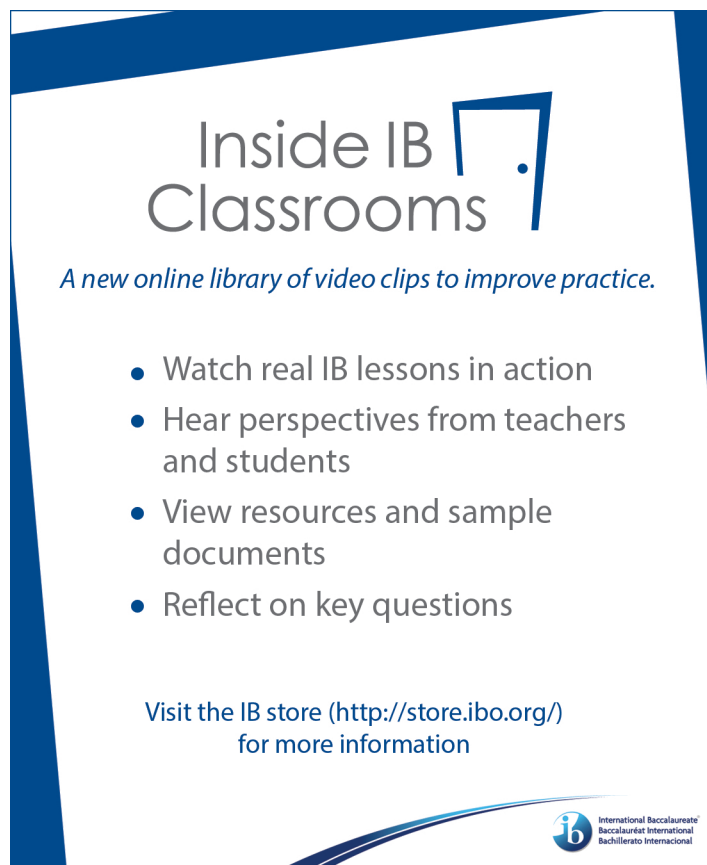
The hope of the study is that operationalizing this research is sending a strong message to this school community that reasonable homework loads, limited late-night use of recreational technology and a little more sleep are associated with academic success. More importantly, it shows that the school supports and values a balanced, healthy lifestyle for its students.

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