The Impact of Screen Time on Academic Achievement in Biology Among Secondary School Students

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Abstract

This study thoroughly investigates the relationship between daily screen time and academic achievement in Biology among Grade 10 students in Lebanon. A total of 102 students from two public schools within the same geographical region participated. The study used a quantitative correlational design over three consecutive months. Students accurately tracked their daily screen time using a reliable mobile application, ensuring data consistency. Their academic performance in Biology was evaluated through three Biology exams administered throughout the academic term. The compelling results showed a consistent, statistically significant negative correlation between daily screen time and Biology grades across all the three months. Regression analysis unequivocally revealed that daily screen time was a significant negative predictor of academic performance in Biology. Screenshots provided by participants indicated that overwhelming majority of their screen engagement was dedicated to popular social media platforms such as TikTok and Instagram. These findings can be explained by the fact that excessive screen exposure often leads to pronounced mental fatigue, shorter attention spans, and decreased ability to concentrate effectively on demanding academic tasks like Biology. Consequently, the study strongly recommends incorporating comprehensive digital hygiene education into schools. Additionally, it advocates for the promotion of targeted awareness campaigns for balanced screen use. This research distinctively fills a crucial gap in the existing literature by focusing on Biology as a specific academic subject in the Lebanese context.

Keywords

Screen time, Biology, Academic achievement, Cognitive load, Lebanese students

Résumé

Cette étude analyse la relation entre le temps d'écran quotidien et la réussite scolaire en biologie chez les élèves de 10e année au Liban. Un total de 102 élèves issus de deux écoles publiques situées dans la même région a participé à cette recherche. L'étude a adopté une approche quantitative corrélationnelle sur trois mois. Les élèves ont suivi leur temps d'écran quotidien à l'aide d'une application mobile, et leurs performances scolaires ont été évaluées à travers trois examens de biologie. Les résultats ont montré une corrélation négative constante et statistiquement significative entre le temps d'écran et les notes en biologie au cours des trois mois. L'analyse de régression a révélé que le temps d'écran constituait un prédicteur négatif important des performances scolaires. Les captures d'écran ont indiqué que la majorité du temps était consacrée à des plateformes de médias sociaux telles que TikTok et

Instagram. Ces résultats s'expliquent par le fait qu'une exposition excessive aux écrans entraîne souvent une fatigue mentale, une attention réduite et une capacité diminuée à se concentrer sur des tâches académiques exigeantes comme la biologie. L'étude recommande d'intégrer une éducation à l'hygiène numérique dans les écoles et de promouvoir des campagnes de sensibilisation visant à un usage équilibré des écrans. Cette recherche comble une lacune en se concentrant sur la biologie en tant que matière académique spécifique dans le contexte libanais.

Mots-clés

Temps d'écran, Biologie, Rendement scolaire, Charge cognitive, Élèves libanais

مستخلص

تهدف هذه الدراسة إلى تحليل العلاقة بين مدة استخدام الشاشة يوميًا والتحصيل الأكاديمي في مادة علوم الحياة لدى طلاب الصف العاشر في لبنان. شملت العينة 102 طالبًا وطالبة من مدرستين رسميتين تقعان ضمن النطاق الجغرافي ذاته. استخدمت الدراسة منهجًا كميًا ترابطيًا، أُجريت خلال فترة ثلاثة أشهر متتالية. قام الطلاب بتتبع استخدامهم اليومي للشاشة عبر تطبيق موثوق للهاتف المحمول. في الوقت نفسه، تم تقييم أدائهم في مادة علوم الحياة من خلال ثلاث اختبارات كتابية أُجريت على مدار الفصل الدراسي. أظهرت النتائج وجود علاقة سلبية ذات دلالة إحصائية واضحة وثابتة بين وقت الشاشة وعلامات مادة علوم الحياة خلال الأشهر الثلاثة. علاوة على ذلك، أظهرت تحليلات الانحدار أن وقت الشاشة كان مؤشرًا سلبيًا وهامًا للتنبؤ بانخفاض الأداء الأكاديمي في مادة علوم الحياة. وقد أشارت لقطات الشاشة التي قدمها المشاركون إلى أن الغالبية العظمى من انخراطهم في الشاشات كانت مخصصة لتطبيقات وسائل التواصل الاجتماعي الشائعة مثل "تيك توك" و"إنستغرام". يمكن تفسير هذه النتائج بأن التعرض المفرط للشاشات غالبًا ما يؤدي إلى إرهاق عقلي ملحوظ، وتشتت في الانتباه، وضعف في القدرة على التركيز بفعالية على المهام الأكاديمية الصعبة الكامنة في إتقان مفاهيم مادة علوم الحياة. بناءً على ذلك، توصي الدراسة بدمج مفهوم "النظافة الرقمية" في البرامج التعليمية، بالإضافة إلى ذلك، تدعو الدراسة إلى تنظيم حملات توعية لتعزيز عادات استخدام متوازنة للشاشات. تساهم الدراسة في سد فجوة بحثية في الأدبيات الموجودة من خلال تركيزها على مادة علوم الحياة ضمن السياق اللبناني.

كلمات مفتاحية

وقت الشاشة، علوم الحياة، التحصيل الدراسي، الحمل المعرفي، تلاميذ لبنان

1. Introduction

Secondary education is now more than ever dominated by digital technologies, which signifies a massive transformation in the school learning environment (Qureshi et al., 2021). As a result, electronic devices are used by students on a regular basis, leading to an increase in screen time as they engage with educational content, socialize and play games (Mupalla et al., 2023). While technology presents new avenues for learning, it also introduces challenges regarding its effects on student academic achievement (Monserate, 2018).

In particular, Biology plays a crucial role in developing critical thinking skills, practical problem-solving abilities, and an understanding of living systems (Ibrahim et al., 2023). Given the complexity of this subject, there is a growing body of academic work examining the impact of screen time on secondary students' academic achievement in Biology. Mastering this subject requires two essential components: conceptual understanding and the ability to memorize intricate details. Both of these components are sensitive to the detrimental cognitive effects that may arise from excessive or irregular screen use (Firth et al., 2019).

Furthermore, as digital technologies have evolved, they have significantly altered the way Biology is taught and learned. Online videos, simulations, and applications have the potential to enhance comprehension when used appropriately (Nietbaeva, 2023). However, it is important to note that excessive digital use, particularly for non-educational purposes, can detract from the time and mental effort students allocate to their coursework (Oliveira et al., 2023). This issue is particularly concerning in the context of Biology, which necessitates a strong focus and the ability to establish connections between abstract scientific concepts.

Moreover, increased screen time can negatively affect students' sleep patterns and concentration levels, both of which are essential for effectively processing complex scientific material (Kushwaha et al., 2024). Given that a significant number of Lebanese adolescents have regular access to smartphones, coupled with the country's growing reliance on digital tools in education, it becomes critical to examine how this exposure to screens impacts core subjects. While few

studies in Lebanon have addressed this issue with a focus on Biology, the current investigation is both timely and relevant. According to the literature review conducted for this study, no previous research has specifically explored the relationship between screen time and academic performance in Biology as a distinct subject over a three-month period among Lebanese secondary students.

Consequently, this study fills an important gap by offering a subject-specific, time-sensitive, and culturally contextualized analysis of how digital behavior intersects with academic performance. The findings advocate for more focused investigations that move beyond general GPA metrics, urging researchers to explore how screen time influences performance in key scientific disciplines.

1.1.   Significance of the Study

This study's significance lies in empirically investigating the relationship between daily screen time and academic achievement in Biology among Lebanese Grade 10 students, addressing the pervasive influence of digital engagement on learning outcomes. This investigation will provide a much-needed supplement to current research because it specifically examines biology, which is a fundamental area for developing scientific literacy and driving innovative advancements (Nizomova et al., 2023). Its findings will provide vital insights for policymakers and educators to develop evidence-based digital literacy policies and foster balanced digital environments conducive to academic success, especially given the unique considerations of contemporary screen use and the critical need to examine its unanticipated benefits and drawbacks in educational contexts.

This study is guided by two principal research questions:

•   Is there a statistically significant relationship between screentime and academic achievement in Biology of secondary students?

•   Is screen time a significant predictor of academic achievement in Biology of Secondary students?

1.2.   Research Hypotheses

Hypothesis 1: There is a statistically significant negative relationship between screentime and academic achievement in Biology among secondary students.

Hypothesis 2: Screen time is a significant predictor of academic achievement in Biology among Secondary students.

2. Literature Review

A great number of studies show that high screen use leads directly to poor academic performance among secondary school biology students. Exceeding recommended screen time limits creates poor academic results, mainly due to a decrease in study duration, cognitive growth limitations and interruptions to physical activity patterns (Gupta et al., 2023; Manuja et al., 2024). Moreover, research shows that heavy screen time negatively affects mental performance, since students who are learning biology need strong attention spans and memory to practice critical and analytical thinking (Mupalla et al. 2023). Recent studies demonstrate that television viewing and gaming activities produce opposite educational results to scientific academic achievements (Adelantado-Renau et al., 2019). Sustaining attention in biology learning becomes difficult, because of the student's usage of screens before bedtime which results in reduced sleep time which leads to more tiredness during the day (Pérez-Chada et al., 2023). Digital tools possess the potential to offer significant benefits when utilized appropriately; however, excessive screen time can lead to detrimental effects. Research demonstrates that the performance of biology students is enhanced through the use of interactive digital media, provided that students strike a balance between screen time, sleep, and physical activity (Clemente-Suárez et al., 2024). Nevertheless, there remains a notable gap in the literature regarding the impact of varying amounts of screen time on academic achievement in biology, thereby underscoring the necessity for targeted future research.

Furthermore, in the context of Lebanon, additional research highlights that younger adolescents are particularly vulnerable to Internet Gaming Disorder (IGD), which has a prevalence rate of 9.2%

among high school students. Those suffering from IGD typically average only 5 hours of sleep per night, in contrast to the 7 hours logged by casual gamers (Hawi et al., 2018). This lack of adequate rest correlates with diminished academic performance, as these individuals often achieve grades that fall below passing levels (Hawi et al., 2018).

Moreover, excessive use of social media among university students in Lebanon is associated with lower GPAs, increased absenteeism, and reduced rates of academic passing. The compulsive nature of social media engagement, combined with time displacement, adversely affects students' academic engagement and overall success (Hamam et al., 2023). Thus, these findings collectively emphasize the importance of further inquiry into the balance between digital engagement and academic achievement, particularly in specific educational contexts like Biology.

Although some studies show that digital integration in Biology subject has a positive impact on student's performance, numerous studies prove that it can have serious negative impacts on cognitive development and academic achievement.

3. Methodology

3.1. Research Design

The study used a quantitative, correlational research design to study how secondary school students' screen time affects their biology academic achievement. The research examined whether the amount of screen time showed meaningful predictions about secondary students' achievement in biology, through the collection of the amount of screen time of each student over one academic term, which was then correlated to their grades.

3.2. Sample

The target population included 102 biology secondary students aged between 15 and 18 years old and coming from 2 different schools, using a stratified random sampling technique. The inclusion criteria were regular attendance at biology classes and access to digital devices, which ensured the relevance of screen time to their academic activities in Biology.

3.3. Tools

The research used several tools to achieve its aim, these tools being:

1. Screen Time Tracker (weekly): Students were required to log their daily screen time using a digital tracking app (Action Dash), detailing their total daily screen usage. Where they sent a screenshot in a weekly manner on a Google form to collect the data.

2. Biology Academic Grades: Biology grades that were collected from tests administered throughout the academic term will be used to measure the academic achievement of the students.

Correlation Analysis: The relationship between the recorded screen time and biology grades was measured using Pearson's correlation coefficient to determine the strength and direction of the association. In addition, regression analysis to determine if screen time is a significant predictor of academic achievement.

3.4. Procedure

The study was conducted over one academic term. Students were required to log their daily screen time using the Action Dash app and submit screenshots weekly via a Google form. Biology grades were collected from tests administered throughout the term. The data was then analyzed to determine the relationship between screen time and academic achievement.

3.5. Data Analysis

Pearson's correlation coefficient was used to analyze data to assess the strength and direction of the relationship between screen time and biology grades. Screen time was examined in regression analysis to determine if it is a serious determinant of academic achievement.

3.6. Reliability and Validity

Previous research showed that the mean bias of Action Dash was not significant, -0.8 minutes per day, versus a reference method, demonstrating that it was able to effectively observe screen time (Wang, 2022). Moreover, the correlation coefficient of 0.99 implies that Action Dash takes equivalent measurements more than some time, so users who are worried about their screen propensities can trust it (Wang, 2022).

To further guarantee the reliability and validity of the instruments used in the study, a pilot test was conducted before the main research. This phase involved a small, representative sample of five secondary school biology students who completed both the screen time tracking and the biology tests under conditions similar to those of the main study. The pilot test aims to identify any potential issues or ambiguities in the data collection process and refine the instruments for clarity and accuracy. In addition, an expert PhD holder reviewed the three exams used in collecting the students' grades. Feedback from participants and an analysis of the pilot data were used to make necessary adjustments to the app instructions and test items, thereby enhancing the precision and reliability of the measurements in the main study.

Students had to use the app throughout the entire academic term to ensure Screen Time Tracker's reliability. The established statistical methods were used in conducting correlation and regression analyses for reliable results.

3.7. Ethical Consideration

Ethical considerations included obtaining informed consent from students and their parents, ensuring confidentiality of the data collected, and providing students with the option to withdraw from the study at any time without any consequences.

4. Results and Discussion

4.1.   Main Findings

This section presents the descriptive and inferential findings of the study, which examined the relationship between daily screen time and academic performance in Biology over three months among Grade 10 students. The results include descriptive statistics, Pearson correlation analyses, and linear regression models to assess the predictive value of screen time on Biology achievement.

This section presents the descriptive and inferential results of the study on exploring the relationship between daily screen time and academic performance in Biology for Grade 10 students over a period of three months. Descriptive statistics, Pearson correlation analyses, and linear regression models were used to assess the screen time and whether it has predictive value on Biology achievement.

All participants were students from two public schools located in the same region and of comparable socioeconomic background. Each student owned a personal smartphone. To ensure reliability, students who failed to report their screen time consistently across all three months were excluded from the final dataset, reducing bias in the results. Moreover, pilot testing was conducted on five students, and the outcome was used to refine the questions before the procedure.

4.1.1.   Descriptive Statistics

The descriptive statistics in Table 1 summarise students' daily screen time and Biology grades over the three months. The mean daily screen time was highest in the second month (M = 402.97 minutes), followed by the first (M = 385.44) and third (M = 368.60). Biology grades slightly increased in the second month (M = 11.98) compared to the first (M = 11.50), before decreasing again in the third (M = 11.55). Standard deviations for screen time and grades were notably high across all three months, indicating wide variability among students.

These fluctuations may correspond to contextual factors. The first month included the Christmas–New Year vacation, the second had no holidays, and the third month was disrupted by Al-Fitr and Teacher's Day breaks.

Table 1 - Descriptive Statistics of Screen Time and Biology Grades

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
1st month daily screen time (min)	102	29	787	385.44	148.765
DST (min) daily screen time 2nd month	102	29	855	402.97	180.993
DST (min) daily screen time 3rd month	102	84	772	368.60	143.205
M1 grades 1st month grades	102	2.5	19.5	11.500	4.4649
M2 grades 2nd month grades	102	2.5	20.0	11.975	4.5952
M3 grades 3rd month grades	102	1.0	18.0	11.554	4.1933
Valid N (listwise)	102				

4.1.2. Correlation Analysis

As shown in Table 2, Pearson correlation analyses revealed significant negative relationships between daily screen time and Biology grades for each month:

- Month 1: $r = -0.368$, $p < .001$

- Month 2: $r = -0.381$, $p < .001$

- Month 3: $r = -0.412$, $p < .001$

These results indicate that higher daily screen time is consistently associated with lower Biology performance. Notably, the negative correlation strengthened across the months, suggesting a potential cumulative cognitive or behavioral effect of prolonged screen exposure on academic achievement.

Table 2 - Pearson Correlations between Screen Time and Biology Grades

Month	Pearson's r	Sig. (2-tailed)	N
Month 1	-0.368	.000	102
Month 2	-0.381	.000	102
Month 3	-0.412	.000	102

4.1.3. Regression Analysis

To determine whether screen time significantly predicted Biology performance, three simple linear regression models were developed—one for each month. Each model was statistically significant, with screen time emerging as a consistent negative predictor of academic achievement.

As presented in Table 3, the models revealed:

- Month 1:

  - $R^2 = .135$, $F(1,100) = 15.667$, $p < .001$

  - B = -0.011 → Each additional minute of screen time is associated with a 0.011-point decrease in Biology grades.

- Month 2:

  - $R^2 = .145$, $F(1,100) = 16.937$, $p < .001$

  - B = -0.010

- Month 3:

  - $R^2 = .170$, $F(1,100) = 20.479$, $p < .001$

  - B = -0.012

Table 3 - Regression Analysis Summary

Month	R²	B (Unstandardized)	Std. Error	t	Sig. (p)	F(df)
Month 1	.135	-0.011	0.003	-3.96	.000	15.667 (1,100)

Month 2	.145	-0.010	0.002	-4.12	.000	16.937 (1,100)
Month 3	.170	-0.012	0.003	-4.53	.000	20.479 (1,100)

The strength of prediction increased slightly in the third month, further supporting the idea that excessive and sustained screen time may increasingly impair academic performance over time.

4.1.4. App Usage Pattern

To provide context for the screen time data, students submitted weekly screenshots from their tracking apps. A representative screenshot (Figure 1) showed that students primarily used TikTok (22 hours 38 minutes), Instagram (9 hours 2 minutes), and WhatsApp (8 hours 15 minutes). These apps, dominated by passive scrolling and entertainment, are unlikely to contribute positively to academic engagement or cognitive readiness for study, especially in a subject like Biology that requires analytical focus and memory consolidation.

Figure 1 - Screenshot of Weekly App Usage from Student Submission

4.1.5. Summary of Findings

The results demonstrate a consistent pattern: students with higher daily screen time tended to perform worse in Biology. Both the correlation and regression analyses confirm that screen time is a statistically significant negative predictor of Biology achievement across all three months. Additionally, the third month, despite a drop in screen time, saw the lowest academic performance, possibly due to reduced school days and academic pacing after spring holidays.

Efforts to control for sample bias, school type, and curriculum exposure helped strengthen the internal validity of the results. The findings highlight the importance of managing digital engagement, especially on platforms like TikTok and Instagram, to support students' academic success in complex scientific subjects.

4.2. Discussion

This section discusses the main findings of the study within the context of educational theory and existing research. The aim was to investigate the relationship between screen time and Biology academic achievement among Grade 10 students over three months. The findings consistently revealed a negative association between increased daily screen time and performance in Biology. These results are interpreted below, comparing them to findings of previous literature. Educational implications and research limitations are also addressed.

4.2.1. Comparison with Previous Research

The current findings are in alignment with a body of research highlighting the detrimental impact of excessive screen time on academic performance. Gupta et al. (2023) found that digital screen time was inversely related to school performance due to decreased study hours and increased distractions. Manuja et al. (2024) emphasized the link between screen exposure and delayed cognitive development among adolescents, especially during post-pandemic learning recovery phases.

Moreover, Firth et al. (2019) demonstrated that chronic internet use may alter neural pathways, affecting concentration and long-term memory. These findings directly support the observed negative relationship in this study. Similarly, Pérez-Chada et al. (2023) highlighted that screen use before bedtime leads to reduced sleep quality, which in turn impacts academic performance — a likely contributing factor in the present study, given the evening screen time reported.

While Clemente-Suárez et al. (2024) acknowledged the potential benefits of digital learning tools, they emphasized that balance is key. Without regulation, screen time tends to tip toward entertainment and social media rather than academic use, as confirmed by the screenshot analysis showing dominant use of TikTok and Instagram.

Additionally, the current study builds upon previous work by narrowing the focus to Biology, rather than overall GPA, thereby offering more discipline-specific insights. Past studies often assessed general academic outcomes (Adelantado-Renau et al., 2019), which, although

informative, overlooked the cognitive demands of science-based learning. Biology requires sustained attention, critical reasoning, and strong memory retention—all of which are negatively affected by overstimulation from digital media (Mupalla et al., 2023).

Furthermore, in the Lebanese context, this study echoes findings by Hawi et al. (2018) and Hamam et al. (2024), who showed that problematic digital habits such as internet gaming and compulsive social media use significantly undermine academic engagement. However, unlike these broader behavioral studies, the present research introduces a month-by-month regression and correlational analysis, offering temporal depth that allows for tracking academic impact over time.

To summarise, this study not only confirms but also refines existing research, emphasising that screen time's impact is particularly detrimental when persistent and entertainment-based, especially in subjects that demand high levels of cognitive control like Biology.

4.2.2. Educational Implications

The study's findings underscore the importance of promoting digital discipline among secondary students. Teachers, parents, and school administrators should be aware of the strong correlation between screen exposure and reduced academic performance, particularly in scientific subjects. Biology educators can integrate digital literacy modules into their lessons, helping students distinguish between productive and counterproductive screen use.

Furthermore, schools may benefit from organising awareness workshops focused on time management, healthy device use habits, and the neurological impact of screen addiction. Policymakers could also consider incorporating screen-time regulation and mental focus strategies into the national health and civic education curriculum. These interventions are critical in helping students develop executive functioning skills necessary for academic success.

4.2.3. Study Limitations

Despite its contributions, the study has several limitations. First, while the ActionDash app offers reliable tracking, screen time still relies on student compliance and weekly screenshot uploads, which may introduce measurement bias. Second, Biology test difficulty and teaching style may

have slightly varied between the two schools, although the curriculum was consistent. Additionally, the study focused only on daily screen time duration, not the exact nature of content consumed or multitasking behaviors. Future research may benefit from including screen content classification (educational vs. entertainment) and cognitive assessments.

5. Conclusion and Recommendations

This study examined the impact of daily screen time on the academic achievement of Grade 10 students in Biology over a three-month period. Using quantitative methods, including correlation and regression analyses, the study revealed a consistent and statistically significant negative relationship between the amount of daily screen time and Biology test performance. As screen time increased, students' academic achievement decreased, with the predictive effect growing stronger over the three months.

These findings support the fact that excessive screen exposure, especially for entertainment purposes, overloads the cognitive system and diminishes the brain's capacity to process and retain academic content. The data also aligns with national and international research that has identified digital distraction and screen fatigue as serious barriers to adolescent learning.

Based on the results, several practical recommendations can be drawn:

- Educational Awareness: Schools should conduct workshops for students and parents to promote awareness of the cognitive and academic effects of excessive screen use.
- Curriculum Integration: Digital wellness education should be integrated into health or civic studies to promote balanced screen habits, particularly before exams.
- School-Level Interventions: Teachers could incorporate screen time tracking as part of biology class activities, helping students reflect on their tech usage and its academic consequences.
- Policy Guidance: Educational policymakers may consider issuing screen-time guidelines or "digital hygiene" recommendations for schools, especially in science-intensive academic tracks.

In conclusion, managing screen time is no longer a lifestyle choice but a pedagogical and psychological necessity. The evidence provided in this study points toward a need for coordinated efforts between families, schools, and ministries to foster digital habits that support, rather than undermine, student achievement.

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