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# The complexities of digital media use in adolescents' learning and academic performance: An experience sampling study

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ABSTRACT

The increasing amount of time adolescents spend engaged with digital media has raised concerns about its impact on academic performance. This study investigates the relationship between adolescents' digital media use and academic performance, considering the mediating role of time spent on schoolwork. Between September and November 2022, 3087 responses were collected from 343 Austrian students using the experience sampling method. The data captured the use of social media, gaming, surfing the Internet, video streaming, and audio streaming, as well as time dedicated to schoolwork and the frequency of educational digital media use. Multilevel structural equation modeling revealed that social media use, gaming, and video streaming were negatively associated with school-related obligations. In contrast, Internet use positively correlated with time spent on schoolwork. Additionally, gaming showed a direct negative association with academic performance. These findings suggest that while certain digital activities are likely to displace time spent on schoolwork, their use does not necessarily lead to poorer academic outcomes, except for gaming. Other digital activities can provide educational benefits, such as surfing the Internet. Recognizing the risks and opportunities of digital media use is key to guiding effective educational strategies.

## 1. Introduction

Adolescents' high engagement with digital media has prompted concerns about its impact on learning (Sunday et al., 2021) and academic performance (e.g., Adelantado-Renau et al., 2019; Paulich et al., 2021). Digital media encompasses a wide range of new media forms and activities, including the Internet (e.g., websites, forums, and video/image-sharing platforms), communication platforms (e.g., social media and messaging apps), and games (Nesi et al., 2022). At the center of the debate surrounding the interplay of digital media use and adolescents' academic performance are two opposite presumptions, namely the stimulation vs. displacement hypothesis.

The stimulation hypothesis suggests that digital media use can promote positive social and academic outcomes, particularly when

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adolescents leverage it for educational purposes (Wang et al., 2024) or socially oriented digital media use (Marciano et al., 2023). Positive correlation between digital media use and academic achievement may be attributed to several factors, such as enhanced social networks (Ellison et al., 2011), the use of multimodal learning (Jocius, 2013), and the adoption of a student-centered approach that encourages autonomy, collaboration, and creativity (e.g., Wolfe et al., 2013, in Wang et al., 2024). Moreover, a recent meta-analysis indicates that systematic integration of digital media technology can improve deep learning outcomes (Wu, 2024).

On the other hand, scholars note that time is a scarce resource, and media and non-media activities compete for it (Seufert & Wilhelm, 2014). In this context, the displacement hypothesis posits a zero-sum scenario, wherein time spent on digital media reduces the time available for academic pursuits, potentially diminishing educational engagement and performance (Chen et al., 2020; Vilhelmson et al., 2017). Specifically, an increase in digital media use may lead to decreased allocation of time dedicated to school-related tasks, such as studying, completing homework assignments, and preparing for school (Gentile et al., 2011; Marker et al., 2018; Valkenburg & Peter, 2007). This may, in turn, have a negative impact on the academic performance of youth.

Despite a substantial body of literature examining the relationship between digital media use and academic performance, the findings remain inconclusive and mixed. What becomes evident is that the impact of digital media use on academic performance varies significantly depending on the respective digital media activity. For example, searching the Internet for information, engaging in learning communities (Graff, 2006; Kim et al., 2017), or playing educational games (Liu, 2016; Zeng et al., 2020) can enhance school performance. In contrast, excessive Internet use (Kim et al., 2017), frequent online instant messaging (Huang & Leung, 2009), and heavy digital gaming have been linked to diminished academic outcomes, including lower self-reported grades and increased instances of tardiness (Gentile, 2009; Gentile et al., 2012; van Rooij et al., 2014).

Building on this body of research, two key points stand out that this study wants to address: First, existing research frequently concentrates on a singular media activity, such as social media or gaming, or collapses multiple activities into an aggregate measure of screen time; thereby overlooking the heterogeneous digital media repertoires of adolescents (Geers, 2020) and the variations in purpose and content, such as the distinction between entertainment and educational use. Second, existing studies overlook underlying mediators related to stimulation and displacement effects in the context of digital media use and academic performance. In this study, we are particularly interested in the role of school-related obligation time: Previous studies demonstrate the effects of digital media use, such as digital gaming and online communication, on time spent on schoolwork (Reinhardt, Wilhelm, & Mayen, 2023). Thus, we want to investigate whether the displacement of school-related obligation time is the main driver behind negative media effects on school performance. Third, we are interested in the actual share of adolescents' educational digital media use compared to their overall digital media use, as some scholars posit a positive association between educational digital media use and academic outcomes (e.g., Sanders et al., 2019). However, it is unclear whether the educational use of digital media is already a notable aspect of adolescents' everyday digital media habits or if homework and learning largely occur outside these platforms.

In this context, we analyze the relationship between adolescents' digital media use and their academic performance, considering time allocated to schoolwork as a potential mediator. We also explore the frequency of various digital media activities for educational purposes. To capture adolescents' real-time media use patterns, we employ the Experience Sampling Method (ESM). The findings of this study provide actionable insights for parents, educators, and policymakers on the potential risks and benefits of digital media use for academic outcomes.

## 2. Digital media use, school-related obligation time, and academic performance

This section reviews the literature on five common digital media activities among young people: Social media use, gaming, Internet use, video streaming, and audio streaming (Rideout et al., 2022).

### *2.1. Social media use*

With the steep growth of social media use in recent years (Twenge et al., 2019), there has been a corresponding rise in studies examining its association with academic performance. In line with the displacement hypothesis, the significant amount of time young individuals spend on social media, maintaining constant connectivity, is thought to divert attention from learning activities and reduce the time for cognitive development, especially when coupled with excessive multitasking (Baumgartner et al., 2017; Hu & Yu, 2021). On the other hand, meta-analyses by Appel et al. (2020) and Marker et al. (2018) suggest that social media use does not necessarily harm academic performance, including grades. However, a longitudinal analysis of the Programme for International Student Assessment (PISA) database from 2009 to 2018 revealed that social media use is a hindrance to performance, with negative effects increasing over time (Hu & Yu, 2021).

In terms of school-related obligation time, meta-analytical evidence indicates that social networking sites do not significantly affect study time among adolescents and undergraduates in terms of school-related obligations (Marker et al., 2018). In contrast, online communication was identified as a small but significant negative predictor of schoolwork in a secondary analysis of time-use data spanning 20 years (Reinhardt, Wilhelm, & Mayen, 2023). This finding could be related to the growing popularity of messenger apps, which may facilitate involvement in online learning communities and potentially enhance school-related engagement (Graff, 2006; Kim et al., 2017). Based on the literature, we ask:

RQ1: How is social media use associated with (a) the time spent on school-related obligations and (b) students' academic performance?

### 2.2. Gaming

A substantial body of research indicates that both prolonged gaming sessions and disordered gaming are detrimental to adolescents' academic performance (Gentile, 2009; Gentile et al., 2012; Gnambs et al., 2020; Van Den Eijnden et al., 2018). Even non-pathological levels of gaming have been linked to poorer academic outcomes (Chen et al., 2020). Research has indicated a correlation between gaming and high levels of flow—complete absorption in an activity (Cai et al., 2022; Rutrecht et al., 2021)—and strong immersion (Cairns et al., 2014). Therefore, digital gaming's immersive nature increases the likelihood of displacing other activities, including, but not limited to, educational activities (Chen et al., 2020). This is also displayed in literature, showing that heavy digital gaming is expected to be negatively associated with time spent on schoolwork (e.g., Gentile, 2009; Gentile et al., 2012; Reinhardt, Wilhelm, & Mayen, 2023; van Rooij et al., 2014). We therefore hypothesize:

**H1**. Digital gaming will negatively affect (a) the time spent on school-related obligations and (b) students' academic performance.

### 2.3. Internet use

Research concerning the relationship between Internet use (e.g., using Google for information search, surfing the Internet, reading news online) and youths' school performance points to largely positive but context-specific outcomes. As mentioned earlier, some web-based activities, such as using the Internet for educational purposes (e.g., using a computer for homework; Sanders et al., 2019), using email, reading news online, and web browsing (Hu & Yu, 2021) have been associated with positive educational outcomes, supporting stimulation effects. In line, a three-generational study investigating the effects of digital media use on school-related obligation times demonstrates a positive relationship between time spent using the Internet for information-seeking and time spent on school-related tasks (Reinhardt, Wilhelm, & Mayen, 2023). We hypothesize:

**H2**. Surfing the Internet will positively affect (a) the time spent on school-related obligations and (b) students' academic performance.

### 2.4. Video streaming

Although video streaming platforms (e.g., YouTube, Netflix) are the most popular among youth (Rideout et al., 2022), few studies have investigated their impact on academic performance. While some studies indicate that the immersive nature of on-demand streaming services may result in a loss of control over viewing duration (Flayelle et al., 2022), few have specifically examined the relationship between both problematic (e.g., binge-watching) and non-problematic viewing behaviors and academic outcomes. On the one hand, it has been demonstrated that video streaming platforms such as YouTube play a significant role in the learning of adolescents, motivating them to search for specific information and to learn at their own pace, for example, by adjusting video speed (Pires et al., 2022). However, it must also be acknowledged that such platforms are mostly used for entertainment purposes. While studies on the relationship between entertainment-related video streaming and academic performance are lacking, prior research indicates a negative correlation between television viewing and academic performance, particularly when viewing exceeds 2 h (Tremblay et al., 2011)—a pattern that may also apply to video streaming platforms. Moreover, Skvarc et al. (2021) found a negative association between educational television viewing and academic performance among children and adolescents.

Based on the mixed results, we ask:

RQ2: How is video streaming associated with (a) the time spent on school-related obligations and (b) students' academic performance?

### 2.5. Audio streaming

The impact of audio streaming (e.g., Spotify for music or podcasts) on adolescents' academic performance is understudied, although 76 % of adolescents report at least occasional use of music during academic tasks (Rideout, 2015). Experimental studies have shown a positive correlation between music-based interventions and enhanced attention (Kasuya-Ueba et al., 2020), an important aspect of academic performance (Rueda et al., 2010). However, other research indicates that using media during academic tasks (i.e., multitasking while learning) generally impairs cognitive abilities, which may result in poorer academic outcomes (Uncapher et al., 2017; Van Der Schuur et al., 2015). Also, the relationship between audio streaming and time spent on schoolwork time is uncertain: On the one hand, listening to the radio was found to be a typical background activity that does not affect the time spent on school-related tasks (Reinhardt, Wilhelm, & Mayen, 2023). On the other hand, unlike radio, audio streaming platforms offer not just music but also podcasts, which provide much deeper information and require significant cognitive effort to follow the story. Given the inconclusive research findings, we ask:

RQ3: How is audio streaming associated with (a) the time spent on school-related obligations and (b) students' academic performance?

### 2.6. The mediating role of school-related obligation time

The literature underscores the importance of time spent on schoolwork beyond the classroom, including homework and self-study, as a pivotal factor in fostering student engagement and optimizing academic performance (for meta-analyses, see Cooper et al., 2006; Fan et al., 2017; Grodner & Rupp, 2013). From a time-use perspective, some studies report a decline in study time among adolescent cohorts (Vilhelmson et al., 2018), while others showed that adolescents' school-related obligation time remains unaffected by the sharp increase in digital media use (Reinhardt, Wilhelm, & Mayen, 2023). Scholarly interest in the relationship between youths' digital media use and time spent on schoolwork stems from the premise that learning time, including homework, enhances academic achievement (Cooper et al., 2006; Fan et al., 2017; Jez & Wassmer, 2015). However, to the best of our knowledge, no study has examined this pathway in its entirety (Fig. 1). Therefore, we hypothesize:

**H3**. Time spent on school-related obligations mediates the effects of students' digital media use on academic performance.

## 3. Methods

### 3.1. Data collection

This study is part of a larger project examining the interplay between youth digital media use, well-being, and academic performance. Prior to data collection, the study was registered on OSF (https://osf.io/rh7np/?view_only=cc847fd02a5e40e780f74146dc326fef)[2] and approved by the ethics committee of the University of Vienna. Participants were recruited from nine schools in two urban cities in Austria, representing different types of schools (high school, middle school). Eligible students were required to be at least 11 years old. Data collection occurred from September to November 2022 and was initiated by an online baseline survey, which was followed by a one-week experience-sampling method (ESM) study. Prior to data collection, informed consent was obtained from all participants. For students aged 14 and above, this was provided directly by the students themselves; for those below the age of 14, consent was provided by a parent or legal guardian. Consent forms were distributed through participating schools and re-collected once completed. The forms stated that participation was voluntary and that participants could withdraw from the study at any time without penalty. Contact information for the researcher was provided to facilitate withdrawal requests.

During the ESM study, participants received prompts ("beeps") via text message on their smartphones, providing them with a link to the survey. The 15-min baseline survey was conducted on Monday at 5 p.m. and measured all relevant sociodemographic variables, including age, gender, educational level, and cultural background. Subsequently, participants were prompted on two consecutive school days (Tuesday and Wednesday) and one weekend day (Saturday), with a total of three prompts per day (i.e., nine prompts in sum). The ESM survey measured participants' time use and experiences during the previous hour, including questions on digital media use, time spent on schoolwork, and digital media used for educational purposes. The prompts were scheduled at 2 p.m., 4:30 p.m., and 7 p.m. on school days and at 11 a.m., 2 p.m., and 5 p.m. on weekends. All participating adolescents were compensated with €5.

### 3.2. Analytical sample

In order for participants to be included in the final study sample, it was necessary for them to respond to the baseline survey on the first day of the study. The final study sample ($N_{ESM} = 3537$) represents the total number of completed ESM surveys, taking into account that each participant was invited to complete nine ESM surveys (excluding the baseline survey). During the data cleansing process, participants who answered fewer than three ESM surveys were dropped from the analytical sample to ensure sufficient within-person variability (Sun et al., 2021). Consequently, the analytical sample comprises 343 eligible adolescents with 3087 completed ESM surveys.

As indicated in Table 1, the mean age of participants was 14.43 years ($SD = 1.79$; range = 11–20; median = 14), with 55.7 % ($N = 191$) of participants identifying as female. With regard to the participants' educational level, 77.8 % were enrolled in high school, while 22.2 % were in middle school. In the Austrian academic system, adolescents typically attend middle school between the ages of 10 and 14. Following this, students may opt to attend high school (typically between the ages of 14 and 18), which prepares them for university.

Furthermore, 42.3 % of the participants ($N = 145$) indicated that German is their mother tongue, which is consistent with the ethnic distribution observed in the respective school districts.

[2] To ensure transparency, we note minor changes from the pre-registration. Specifically, we restructured the research questions for better alignment with the literature and clarity. We framed social media use as a research question and proposed a directed hypothesis for surfing the Internet to closely align with the current literature. Moreover, we accounted for the multilevel structure of our data, applying multilevel SEM in the analyses.

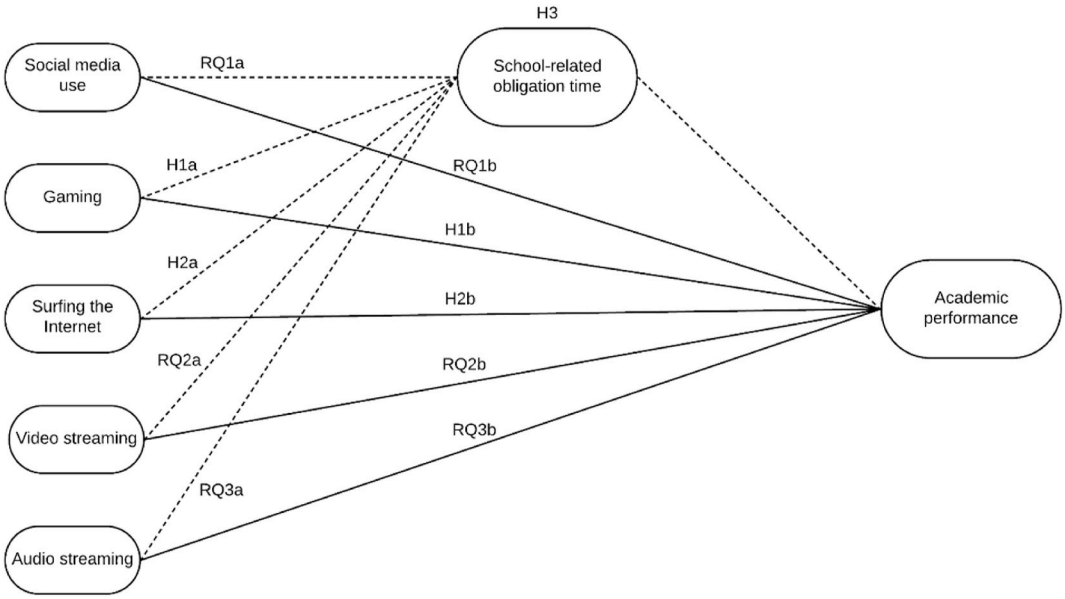


**Fig. 1.** Conceptual model with mediation paths.

**Table 1**
Sample characteristics at baseline survey.

| | % (*N*) | Mean (*SD*) |
|---|---|---|
| Age | | 14.43 (1.79) |
| Gender | | |
| Female | 55.7 (191) | |
| Male | 44.3 (152) | |
| Native German speaker | 42.3 (145) | |
| Educational level | | |
| High school | 77.8 (267) | |
| Middle school | 22.2 (76) | |
| Academic performance | | 3.27 (.96) |
| Socioeconomic status | | 3.18 (1.43) |
| Deficient self-control | | 2.51 (.87) |

Note. $N = 343$.

### 3.3. Variables and measures

#### 3.3.1. Digital media use

The use of digital media during the previous hour was evaluated by assessing five specific activities: Internet use, digital gaming, social media use, video streaming, and audio streaming. Participants selected one of the following values at 15-min intervals using a drop-down menu: 1 (“not at all”), 2 (“under 25 min”), 3 (“under 30 min”), 4 (“under 45 min”), and 5 (“above 45 min”); $M_{internet} = 1.53$, $SD_{internet} = .92$; $M_{gaming} = 1.48$, $SD_{gaming} = 1.08$; $M_{socialmedia} = 2.00$, $SD_{socialmedia} = 1.32$); $M_{video} = 1.79$, $SD_{video} = 1.27$; $M_{audio} = 1.62$, $SD_{audio} = 1.13$.

#### 3.3.2. Time spent on school-related obligations

Participants were asked to report the amount of time they spent on schoolwork (e.g., homework, studying) during the previous hour. The survey used a drop-down menu format, where students selected one of the following values at 15-min intervals: 1 (“not at all”), 2 (“under 25 min”), 3 (“under 30 min”), 4 (“under 45 min”), and 5 (“above 45 min”); $M_{schoolwork} = 2.10$, $SD_{schoolwork} = 1.44$.

#### 3.3.3. Academic performance

We assessed students’ academic performance using the course grades in mathematics and German from the previous semester. In the Austrian grading system, a grade of 1 is the highest achievable, while a grade of 6 is the lowest. The mean grade for mathematics was 2.72 ($SD = 1.15$), and the mean grade for German was 2.74 ($SD = 1.08$). Afterward, we calculated the overall academic performance measure as the mean of the grades ($M = 2.73$, $SD = .96$).

#### 3.3.4. Digital media use for education and learning

In addition to assessing digital media use, participants were asked if they had used the Internet, digital gaming, social media, video streaming, and audio streaming for educational purposes in the previous hour. This included activities such as accessing online resources and watching educational videos on YouTube. Participants were allowed to provide multiple responses. For each digital media activity, participants indicated whether they had used it for educational purposes (1 = used; 0 = not used).

#### 3.3.5. Covariates

The covariates in the study included age, gender, educational level (low vs. high), first language (1 = German, 0 = other languages), socioeconomic status (SES), and deficient self-control. To approximate SES, participants reported the number of books in their household (Heppt et al., 2022) using a five-point Likert scale (1 = no/very few books, 5 = enough books to fill three whole bookshelves; $M = 3.18$, $SD = 1.43$). We assessed deficient self-control (Schnauber, 2017) with a single item: "I would have a hard time using media less often" ($M = 2.51$, $SD = .87$).

### 3.4. Analytical strategy

The R-script for all analyses is available on OSF at https://osf.io/7g9ha/?view_only=6b8417cbb6ff47938f6b782062d3693b.

#### 3.4.1. Data preparation

Prior to analysis, we applied multiple imputations as the amount of missing data exceeded the 5 % threshold (Jakobsen et al., 2017). We used the 2-level predictive mean matching method for all continuous variables (i.e., digital media use, time spent on schoolwork) while binary outcome variables (i.e., digital media use for educational purposes) were imputed using the logistic regression ('logreg') method in the 'mice' (Multivariate Imputation by Chained Equations) package in R (Buuren & Groothuis-Oudshoorn, 2011; Enders, 2023). We generated ten imputed datasets and pooled the imputed estimates according to Rubin's Rules (Rubin, 1987). Following imputation, all continuous predictor variables were grand-mean centered (Yaremych et al., 2021) to facilitate interpretation in subsequent analyses.

#### 3.4.2. Structural equation modeling

We used a multilevel structural equation modeling (SEM) approach to investigate the effects of digital media use on academic performance, including time spent on schoolwork as a mediating pathway. We employed the 'lavaan' package (Rosseel, 2012) to specify and fit the SEM model and the 'semTools' package (Jorgensen et al., 2012) to leverage imputed datasets and pool results for robust model estimation. The SEM model included pathways from all digital media usage variables to academic performance (outcome) and time spent on schoolwork (mediator). The mediation pathway modeled academic performance as predicted by time spent on schoolwork. Covariates for both academic performance and time spent on schoolwork included age, gender, native language, educational level, SES, and deficient self-control. We report the estimates from the single imputed dataset since we observed that the pooled estimates were highly consistent with these, suggesting that the imputation process did not introduce substantial bias into our results.

#### 3.4.3. Exploratory analysis

Lastly, we decided to conduct an exploratory analysis to investigate if, and how often, students use the observed media activities for educational purposes. This analytical step was not part of the preregistration; however, we deemed it necessary to gain a better understanding of the underlying effects on academic performance. For this, we calculated a count variable displaying how often the assessed digital media activities were used for educational purposes per participant over the course of the study.

## 4. Results

### 4.1. Effects of digital media use on school-related obligation time

RQ1a-3a aimed to investigate the relationship between social media use, video streaming, and audio streaming and the time spent on school-related obligations. Specific hypotheses concerning the associations between gaming (H1a), surfing the Internet (H2a), and time spent on schoolwork were tested.

In this study, Internet use was positively associated with more time spent on schoolwork ($b = .300$, $SE = .048$, $p < 0.001$), supporting H3a. The results indicated that both social media use ($b = -.229$, $SE = .033$, $p < 0.001$) and digital gaming ($b = -.099$, $SE = .041$, $p = 0.015$) were negatively associated with time spent on schoolwork, aligning with H1a. In addition, video streaming had a negative effect on time spent on schoolwork ($b = -.149$, $SE = .032$, $p < 0.001$), while audio streaming did not significantly affect time spent on schoolwork ($b = -.014$, *ns*).

### 4.2. Effects of digital media use on academic performance

RQ1b-3b sought to examine the association between adolescents' social media use (RQ1b), video streaming (RQ2b), and audio streaming (RQ3b) and academic performance. Moreover, we formulated directed hypotheses for the relationships between adolescents' use of gaming (H1b) and surfing the Internet (H2b) and academic performance.

As shown in Table 2, digital gaming was negatively associated with academic performance ($b = -.072$, $SE = .028$, $p = 0.012$), supporting H1b. However, Internet use ($b = -.007$, *ns*), social media use ($b = -.034$, *ns*), video streaming ($b = .027$, *ns*), and audio streaming ($b = -.037$, *ns*) showed no significant relationship with academic performance. Thus, H2b was rejected.

Furthermore, we hypothesized that the time spent on schoolwork mediates the relationship between digital media use and the academic performance of adolescents (H3). Both the overall indirect effect of digital media via school-related obligation time on academic performance ($b = -.025$, *ns*) and the single mediation paths per media activity did not reach significance (social media use: $b = -.008$, *ns*; gaming: $b = .003$, *ns*; Internet use: $b = -.008$, *ns*; video streaming: $b = .004$, *ns*; audio streaming: $b = .000$, *ns*). Hence, H3 must be rejected.

### 4.3. Exploratory analysis: Digital media use for educational purposes

Lastly, we investigated how frequently students use digital media for educational purposes. Fig. 2 illustrates the frequency of digital media use for educational purposes across study beeps 1 through 9. As shown, adolescents rarely engage in digital media activities for educational purposes, except for using the Internet. Of all digital media activities, Internet use was the most frequently utilized, with a total count of $n = 419$ (out of 3087 ESM assessments overall). The second most frequent digital media activity was social media ($n = 235$), followed by video streaming ($n = 197$) and audio streaming ($n = 134$). Adolescents rarely reported using digital gaming for educational purposes ($n = 83$).

## 5. Discussion

This study addressed concerns about the impact of adolescents' increasing time spent with digital media, which has become deeply integrated into their leisure and educational activities (Twenge et al., 2019). In particular, we investigated the association between adolescents' digital media use and academic performance using comprehensive ESM data, aiming to overcome gaps in the existing body of research.

The study highlights four key findings: (1) Increased digital media use does not appear to significantly increase the risk of poorer school outcomes, except in the case of gaming. (2) Digital media use acts as a time drain, reducing time spent on school-related tasks: gaming, social media, and video streaming often displace time that could be devoted to schoolwork, although surfing the Internet may

**Table 2**
Associations between digital media use, time spent on school-related obligations, and academic performance with mediation pathway.

| Effect | Estimate | *SE* | 95 % CI | | *p* |
|---|---|---|---|---|---|
| | | | *LL* | *UL* | |
| DV: Time spent school-related obligations | | | | | |
| Internet use | **.300** | .048 | .205 | .394 | .000 |
| Digital gaming | **−.099** | .041 | −.179 | −.019 | .015 |
| Social media use | **−.229** | .033 | −.294 | −.165 | .000 |
| Video streaming | **−.149** | .032 | −.211 | −.087 | .000 |
| Audio streaming | −.014 | .041 | −.095 | .066 | .729 |
| Age | **−.067** | .031 | −.128 | −.006 | .030 |
| Gender | −.024 | .114 | −.248 | .199 | .830 |
| Native German speaker | .001 | .133 | −.260 | .261 | .995 |
| Educational level | .031 | .144 | −.251 | .313 | .830 |
| SES | −.083 | .045 | −.171 | .005 | .064 |
| Deficient self-control | −.028 | .068 | −.161 | .104 | .674 |
| DV: Academic performance | | | | | |
| Internet use | −.007 | .028 | −.062 | .049 | .812 |
| Digital gaming | **−.072** | .028 | −.128 | −.016 | .012 |
| Social media use | −.034 | .027 | −.087 | .010 | .218 |
| Video streaming | .027 | .021 | −.014 | .067 | .199 |
| Audio streaming | −.037 | .024 | −.085 | .010 | .122 |
| Mediation pathway | | | | | |
| Time spent on school-related obligations → academic performance | −.025 | .017 | −.060 | .009 | .143 |
| Covariates | | | | | |
| Age | **−.100** | .031 | −.161 | −.038 | .002 |
| Gender | .157 | .103 | −.045 | .358 | .127 |
| Native German speaker | **.319** | .117 | .089 | .548 | .007 |
| Educational level | −.129 | .142 | −.407 | .149 | .363 |
| SES | .063 | .041 | −.018 | .143 | .126 |
| Deficient self-control | .066 | .061 | −.053 | .186 | .276 |

*Note.* $N_{ESM} = 3087$. All variables are between-person centered (also known as grand-mean centering). Digital media use: 1 = not at all, 5 = more than 45 min; time spent on schoolwork: 1 = not at all, 5 = more than 45 min. Age: 11–20 years. Gender: 1 = female, 0 = male. Native German speaker: 1 = German, 0 = other languages. Educational level: 0 = middle school, 1 = high school. SES: number of books at home (proxy; 1 = none/very few, 5 = enough to fill three bookshelves); Deficient self-control: 1 = do not agree at all, 5 = fully agree. *SE* = Standard Error. CI = Confidence Interval: *LL* = lower limit, *UL* = upper limit. *p* = p-value.

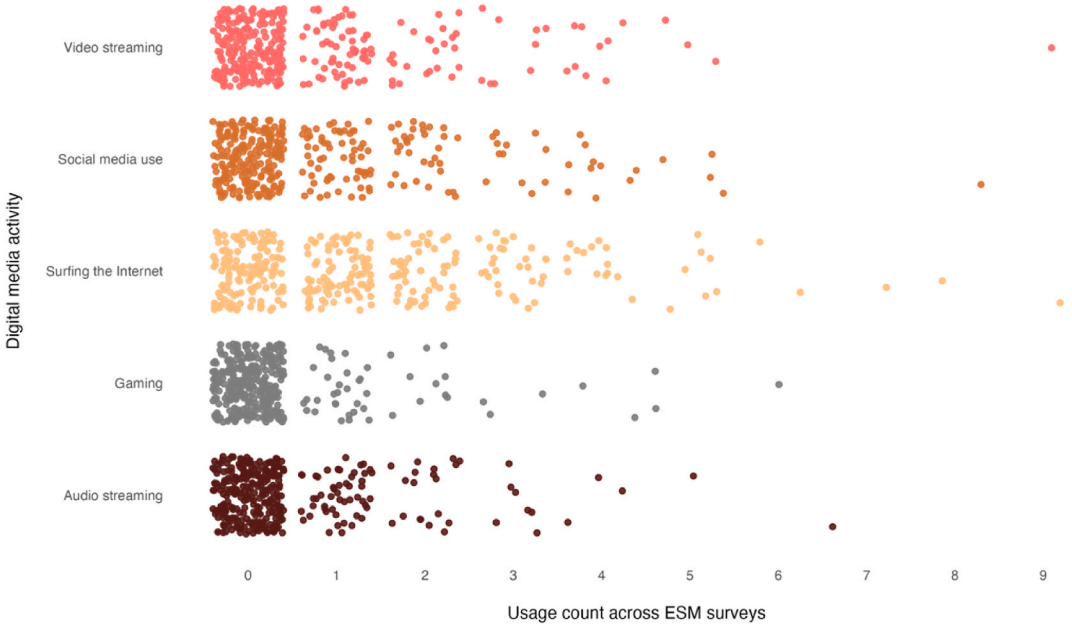


**Fig. 2.** Frequency of digital media activities used for educational purposes across individuals, *Note.* The usage count across ESM surveys represents the total number of times a digital media activity was reported as being used for educational purposes across all surveys. For example, a participant with a usage count of three in social media used social media for educational purposes (e.g., doing homework, learning) three out of nine ESM survey points.

have a stimulating effect on performing academic tasks. This aligns with (3) the observation that students generally use digital media for non-educational purposes, with surfing the Internet being a notable exception. Lastly, (4) time spent on schoolwork does not mediate the relationship between digital media use and academic performance. What more specific meanings and implications can be drawn from these findings?

Firstly, the finding that higher gaming duration is linked to both a reduction in overall academic achievement and a decrease in time spent on schoolwork suggests that gaming has a considerable impact on students' ability to engage in educational activities (e.g., Chen et al., 2020), leading to diminished academic performance (Chen et al., 2020; Van Den Eijnden et al., 2018). There are two main reasons for this finding: First, students very rarely indicated to have used educational games (such as serious games, quizzes, etc.); thus, their main usage intention is aimed at entertainment. Second, gaming has a highly engaging and immersive nature (Bowman, 2018), which challenges adolescents' capacity to control their gaming times; moreover, consumeristic and entertaining online activities, including gaming, have been associated with diminished learning benefits in previous research (e.g., Camerini et al., 2018). Hence, while gaming holds significance in adolescents' media repertoire, particularly in regulating affective well-being (Mayen, Reinhardt, & Wilhelm, 2025), the findings of this study imply that it is necessary to moderate adolescents' gaming time to prevent possible academic decline.

Secondly, the study demonstrated that, in a manner analogous to gaming, social media use and video streaming also displace time spent on schoolwork. Again, both activities occurred only very rarely for educational purposes. These findings can be explained once more by the high prevalence of these digital media activities among youths (Rideout et al., 2022) and by their inherent engaging characteristics, which likely conflict with adolescents' self-control capacities to limit usage times (Gentile et al., 2012). As with gaming, the results indicate that the use of leisure-focused and consumer-oriented digital media activities, including social media use and video streaming, may result in adolescents allocating less time to educational activities (see also Camerini et al., 2018). Albeit we found no significant detrimental impact from video streaming and social media use on academic performance per se, our data's micro-longitudinal nature suggests the need for longer observation periods to explore outcomes on academic performance—an important consideration we acknowledge in our limitations section.

Another important finding is that surfing the Internet appears to stimulate time spent on school-related obligations, indicating that not all digital media have the same impact on academic outcomes. The results from our exploratory analyses further show that adolescents indeed use the Internet for online information seeking. This is consistent with previous studies indicating a positive association between Internet use and educational outcomes when used for school-related pursuits (Sanders et al., 2019). Unlike more dynamic and immersive media, Internet use (such as browsing the web for information) may be less engaging and, thus, less distracting from schoolwork. Moreover, it seems plausible that young individuals have adapted to using the Internet for academic purposes due to their exposure to educational contexts during their formative years (Vilhelmson et al., 2018). This may not be the case with their use of social media, gaming, or video streaming platforms, where the educational benefits are less apparent.

Our results show that adolescents seem to utilize digital media primarily for leisure rather than educational purposes, except for

Internet use, revealing a discrepancy between the academic potential of digital tools and their actual usage by students. This is an important finding: The premise that digital media can positively influence academic performance is rendered void if adolescents do not use these tools or use them minimally for educational purposes. We present two possible explanations for this finding. First, not all adolescents may be equally equipped (e.g., with technical devices and digital literacy resources) to take advantage of digital device use for their academic pursuits. From the perspective of the digital divide theory (Rogers, 2001), unequal benefits from media use promote a gap between those who find digital media to be a valuable resource for learning and those who are at risk of being exposed to distraction, procrastination, and escapism (Anthony et al., 2021).

Second, prior studies have noted that the built-in academic benefits of digital media are still underused or largely unlinked to traditional school-related obligations (Hietajärvi et al., 2020). Despite the ongoing digitization of youth media use, which is likely not yet at its peak, the educational system has by no means exhausted the full range of benefits for enhancing digital learning experiences (see also Timotheou et al., 2023). However, the COVID-19 pandemic necessarily pushed forward digital development in schools (Hietajärvi et al., 2022). From a media education perspective, this shift presents an opportunity to integrate digital activities into learning routines with pedagogical guidance.

Contrary to expectations, this study did not find a mediating influence of time spent on schoolwork in the relationship between digital media use and academic performance. Although schoolwork time at home is often linked to academic achievement (Cooper et al., 2006; Magalhães et al., 2020), other studies report a modest relationship between homework and outcomes; this "Janus-faced" effect suggests that homework's impact depends not only on time spent but also on the effort invested (Flunger et al., 2015).

The findings of this study show that certain digital media activities displace the time spent on school-related obligations. However, it is crucial to evaluate whether such time displacement actually detracts from educational outcomes. One possibility is that with better strategies and time management, adolescents could adapt their behaviors to use digital media more efficiently. For example, integrating structured digital activities into their routines may allow for more productive use of digital platforms, maximizing their learning efforts in a minimum amount of time. By developing targeted and individual approaches to managing students' digital engagement, they may be able to purposefully balance screen time with academic responsibilities.

Moreover, academic performance is a multifaceted construct shaped by external factors, including socioeconomic status, educational background, and migration background, among others. While we included a number of covariates in our statistical model to account for these facets, it is likely that there are other external factors, such as school-related well-being or developmental stages, that add even more complexity to the relationship between digital media use and academic performance, besides time spent on school-related obligations. Methodological limitations may also explain these findings, which will be discussed in detail in the following section.

The current study has certain limitations. Firstly, it relies on time-use measures and does not explore the specific content that adolescents engage with. Secondly, while the ESM addresses several methodological weaknesses of traditional survey approaches, it remains a self-report method and is, thus, potentially subject to biases. Moreover, we recognize that academic performance could be assessed through a more sensitive set of measures, such as learning motivation or memory tasks, rather than solely relying on grades. Additionally, we were unable to perform a more advanced statistical analysis of educational digital media use due to the low frequency of use among participants, which resulted in low variance. Finally, while the micro-longitudinal data in this study captures transient behavioral patterns in situ, we only covered one week in an adolescent's life, while we believe that covering longer periods using the ESM method can fundamentally foster even more comprehensive investigations in future studies.

## 6. Conclusion

This study demonstrates a nuanced relationship between adolescents' digital media use, time spent on schoolwork, and academic performance. While most digital media activities are a time drain, this does not necessarily translate into poorer academic outcomes. The negative association of gaming with both the time spent on school-related obligations and academic performance suggests the need to closely monitor such particularly immersive digital media. Instead, Internet surfing shows positive potential to promote more time spent on schoolwork and a high frequency of educational use, suggesting that students are already tapping into its benefits for academic purposes. This study informs about the risks and benefits of digital media use and school performance, revealing a significant opportunity to effectively integrate digital media activities into youths' academic contexts. We posit that recognizing the benefits of digital media use is critical as a first step. Future research is needed to facilitate the effective use of digital media by youth, with a view to providing a more informed basis for digital educational strategies.

## CRediT authorship contribution statement

**Sophie Mayen:** Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Anne Reinhardt:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Claudia Wilhelm:** Writing – review & editing, Supervision, Methodology, Conceptualization, Funding acquisition.

## Open science statement

Data, R code, and survey are openly accessible via OSF (https://osf.io/7g9ha/?view_only=6b8417cbb6ff47938f6b782062d3693b).

## Declaration of interests statement

The authors report there are no competing interests to declare.

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## Data availability

Data, R code, and survey are openly accessible via OSF (https://osf.io/7g9ha/?view_only = 6b8417cbb6ff47938f6b782062d3693b).

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