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The Correlation Between Academic Media Multitasking and Achievement-a Meta-Analysis

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Abstract: Academic media multitasking specifically refers to the phenomenon where students or academics divide their attention between learning-related activities, such as studying or reading scholarly material, and non-learning activities like texting friends, checking social media, or browsing unrelated websites. Studies confirm a negative correlation between media multitasking and academic achievement, with some reporting small to moderate effects or no correlation at all. This topic is particularly important today due to the pervasive use of media among younger generations and its impact on attention, focus, academic performance, and cognitive load. This meta-analysis aimed to quantitatively integrate individual correlational studies and draw general conclusions about the relationship between academic media multitasking and academic achievement. The sample comprised studies published in English scientific journals from 2010 to the present, with methodological characteristics matching the context of this analysis. A total of 11 studies were included in the final analysis. Correlation coefficients were used as a measure of effect size, with both fixed and random effects models applied to calculate the overall measure of effect size. The quality of the included studies was assessed, and potential publication bias was examined using a symmetry graph and Trim and Fill analysis. The results confirmed a low-intensity negative correlation between digital multitasking and academic achievement with a weighted average correlation coefficient of r=−0.252 (fixed effects model) and r=−0.246 (random effects model) and high heterogeneity (I^2 = 93.98%) among the studies, suggesting variability in the findings. The present meta-analysis also revealed high heterogeneity among the studies, suggesting variability in the findings. This heterogeneity opens avenues for exploring potential mediating relationships or covariates that impact why students engage in digital multitasking.

Keywords: *academic media multitasking, academic achievement, GPA, media use, meta-analysis.*

Introduction

The digital environment provides opportunities for communicating, accessing, creating, and sharing an abundance of information effortlessly, quickly, and almost ubiquitously. The consequence of having so many choices is divided attention: an individual constantly switches attention between different types of information while performing various tasks – in other words, they perform multiple tasks simultaneously, or multitask. Although the term "multitasking" suggests that a person is doing multiple things at once, what actually happens is a change of activity (Wagner, 2018). Therefore, multitasking in the true sense refers to the ability to quickly switch attention from one activity to another (Kirschner and De Bruyckere, 2017). In psychological literature, the term media multitasking refers to behaviors such as using multiple devices like smartphones, computers, and smart TVs simultaneously, managing numerous active applications and constant notifications that redirect attention between tasks (Baumgartner et al., 2014).

Current research predominantly investigates the adverse impacts of multitasking across three primary domains: cognition and academic performance, health outcomes, and interpersonal relationships (Za-

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manzadeh and Rice, 2021). Multitasking in educational context, or academic media multitasking (Merrill, 2018; van der Schuur et al., 2020) is engaging with another media source or media technology while primarily working on academic coursework, such as checking social media while doing homework (Yeykelis et al., 2014). Multitasking in interpersonal context may be when we use mobile phone while we talk to our partner. The results show that even the passive presence of a phone can reduce the sense of closeness, trust, and empathy between conversation participants (Przybylski and Weinstein, 2013). In domen of health distractions such as mobile or other media can lead to increased food intake, poor dietary choices, and a higher risk of obesity (Robinson and Matheson, 2015). The focus of our study is on academic media multitasking.

Adolescence and early adulthood is a period when digital media are frequently used during academic activities (Carrier et al., 2015; Junco and Cotten, 2012; Wallis, 2010), therefore, our study includes research focused on populations of high school students and college students. Young people find it difficult to distance themselves from their phones, which is supported by the fact that the smartphone is perceived as an "extension of the body" with a strong sense of emotional attachment (Gertz et al., 2021). The phone is always "at hand" during young people's daily activities, including academic ones. Students often justify device use for course-related tasks, while significant time is spent on non-course-related activities, impacting focus and potentially leading to lower academic performance (Kraushaar and Novak 2010; Rosen et al., 2013). The use of digital media is how adolescents and young adults mostly spend their time, on average more than 7.5 hours a day – which is almost equivalent to the length of a typical workday (Rideout et al., 2010). Students and young adults increase their digital media absorption by using two or more media simultaneously through multitasking, experiencing 10h and 45 minutes of media content within their 7.5 hours per day. This behavior also manifests in educational institutions, where the use of digital media is largely uncontrolled and unregulated. If students do not invest enough time in completing academic tasks, they will not fully utilize their potential (Fox et al., 2009). Researchers who have examined the relationship between media use during academic activities and academic achievement assume that media use during academic activities can lead to negative consequences for young people's academic performance (Bellur et al., 2015; Fox et al., 2009; Karpinski et al., 2013; Kokoç, 2021; Kostić and Ranđelović, 2022). Several cognitive learning theories assume that using multiple streams of information reduces information processing as a result of the limited cognitive capacity of humans (Salvucci and Taatgen, 2010; Junco and Cotten, 2011). Cognitive theories related to information processing (Mayer, 1998) and multimedia learning (Mayer and Moreno, 2003) highlight that "meaningful learning" happens when individuals are actively engaged with information, concentrate on new inputs, and systematically integrate this new information into their pre-existing knowledge structures. These theories indicate that multitasking, or frequently switching between tasks, causes individuals to be only partially engaged with each task, leading to decreased attention and poorer learning and performance outcomes (Kraushaar and Novak, 2010). The cognitive control deficit resulting from frequent digital media multitasking can also cause difficulties in maintaining focus on academic tasks, leading to lower achievement (Ophir et al., 2009; Wallis, 2010). Frequent multitasking is associated with a lower GPA (Bellur et al., 2015; Junco, 2012; Rosen et al., 2013; Walsh et al., 2013) since the time spent using digital media takes away from time devoted to academic activities. Junco (2012) found that overall GPA dropped 0.12 points for every 93 minutes above the average of 106 minutes per day spent on Facebook**.** Ophir, Nass, and Wagner (2009) suggest that high media multitaskers have poorer cognitive control abilities, meaning they have more difficulty managing attention and executive functions. This reduced self-regulation capacity makes it harder for them to focus on tasks and learn effectively, which can result in lower GPAs. Similar research by Rosen et al., (2013)**,** indicates that frequent task-switching caused by media distractions can diminish the quality of studying and negatively affect GPA. Lepp et al., (2014) confirm that the use of mobile phones and other media can pose a significant distraction that interferes with the learning process and lowers GPA. Additionally, Langberg et al. (2013) explore how self-regulation impacts academic success and emphasize that students with better self-regulation skills can more effectively manage distractions, including media multitasking, and achieve better academic results. To avoid distractions and remain focused on learning, selective attention is crucial (Dayan and Solomon, 2010). Learners need to understand their attention state and employ effective strategies to regulate their attention. If a student has a clear and specific goal and sufficient motivation, such as studying for an upcoming exam, they are less likely to multitask and vice versa (Judd and Kennedy, 2011).

Although numerous studies confirm a negative correlation between media multitasking and academic achievement, some also report small to moderate effects (Burak, 2012; Junco and Cotten, 2012;

Ravizza et al., 2014), as well as no correlation (Karpinski et al., 2012; Wei et al., 2012; Clayson and Haley, 2013). This indicates a lack of consistency among researchers regarding the correlation between media multitasking and academic achievement in high school and college students.

This topic is crucial because it provides empirical evidence on how digital distractions impact learning outcomes, helping educators and policymakers develop effective strategies to mitigate these effects and enhance student performance in educational settings. Our study is a meta-analysis and attempts to systematize the results of previous studies on the topic of the correlation between academic media multitasking for non-academic purposes and student achievement. This approach aggregates data from various studies to provide more robust conclusions, offering insights into the consistency and strength of the association between media multitasking behaviors and academic outcomes that individual studies alone may not achieve. A meta-analysis is important in this study because it allows for the comprehensive integration of findings from multiple studies, increasing statistical power and generalizability. Even though this field began developing more than a decade ago, the present times and unique environmental factors during the pandemic greatly increased its significance.

Materials and Methods

Variable operationalization

Academic media multitasking – operationalized through a questionnaire measuring the frequency of digital media use (social networks, email, games, websites, search engines, watching/listening to videos, talking on the phone) during academic activities, either in class or at home, for non-academic purposes. The scales research authors identified as adequate measures of media multitasking were also taken into consideration. These measure the use of various digital media during academic activities or assess attitudes about being able to efficiently follow lessons/complete tasks while using some of the media (e.g. social networks). The measures are intercomparable, and higher scores indicate greater frequency/inclination for multitasking.

Academic achievement – operationalized as the current GPA, the semester average grade, the average grade from the previous level of education (high school), or the average grade in compulsory subjects. All measures are equivalent.

Inclusion and Exclusion Criteria

In order to be included in the meta-analysis, the research had to meet the following criteria:

1. It was published in a scientific journal with an impact factor (Clarivate JCR).
2. The publication language of the journal is English.
3. The study is not older than 2010 (statistical data indicate a continuous increase in the use of the internet itself, as well as social networks at the end of the first decade of the 2000s, while Instagram, the currently most popular social network, was founded in 2010).
4. The independent variable relates to the use of media multitasking.
5. Media multitasking refers to the use of digital tools in an educational context for non-academic purposes.
6. The study must report correlation coefficients between the variables or provide sufficient data to calculate these coefficients. The correlation coefficient was chosen as the measure of effect size because it was consistently reported across studies, allowing for a standardized comparison of the relationship between media multitasking and academic achievement. This approach maintains the internal and external validity of the meta-analysis by ensuring that the effect sizes are comparable across different studies.
7. The dependent variable must be operationalized as an average grade (GPA or equivalent measure). GPA is used due to its standardization and comparability across different educational contexts and time periods, providing a reliable measure of academic performance. This decision helps maintain both internal and external validity by ensuring that the measure of academic achievement is consistent and comparable across all included studies.

After all the criteria were applied, 11 correlational studies were included in the final sample. The table with the studies contained in the sample can be seen in Appendix A.

Data Extraction Process

The data extraction process involved systematically reviewing each included study to obtain the necessary information for the meta-analysis. This comprehensive approach ensured that we had consistent and comparable data across all studies, which is crucial for maintaining the validity and reliability of the meta-analysis. For each study, we extracted detailed information including the study title, authors, year of publication, and the journal in which the study was published. We also recorded the impact factor (IF) of the journal to ensure the quality and credibility of the included studies. From the sample details, we documented characteristics such as the type of participants (e.g., students, adolescents), along with the sample size. Regarding the measures used, we extracted specific information on media multitasking, including the types of digital media use (e.g., social networks, email, games) and the context of use (e.g., during class or at home for non-academic purposes). Similarly, we noted the measures used to assess academic achievement, such as current GPA, semester average grade, or average grade from the previous level of education. Importantly, each study reported the effect size measure required for our analysis in the form of correlation coefficients. This consistency eliminated the need to use other statistics or perform additional calculations to derive these values. Each study provided a single relevant correlation measure between media multitasking and academic achievement, so there was no need to merge multiple effect sizes from individual studies.

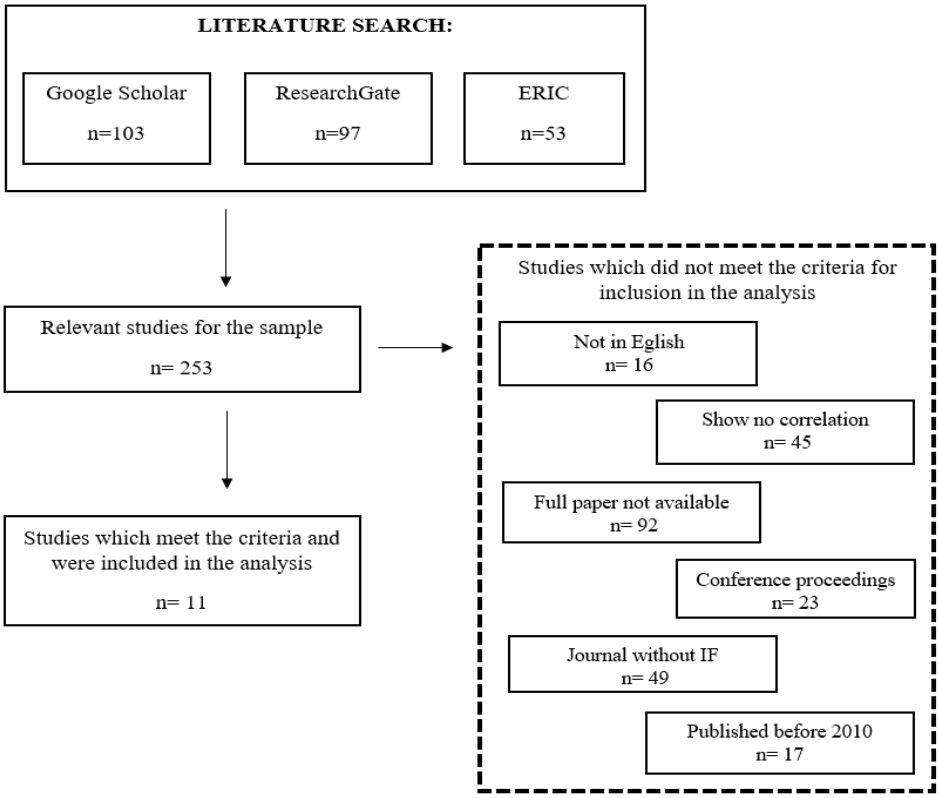
Quality Assessment of Studies

The quality of the included studies was assessed using established criteria to evaluate risk of bias and methodological rigor. This process involved a thorough review of each study's research design, data collection methods, and analysis techniques. To ensure a comprehensive and objective assessment, multiple researchers independently evaluated each study. Each study was first evaluated for potential sources of bias, including the selection of participants, measurement of variables, and control of confounding factors. Additionally, the methodological rigor of each study was assessed based on the clarity of research questions, appropriateness of study design, and robustness of data collection and analysis methods. The validity of the measures used for both media multitasking and academic achievement were also considered. To enhance the reliability of the quality assessment, three researchers independently coded each study. This involved assigning ratings for each criterion based on predefined scales. The initial ratings were then compared to identify any discrepancies. In cases where discrepancies were identified, researchers discussed the differences and reached a consensus on the final ratings. This quality assessment process ensured that the included studies were evaluated consistently and objectively, enhancing the validity and reliability of the meta-analysis.

Literature search

To ensure systematic and transparent reporting, we followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines throughout the review process. These guidelines provided a structured approach to conducting and reporting the meta-analysis, enhancing the reproducibility and credibility of our findings.

The literature search was conducted via available internet databases for accessing scientific publications that do not require special permissions, and are widely used in the scientific community: Google Scholar, ResearchGate, and ERIC. The keywords used in the search were: digital multitasking, digital distraction, media multitasking, cyberloafing, academic achievement, academic performance, GPA. The search was narrowed down to include only full-text articles published in 2010 and later. A review of the studies included in the analysis is shown in Graph 1:



Graph 1. Search and selection of works for analysis

Statistical Analyses

Correlation coefficients were used as a measure of the effect size of individual studies and the overall measure of effect size. There was no need for additional conversion of measures. The sample size was used for weighting the effect size. The participants from the original studies differ in age, level of education, country of origin, and potentially other covariates. Due to this, it is assumed that there is no distribution of true effects, indicating that a random effects model would be suitable for calculating the overall measure of effect size. Regarding the assessment of the existence of a "file drawer effect," i.e., the bias of the effect size measure in published versus unpublished studies, a symmetry graph of the of studies around the overall measure of effect size is shown, along with the results of the so-called Trim and fill analysis. The software used for calculating individual and overall measures of effect size is the trial version of Comprehensive Meta-Analysis.

Correlation coefficients were used as a measure of the effect size of individual studies and the overall measure of effect size. As these coefficients were consistently reported across all studies, there was no need for additional conversion of measures. The sample size of each study was used for weighting the effect size, ensuring that larger studies had a proportionately greater impact on the overall results. The participants from the original studies varied in age, level of education, country of origin, and other potential covariates. Due to this heterogeneity, it was assumed that there is no single distribution of true effects, indicating that a random effects model would be suitable for calculating the overall measure of effect size. The random effects model accounts for variability both within and between studies, providing a more generalized estimate of the effect size. Additionally, we assessed the potential existence of a "file drawer effect," which refers to the bias of effect size measures in published versus unpublished studies. This was done using a symmetry graph (funnel plot) to visualize the distribution of studies around the overall measure of effect size. The results of the Trim and Fill analysis were also presented to adjust for potential publication bias. The software used for calculating individual and overall measures of effect size was the Comprehensive Meta-Analysis (CMA). CMA provided the necessary tools for conducting both fixed and random effects models, as well as additional analyses such as the Trim and Fill method for assessing publication bias. By using both fixed and random effects models, weighted effect sizes based

on sample size, and following PRISMA guidelines, our analysis aimed to provide a robust and reliable synthesis of the relationship between media multitasking and academic achievement.

Results

As for the heterogeneity of the effect size measure, considering the values of the Q statistic and its statistical significance, the hypothesis of the existence of a fixed effect can be rejected. The results suggest that 93.98% of the total variance can be attributed to heterogeneity – variance between individual studies (I^2 = 93.985). This result can be interpreted as very high heterogeneity (Huedo-Medina et al., 2006).

Table 1. *Results of heterogeneity testing*

Heterogeneity			
Q	df	*p*	I^2
166.241	10	.000	93.985

Q – significance indicator of heterogeneity; I2 – percentage of total variability that can be attributed to heterogeneity

Table 2. *Random effects when calculating meta-statistics of correlation between media multitasking and academic achievement*

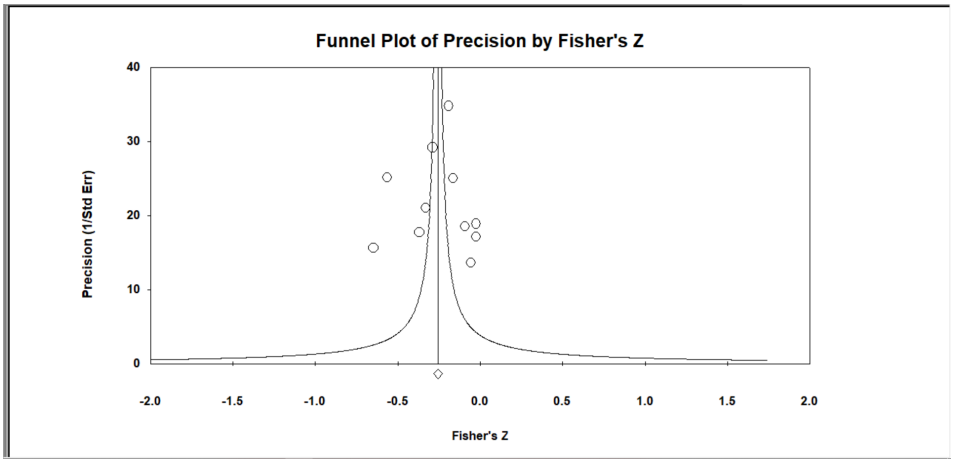
Effect size				*Test of Null*	
N	$\hat{r}$	GG	DG	*Z*	*p*
11	-.246	-.347	-.140	-4.465	.000

N – number of studies included in the analysis; $\hat{r}$ - weighted average correlation coefficient; GG – upper limit; DG – lower limit

The results indicate that the overall measure of effect size differs from zero after applying the random effects model (z= -4.465, p= 0.000), meaning there is a statistically significant negative correlation between media multitasking and academic achievement.

File Drawer Effect

The existence of the file drawer effect was also examined. This refers to the bias of studies included in the meta-analysis compared to those not included, which could have an impact on the overall measure of effect size. The results indicated that the overall measure of effect size does not differ with respect to the random and fixed effect model, therefore, the results are only shown for the random effects model in Graph 2.



Graph 2. File drawer effect for the random effects model

Graph 2 shows the file drawer effect for the random effects model. The studies included in the meta-analysis are represented by circles. They are evenly distributed around the vertical axis, and considering the fact that 11 studies were included in the analysis, a distribution of 6:5 can be considered equal. Therefore, a bias in the selection of studies for analysis can be excluded based on this graph.

Discussion

This meta-analysis aimed to quantitatively integrate works and draw general conclusions about the existence of a correlation between media multitasking and academic achievement. Media multitasking in an academic environment has been the focus of researchers' attention in recent years. This topic is gaining significance with the increasing application of teaching in an online environment. The idea for the research stemmed from a thorough review of the relevant literature and the observation of inconsistencies in the obtained results. Among the numerous studies that confirm a negative correlation between media multitasking and academic achievement, there are also those that report small to moderate effects or no correlation.

The results of this meta-analysis confirmed the existence of a negative correlation between academic media multitasking and academic achievement, as indicated by the obtained meta-statistics, i.e., the average weighted Pearson correlation coefficient. A low-intensity correlation was obtained. Most individual studies included in the meta-analysis report a low negative correlation, hence these results are within the expected range.

Analyses have shown that over 93% of the total variance can be attributed to heterogeneity, i.e., variance between individual studies. Such a result confirms the justification for using a random or variable effects model. Namely, when the I^2 statistic is of moderate or high intensity, there is a basis for further examination of the relationship between constructs, i.e., examining the impact of moderating variables that can explain heterogeneity (Sánchez-Meca and Marin-Martinez, 2010). In the presented meta-analysis, heterogeneity is very high, and this result indicates the need for further research. Given the results from the funnel plot analysis, there is no indication of a significant file drawer effect in this meta-analysis. The distribution of effect sizes appears relatively symmetric, suggesting that studies with both positive and non-significant results were included in the analysis without substantial bias in the selection process. This absence of a file drawer effect strengthens the validity of the findings and supports the robustness of the conclusions drawn from the studies included in the meta-analysis. However, while the visual inspection does not suggest a publication bias, it is important to note that the potential for undetected bias always exists, and further statistical tests could be employed to confirm these observations.

Today's adolescents have easy access to digital technology and often use it during other daily activities, which is why they can be referred to as 'multitaskers' (Demirbilek and Talan, 2018). Our sample consisted of research which included respondents in the early, middle, and late adolescence period, and the results of the meta-analysis indicate that frequent use of technology during academic activities for non-academic purposes is negatively correlated with academic achievement. The availability of technology, such as smartphones, allows students to switch between tasks during lectures (Ralph et al., 2020). Additionally, some students engage in multitasking to stay connected with friends or because they believe it is an efficient way to handle multiple tasks (Kuznekoff and Titsworth, 2013). Multitasking can also serve as a coping mechanism for boredom or stress during lectures (Wiradhany et al., 2021), while a lack of self-regulation may contribute to increased multitasking (Ralph et al., 2020). Furthermore, social pressure and the desire for interaction on social media can also play a role (Liu and Gu, 2019). It is widely known that human cognitive capacities are limited, i.e., working memory inhibits the ability of humans to process newly acquired information (Sweller, 1988). When media multitasking is intense or prolonged, it leads to cognitive overload, which impairs message processing and triggers stress responses, ultimately harming academic performance (Baumgartner and Wiradhany, 2021). Switching from one task to another or performing multiple tasks during academic activities requires a change in focus, cognitive work, and attention (Demirbilek, and Talan, 2018), which can explain the negative correlation with academic achievement. Cognitive load increases due to frequent activity changes (Paivio, 1986), performance decreases as a result of simultaneous activities (Junco and Cotten, 2012), and the completion of activities is delayed (Bowman et al., 2010). Previous research suggests that attention problems in the academic context, i.e., difficulties in directing and maintaining attention, may be at the core of multitasking, and can lead to lower academic achievement (Ophir et al., 2009). Additionally, insufficient investment of time in completing academic tasks will result in decreased use of one's potential (Fox et al., 2009). Other correlational

research points to a small to moderate negative correlation between academic media multitasking and achievement (e.g., Junco and Cotten, 2012; Ravizza et al., 2014).

Conclusion

When it comes to the construct of academic media multitasking, the existence of deviations in operationalizations and instruments used in primary research prompted the author of this meta-analytic study to rely on journal credibility, as well as on the subjective assessment of the adequacy of operationalization. Only the studies which met the set quality criteria were included in the analysis. Furthermore, the analysis of bias in the selection of primary research showed that there is no file drawer effect. Studies included in the analysis were published in leading scientific journals with a high impact factor, which is one of the indicators of the quality of the study. On the one hand, the limitations of this study are reflected in the small sample of primary research which were included in the meta-analysis process (N=11), although, on the other hand, this can be viewed as an advantage due to appropriateness, quality, and credibility of the data contained in the final selection of articles.

Given that this meta-analysis was conducted on a sample of correlational studies, causality can be ruled out. Other explanations and possible confounding variables should also be considered. Although it might seem less likely, poorer achievement can negatively affect the motivation to engage in academic activities, which in turn promotes multitasking. However, despite the aforementioned limitations, this meta-analytic study has primarily theoretical implications in terms of its contribution to a better understanding of the phenomenon of academic media multitasking and academic achievement. The present meta-analysis not only confirmed the value of previous studies, but also paved the way for exploring potential mediating relationships or covariates affecting reasons why students engage in media multitasking. Future meta-analytic studies dealing with the topic are recommended to consider the moderating impact of some other variables from the domain of personality, self-regulation skills, and motivation.

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Conflict of interests

The authors declare no conflict of interest.

Author Contributions

Conceptualization – K. C. and N. L.; Data Curation – M. V. and J. K.; Formal analysis – K. C. and Jelena O. K.; Investigation – N. L. and J. K.; Methodology – J. O. K. and K. C.; Project Administration – K. C. and N. L.; Visualization – J. K. and M. V.; Writing original draft – K. C. and N. L.; All authors have read and agreed to the published version of the manuscript.

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Appendix A:

Table 1. *The studies contained in the sample*

Study	Authors	Year	Journal	IF	Sample	Sample size	Multitasking	Achievement	r
1	Bellur, S., Nowak, K. L., & Hull, K. S.	2015	*Computers in Human Behavior*	6.829	Students	361	Multitasking during homework (Bellur, Nowak, & Hull, 2015)	High school GPA	−.025
2	Karpinski, A. C., Kirschner, P. A., Ozer, I., Mellott, J. A., & Ochwo, P.	2013	*Computers in Human Behavior*	6.829	Students	857	Multitasking with SNS while studying (Karpinski, Kirschner, Ozer, Mellott, & Ochwo, 2013)	GPA	-0.28
3	Kokoç, M.	2021	*Scandinavian Journal of Psychology*	2.25	Students	637	Multitasking with Social Media (Ozer, 2014)	GPA	–0.51
4	Lau, W. W.	2017	*Computers in human behavior*	6.829	Students	348	Multitasking with Social Media (Ozer, 2014)	GPA	-0.092
5	Luo, J., Yeung, P. S., & Li, H.	2020	*Children and Youth Services Review*	2.393	Adolescents (12-18)	447	Media Multitasking Scale (MMS) (Luo et al. 2018)	Current average grade for all school subjects	−0.32
6	Raza, M. Y., Khan, A. N., Khan, N. A., Ali, A., & Bano, S.	2020	*Journal of Public Affairs*	1.08	Students	248	Media multitasking (Lau, 2017 adapted from Ozer's, 2014)	GPA	−0.57
7	Uzun, A. M., & Kilis, S	2019	*Computers in Human Behavior*	6.829	Students	631	Sub-dimension Multitasking Preference of the attitudes subscales of MTUAS (Rosen et al., 2013)	GPA	-0.164
8	van der Schuur, W. A., Baumgartner, S. E., Sumter, S. R., & Valkenburg, P. M	2020	*New media & society*	8.061	Adolescents (11-15)	1215	AMM (van der Schuur, Baumgartner, Sumter & Valkenburg, 2020) based on the Media Multitasking Index (MMI) developed by Ophir et al. (2009).	Academic achievement scores	−.19
9	Wei, F. Y. F., Wang, Y. K., & Klausner, M.	2012	*Communication Education*	1.759	Students	190	Text messaging during class (Wei & Wang, 2010)	AP, traditional academic performance (grade-oriented learning)	-0.056
10	Legkauskas, V., & Steponavičiūtė-Kupčinskė, I.	2021	*Education and Information Technologies*	2.917	High school students	319	In-class use of social media (Legkauskas & Steponavičiūtė-Kupčinskė, 2021)	GPA	−0.353
11	Clayson, D. E., & Haley, D. A.	2013	*Journal of Marketing Education*	3.122	Students	298	General attitudes toward texting (Clayson & Haley, 2013)	GPA	−.025