2022

Technology Screens and Effects on Attention: A Meta-Analysis

Carly A. Haxel
University of Central Florida

Technology Screens and Effects on Attention: A Meta-Analysis

Carly A. Haxel

University of Central Florida

Abstract

This study looks at how technology screens have an effect on academic performance considering how technology is becoming relied upon more every day. A meta-analytic review that quantitively combines data was conducted to estimate effect sizes between technology screens and academic performance. The study held no restrictions on location or ethnicity. 12 studies were chosen, consisting of 31,844 total participants. Ethnicity, research design, and screen type were found to moderate the effect of screen time on academic performance. Theoretical implications and future research is also discussed in this study.

TABLE OF CONTENTS

LIST OF TABLES

Running Head: TECHNOLOGY AND HOW IT EFFECTS ATTENTION

CHAPTER ONE: INTRODUCTION

T.V. is a type of technology enjoyed by people all around the world. Although it can be informative and entertaining, the question has been pondered whether long-term exposure to technology screens has negative effects on attention span and ability to focus. Now studies have found evidence to support the theory that excessive amounts of T.V. screen exposure can lead to attention deficit issues (Zimmerman & Christakis, 2007). Attention deficit issues will create problems for a person of any age, but especially for children who are still in school learning and emerging adults. Since many people enjoy eating in front of the T.V., this could cause issues to executive functions. A study done by Corkin and Peterson found a negative relationship between preschool children eating meals in front of a T.V. screen and cool executive functions (2021). Not only does watching T.V. while eating withhold negative effects, but the reliance on T.V. for distracting children is overused. A research study by Lin and Cherng concluded that digital T.V. screens created cognitive developmental delays amongst children who used them more (2015). This highlights how important this research topic is because people are exposed to a lot more screens than just T.V.s'. Another study with 5-year-old children assessed the effects of all screen use during early childhood. The conclusion was that 5-year-olds with higher exposure to screen media reported higher levels of hindered adaptation skills, poor achievement ratings, and externalizing attention issues (McArthur & Browne, 2020). This proves that all screen media time is a concern if not carefully monitored.

Teenagers and emerging adults use technology every day, especially for important tasks like school and work. This population most likely uses screen media the most, estimated to about

4 hours a day (Rasi & Ashifa, 2020). Students nowadays are inclined to use multiple technologies and media platforms for priorities, like school and work. This, unfortunately, can have an adverse effect on student attention. Parry and Roux conducted a study about multitasking with digital media. One student interviewed admitted when he/she gets a message or alert during a lecture, the immediate response is to answer (2020). This illustrates how digital media can be a distraction, pulling attention away from education. While in class, distractions like phones or tablets should be put away.

Although digital distractions should be out of reach during learning, this can sometimes be an issue when it is a class requirement. Not only is technology occasionally used in class, but online classes are substantially growing. This makes it hard to avoid long-term screen exposure. Now that college students are using media in and out of class, it is becoming even more reliant. An analysis conducted by Roberts and Pullig significantly related attentional impulsiveness with cell phone addiction (2015). If this is true for smartphones, then what are the consequences of one who is addicted to all technology.

A “Digital Detox” examination was done to see how participants reacted when their technology was out of reach. After participants were separated from their phones, and then reunited, their moods increased (Wilcockson & Osborne, 2019). This is concerning due to the fact that a person's happiness can depend on a small, digital device. Since this is true, not only does technology being present bring a distraction but now when it is absent, mood is affected. An attempt to understand the effects of attention and mood was done by Hobiss and Fairnie, finding that emotional distress can lead to failure of attention (2019). Both of these sources help us

underline the idea that technology addiction can have an adverse effect whether it is available or not.

Technology Takeover

Children and emerging adults are reliant on technology because they have grown up with it. Older adults were not subjected to digital screen technology until more recently. Even so, screen media exposure can still affect their attention but in different ways. Another multitasking experiment was performed and this one examined adults and how they can become preoccupied with only one task. Zurcher and King found that with all the different media options available now (e.g., app games, streaming, texting), parents are becoming easily distracted by technology while watching their children (2020). This insinuates that adult attention can be altered in a different way. Also, if adults are busy with their technology, it is most likely going to reduce restrictions on their children's technology time. While children and young adults feel impulsive to check their media and not stick to the task at hand, adults are occasionally not able to focus on anything else while on their cell phone.

Type of Media

Research results found by Huber and Yeates suggest that hot executive functions may be impeded by non-informative content, but interactive education may have no effect (2018). Although interactive activities on technology may not have a negative effect, there is no proof it positively affects attention span. If technology is displaying educational content, it can be beneficial, but the benefits may not outweigh the consequences. Eventually, learning educational content on technology screens will encounter distractions. Pop-up content, messaging

notifications, or intriguing advertisements are all examples of distractions that may be an issue. These are all examples of the types of distractions seen in screen media. Overall, even if screen media provides some educational advantages, the chance that it could lead to addictive tendencies toward technology does not seem worth it

Long-Term Effects

Since it is evident that technology is becoming more depended on, being aware of the potential long-term effects is essential. In a longitudinal study on screen time and mental health in young people, evidence suggested that higher screen time is associated with increased mental health distress (Tang & Werner-Seidler, 2021). This study shows that over time if screen time is abused, it can affect one's health in an unfavorable way. Even though mental health may not be directly correlated, emotional distress can stray a person's attention (Hobiss & Fairnie, 2019)

A questionnaire given out by Hadar and Eliraz gave results indicating that increased attention disorder-like behavior was found in long term, high smartphone users (2015). This experiment was longitudinal, so counteractive effects did not take place immediately. Impulsivity and hyperactivity were found to be increased throughout this study. The study is underlining how long-term exposure to technology screens will make digital media almost seem like a necessity. This should raise the attention that technology addiction should be addressed immediately, before it is taken out of hand. The high risk of becoming attentionally impulsive and hyperactive is not one to ignore.

If taken into consideration all of the research backing the theory that technology screens may affect a person's attention span, it would behoove everyone who uses technology to be

aware of the possible negative side effects. Children at a very young age may possibly have learning/attention issues if over exposed to screen media. Adults are taking their attention away from their children, which could also be an issue in other daily activities. It is now evident that although some interactive screen media may not have a nullifying effect on attention, it does not embody any positive effects. Long-term effects are now a concern because there is evidence suggesting it can affect mental health, which leads to attention and learning issues.

Theoretical Perspective

The current study is grounded in the theory related to absent-mindedness. This theory helps explain why our attention spans are so negatively affected by technology in that technology increases our absent-mindedness, which allows our minds to wander. An article that addresses the consequences of absent-mindedness states that successful learning needs people to process information from the outside world with their own representations. Mind-wandering is an issue because it splits our attention, so instead of processing the information from the external world, our attention is consumed with our own thoughts and feelings (Smallwood & Fishman, 2007). So, because absent-mindedness has such a negative effect on learning due to technology, we can see that teenagers with high screen time will not be as academically successful.

The Current Study

Due to the debate regarding screen time and academic performance it seems apparent that a meta-analytic review that quantitatively combines data from previous research in this area to estimate the effect size between the use of screen time and academic achievement, investigate potential moderators between the use of screentime and academic achievement, and examine

variations in the outcomes of previous research is well over-due. Accordingly, the current study intended to conduct a meta-analysis to provide a statistical review of findings in this area, particularly focusing on teens and young adults. Based on previous research, it was hypothesized that increased screentime would be associated with a decrease in academic achievement.

CHAPTER TWO: METHOD

Literature Search Procedures and Selection of Studies

A systematic, computer-based search was conducted through MedLine and PsycINFO between April 2022 and June 2022 to search for relevant articles. There were no restrictions on geography or culture in which studies were conducted. However, the time period of publication was limited from 2000 to 2022. The following search terms were used: screen time, screen exposure, screen engagement, screen involvement, academic achievement, academic performance, end of course grades per class, and grade point average. For a study to be included it must have met the following criteria:

1. Measure the influence of screen time on academic achievement among teens and/or emerging adults.

2. Present statistical outcomes or data that could be used to determine the effect size r.

3. Participants in the study must have been adolescents and/or emerging adults. Longitudinal studies that began during pre-adolescence and extend into adolescence and emerging adults could be included.

4. Be written or translated in English.

Coding of Studies

Each study was coded for outcomes related to academic achievement and the influence of screen time. The sex of each study sample was coded based on the percentage of male participants in the study. Age of participants was classified as years of age based on either the age range of participants provided or the mean age of participants. Participant ethnicity was coded based on the majority of sample participants (>75%) (e.g., White, Black, Hispanic). The use of screen time was coded based on duration, rounded to the nearest hour. The duration of the use of the screen and how often it was used was also be taken into account. Each study was also coded for the research design that best described the study (e.g., longitudinal, cross-sectional, experimental), the location of data collection, and the publication year. It is important to note that according to Valentine and colleagues (2010), a minimum of two research articles were needed for the meta-analysis. This study included 12 research articles (see Table 1).

Commented [CW1]: Finish this sentence and include the table showing the studies, just like the two examples I provided.

Estimating Effect Size

In the current study, controlled effect sizes (i.e., standardized regression weights) were examined. The effect size r was used in this analysis both due to the inclusion of longitudinal and correlational effect sizes in the analysis and because r is a straightforward effect size and easy to interpret. Additionally, considering that confounding variables may exist, Savage and Yancey (2008) argued that controlled effect sizes are the preferred inclusion for meta-analyses. If studies reported more than one effect size that was relevant to a singly underlying construct, they were aggregated for a single average effect size that was included in analysis in order to maintain the assumption of independent effects, as recommended by Borenstein and colleagues (2009) (see Chapter 24). The effect size *r* was used for this study because it is easy to understand and can be

Commented [CW2]: Were there any longitudinal studies included in yours? Update this sentence if there weren't any.

used in further studies. If studies reported non-significant findings in line with Levine (2013), effect sizes were included in the meta-analysis. According to Levine (2013), reduced statistical power is a major cause of non-significant results, and non-significant results should be included, where provided, in meta-analyses in order to provide a stronger and more robust test than the original study due to the increased power provided by the meta-analysis.

CHAPTER THREE: RESULTS

The Comprehensive Meta-Analysis (CMA) software program was used to conduct the meta-analysis. The current study used a random-effects model weighted by variance, more specifically the DerSimonian and Laird method (see Borenstein et al., 2009, Chapter 12) to estimate effect sizes, rather than a fixed-effects model, due to estimation limitations of fixed-effects models (Cafri et al., 2010; Hunter & Schmidt, 2004). Additionally, positive effects represent associations between the use of screen time and academic achievement. Publication bias and moderator variables were assessed.

Overall effects

Results for academic performance based on screen time can be found in Figure 1. The overall effect size estimate *(r)* of academic performance based on screen time was -.07 (*N*=31,844, *Z*=-9.948, *p*< .000, 95% CI [-.084, -.056]). The meta-analysis found that there was a negative relationship between screen time and academic performance, indicating that as screen time increased academic performance decreased.

Commented [CW3]: This is still not correct. See the examples I provided.

Single Study and Publication Bias

To identify if the overall effect size was influenced by a single study, a second meta-analysis was performed with one study removed. The *r*'s from this second meta-analysis went from -.084 to -.056. These results did not differ from the first analysis; therefore, no single study had a substantial contribution to the overall effects. Fisher's Z funnel plot of standard error was used to identify if there was a publication bias. There was a publication bias in this meta-analysis.

Commented [CW4]: Incorrect format in reporting statistics.

Moderation Effects on Screen Time and Academic Performance

A Q test of homogeneity of variance indicated significant heterogeneity among correlations for screen time and academic performance Q_w (8)= 588.67, p< .000. Consistent with this, the I^2 (Higgins & Thompson, 2002) indicated that a somewhat large percentage (98.47%) of the variation in effect sizes for screen time and academic performance between studies was due to systematic variation, rather than random sampling error. As such, moderator variables were examined.

Studies were compared based on age (teenager or emerging adult). There were no significant moderating effects found for the ages that were examined, Q_b (1)= .017, p<.895. The largest effect of screen time on academic performance was found for studies that used teens (k= 7, r=.094, Z=.86, p< .390, 95% CI [-.120, .301]. The smallest effect was found for studies with emerging adults (k= 3, r= .062, Z= .476, p< .634, 95% CI [-.190, .306].

Studies were compared based on the research design that was used Q_b (3)= 102.879, p<.000. The smallest effect size was correlational (k= 5, r= -.096, Z= -11.610, p< .000, 95% CI [-.112, -.08], followed by cross-sectional studies (k= 2, r= -.068, Z= -3.765, p< .000, 95% CI [-

.103, -.032]. The largest effect was found in longitudinal studies (*k*= 2, *r*= .164, *Z*= 5.777, *p*<.000, 95% CI [.109, .218].

Studies were compared based on screen type Q_b (2)= 36.701, *p*<.000. The smallest effect size was social media (*k*= 1, *r*= -.184, *Z*= -7.2, *p*<.000, 95% CI [-.233, -.135], followed by time (*k*= 8, *r*= -.068, *Z*= -8.773, *p*<.000, 95% CI [-.083, -.052]. The largest effect was found for the study that combined both screen types (*k*=1, *r*=0.77, *Z*=2.119, *p*<.034, 95% CI [.006, .147].

Studies were compared based on ethnicity Q_b (4)= 420.638, p< .000. The ethnicity with the smallest effect was hispanic (*k*= 1, *r*= -.550, *Z*= -21.566, *p*<.000, 95% CI [-.588, -.510], followed by asian (*k*= 1, *r*= -.060, *Z*= -1.078, *p*<.28, 95% CI [-.168, .049], followed by white (*k*= 6, *r*= -.042, *Z*= -5.418, *p*<.000, 95% CI [-.057, -.027]. The ethnicity with the largest effect size was middle eastern (*k*=1, *r*= .077, *Z*= 2.119, *p*<.034, 95% CI [.006, .147].

CHAPTER 4: DISCUSSION

Interpreting the Overall Effect

The present meta-analysis found a negative relationship between screen time and academic performance. The *r* value for the relationship was -.07. This study included 12 studies, with a total sample size of 31,844, increasing the power of the test (Levine, 2013). This shows that our effect size is most likely an accurate indicator of the effects of screen time on academic performance.

One way to interpret the size of the effects is to compare them to Cohen's (1988) effect size benchmarks, which proposed that *r* values around the .10, .30, and .50 marks should be considered small, medium, and large. This indicates that the present meta-analysis is less than a

small effect size. In this meta-analysis it may be more useful to focus on the size of the effect for each age group or study design. While this effect size usually means there are limited applications, it can still have some implications in the real-world (McCartney & Rosenthal, 2000), insinuating that the effect found in this meta-analysis could be potentially relevant.

Additionally, when examining the various effects of research design (i.e., cross-sectional, correlational, and longitudinal) on the outcome variable, we see variation in the effect sizes. While we did not expect to see significant moderating effects for research design on academic performance, it is interesting to note that longitudinal (.164) had the largest effect on academic performance, followed by cross-sectional (-.068), and correlational (-.096). These variations could be attributed to the fact that more screen time lowers academic performance more gradually rather than instantaneously. This could be a factor that future research will consider when collecting data.

Considering that there were moderating effects found when examining the design of the study, we expected to see moderating effects based on screen type. While this was the case, some studies had both screen types, and studies that combined the two seemed to have the largest effect size (.077), followed by the amount of screen time (-.068) and social media (-.184). These results may be attributed to the possibility that the amount of screen time combined with being on social media has more harmful effects on academic performance than the two separate variables.

Moderation effects

The current meta-analysis found moderating effects for ethnicity of the participants for academic performance. This is most likely attributed to how ethnicity was coded for each study. We coded ethnicity based on how researchers chose their participants and narrowed it down to four different ethnic groups. About 60% of the studies had white participants, and this is most likely related to the fact that most of the research has been conducted where most of the residents, and thus research participants, are white. This limits the diversity of the participants represented in the meta-analysis. Even with this considered, studies where most participants were white (-.042) reported a smaller effect size than the study where participants were middle eastern (.077). Hispanic (-.550) and asian (-.060) had small effect sizes as well. This indicates that there may be differences across ethnicities about how screen time affects academic performance.

While screen time use during teenage years and emerging adulthood is concerning due to the possible negative outcomes it may have, there were no moderating effects of age for academic performance. Even with this being considered, studies observing teens had a bigger effect (.094) than studies that observed emerging adults (.062). This may indicate that teens are more concerned with their technology screen rather than their academic performance over emerging adults.

Theoretical explanation

The results of this meta-analysis can support the theory that the reason screen time influences academic performance is because screen time causes absent-mindedness. Absent-mindedness can lead to mind-wandering, which splits our attention. Split attention can cause a person to stop processing information from the external world and instead a person's attention is

caught up with thoughts and feelings (Smallwood & Fishman, 2007). Since screen time has been correlated to mind-wandering and absent-mindedness, this could explain why screen time has a negative relationship with academic performance. This relationship may happen gradually over time, and this could be why longitudinal studies were found to have the biggest effect size.

Limitations of study

Within the meta-analysis, there are some limits to the validity of our findings. In addition to the fact that the results from each study varied, current research in this area is very broad. Different research designs are a limitation to the strength of our results because different designs were found to have larger effects than others. The studies used to conduct this meta-analysis were all performed differently, and the lack of common terms among previous research (e.g., screen type) can be a limitation. Limitations on sample size for different ethnicities within research can affect results. Different ethnicities have different standards when it comes to how tolerated technology is. As such, the true size of the relationship between screen time and academic performance is higher than the reported effect sizes here.

Significance of the study and implication for future research

Results of this meta-analysis indicate that there are risk factors for how much screen time will affect academic performance. Moderating variables also play a role in screen time affecting academic performance. While participant age was not a significant moderator in this meta-analysis, ethnicity, study design, and screen type were found to have a significant moderating effect. Even though age was not a significant moderator, differences in effect sizes showed that teens had a larger effect size than emerging adults. This could be related to the idea that

teenagers are more concerned about their social life, and therefore spend more time on their phones. Emerging adults may be more concerned with their careers and being independent. Although the results of this meta-analysis help to answer questions regarding the relationship between screen time and academic performance, they also pose implications for future research within this domain. Future research should consider how screen time is being defined, and make sure it is consistent. It is possible that more consistent definitions of screen time may increase the significance of these results. The fact that longitudinal study designs had the largest effect may also be an implication for future research. Screen time affecting academic performance may be a gradual process, and therefore designs like cross-sectional and correlational do not dedicate enough time to see the effects. A meta-analysis may only use studies that are longitudinal in order to yield more accurate and significant results. The association between screen time and ethnicity should be addressed more thoroughly to better understand how ethnicity moderates academic performance. Finally, risk factors associated with screen time and mind-wandering should also be considered in future research examining the impact they may have on academic performance.

APPENDIX A: TABLES

Table 1.

Article	N	r	SE	% male	Age	Ethnicity	Location	Research Design	Screen time
Ahmet et al. (2019)	648	-.1842	.025	21.6	2	1	Turkey	CS	MU
Cao & Tian (2022)	256	.854	.03	52	2	4	UAE	C	MU
Chau et al. (2022)	1,559	.0433	.025	49.9	1	1	France	CS	ST
Choi & Park (2019)	1,031	-.15	.03	50.8	1	2	Korea	CS	ST
Cong Qi (2019)	208	.31	.07	34.6	2	2	Hong Kong	CS	MU
Faught et al. (2019)	11,016	.9999	.00013	48	1	1	Canada	L	ST
Marciano et al. (2021	1,208	.155	.028	48	1	1	Switzerland	L	ST
Morita et al. (2016)	315	-.6	.0555	52	1	2	Japan	C	MU

Paulich et al. (2021)	11,672	.0469	.009	52	1	1	USA	C	ST
Peiro-Velert et al. (2014)	3,095	-.55	.02	50	1	3	Spain	C	MU
Rashid et al. (2016)	761	.0766	.036	0	2	4	Saudi Arabia	C	MU
Schulz & Endert (2021)	75	.43	.105	53	1	1	Germany	C	MU
Total *N*	31,844								

Note. Age is coded as 1= teen; 2= emerging adults. Ethnicity is coded as 1= White; 2= Asian; 3= Hispanic; 4= Middle Eastern. Research Design is coded as CS= cross-sectional; C= correlational; L= longitudinal. Screen Time is coded as MU= media use; ST= screen time.

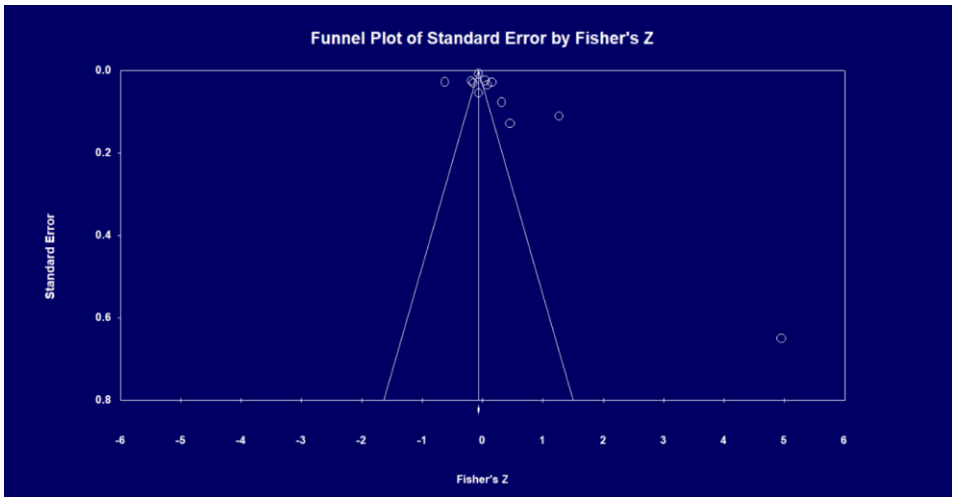
Model	Effect size and 95% interval			Test of nul			Heterogeneity			Tau-squared				
Model	*k*	*o*	CI_{LL}	CI_{UL}	*z*	*p*	*Q*	*df(Q)*	*p*	*i*	*Tau2*	*SE*	*O*	*Tau*
Fixed	12	-.07	-.084	-.056	-9.948	0.0	742	11	0.0	98.5	.059	.043	.002	.24
Random	12	.144	-.002	.284	1.934	.053								

Table 2.

Notes: *k*= number of studies, *o*= point estimate, CI_{LL} CI_{UL}= confidence intervals lower and upper limit, *i*= I-squared,

Tau2= Tau squared, *SE*=standard error, *O*= variance

Figure 1.


Funnel Plot of Standard Error by Fisher's Z
Standard Error
0.0
0.2
0.4
0.6
0.8
-6
-5
-4
-3
-2
-1
0
1
2
3
4
5
6
Fisher's Z

References

Ahmet, M. U., Selcan K., (2019) Does persistent involvement in media and technology lead to lower academic performance? Evaluating media and technology use in relation to multitasking, self-regulation and academic performance, *Computers in Human Behavior*, Pages 196-203, https://doi.org/10.1016/j.chb.2018.08.045.

Cao G., Tian Q., (2022) Social media use and its effect on university student's learning and academic performance in the UAE, *Journal of Research on Technology in Education*, 54:1, 18-33, DOI: 10.1080/15391523.2020.1801538

Chau K., Bhattacherjee A., Senapati A., Guillemin F., Chau N., (2022) Association between screen time and cumulating school, behavior, and mental health difficulties in early adolescents: A population-based study, *Psychiatry Research*, https://doi.org/10.1016/j.psychres.2022.114467.

Choi M., Park S., (2020) The Mediating Effects of Academic Performance between Screen Time, Executive Function Difficulty and School Adjustment, *Comprehensive Child and Adolescent Nursing*, DOI: 10.1080/24694193.2019.1675805

Cong Qi (2019) A double-edged sword? Exploring the impact of students' academic usage of mobile devices on technostress and academic performance, *Behaviour & Information Technology*, 38:12, 1337-1354, DOI: 10.1080/0144929X.2019.1585476

Corkin, M. T., Peterson, E. R., Henderson, A. M. E., Waldie, K. E., Reese, E., & Morton, S. M. B. (2021). Preschool screen media exposure, executive functions and symptoms of inattention/hyperactivity. *Journal of Applied Developmental Psychology, 73*. https://doi.org/10.1016/j.appdev.2020.101237

Faught E.L., Qian W., Carson V. L., Storey K. E., Faulkner G., Veugelers P. J., Leatherdale S. T., (2019) The longitudinal impact of diet, physical activity, sleep, and screen time on Canadian adolescents' academic achievement: An analysis from the COMPASS study, *Preventive Medicine*, https://doi.org/10.1016/j.ypmed.2019.05.007.

Hadar, A.A., Eliraz, D., Lazarovits, A., Alyagon, U., Zangen, A., (2015)

Using longitudinal exposure to causally link smartphone usage to changes in behavior, cognition and right prefrontal neural activity, *Brain Stimulation*, Page 318, https://doi.org/10.1016/j.brs.2015.01.032.

Huber, B., Yeates, M., Meyer, D., Fleckhammer, L., Kaufman, J., (2018) The effects of screen media content on young children's executive functioning,*Journal of Experimental Child Psychology*, pages 72-85, https://doi.org/10.1016/j.jecp.2018.01.006.

Hobbiss, M. H., Fairnie, J., Keya, J., Nilli, L., (2019) Attention, Mind wandering, and Mood, *Consciousness and Cognition*, Pages 1-18, https://doi.org/10.1016/j.concog.2019.04.007.

Lin Ling-Yi, Cherng Rong-Ju, Chen Yung-Jung, Chen Yi-Jen, Yang Hei-Mei, (2015) Effects of television exposure on developmental skills among young children, *Infant Behavior and Development*, Pages 20-26, https://doi.org/10.1016/j.infbeh.2014.12.005.

Marciano L., Camerini A. L., (2021) Recommendations on screen time, sleep and physical activity: associations with academic achievement in Swiss adolescents, *Public Health*, https://doi.org/10.1016/j.puhe.2021.07.027.

McArthur B. A., Browne D., Tough S., Madigan S., (2020) Trajectories of screen use during early childhood: Predictors and associated behavior and learning outcomes, *Computers in Human Behavior*, https://doi.org/10.1016/j.chb.2020.106501.

Morita N., Nakajima T., Okita K., Ishihara T.,SagawaM., Yamatsu K., (2016) Relationships among fitness, obesity, screen time and academic achievement in Japanese adolescents, *Physiology & Behavior*, https://doi.org/10.1016/j.physbeh.2016.04.055.

Parry, D. A., Le Roux, D. B., Bantjes, J. R., (2020) Testing the feasibility of a media multitasking self-regulation intervention for students: Behaviour change, attention, and self-perception, *Computers in Human Behavior*, https://doi.org/10.1016/j.chb.2019.106182.

Paulich K. N., Ross J. M., Lessem J. M., Hewitt J. K., (2021) Screen time and early adolescent mental health, academic, and social outcomes in 9- and 10- year old children: Utilizing the Adolescent Brain Cognitive Development ℠ (ABCD) Study. *PLoS ONE* https://doi.org/10.1371/journal.pone.025659

Peiro´-Velert C., Valencia-Peris A., Gonza´lez L.M., Garcı´a-Masso´ X., Serra-An˜o´ P., et al. (2014) Screen Media Usage, Sleep Time and Academic Performance in Adolescents: Clustering a Self-Organizing Maps Analysis. *PLoS ONE* doi:10.1371/journal.pone.0099478

Rashid, T., Muhammad Asghar, H., (2016) Technology use, self-directed learning, student engagement and academic performance: Examining the interrelations, *Computers in Human Behavior*, Pages 604-612, ISSN 0747-5632, https://doi.org/10.1016/j.chb.2016.05.084.

Rasi, R.A., Ashifa, K.M., Anu, J. Vengal, Babu, Cinniya, (2020) Usage of smart technologies among young adults, *Materials Today: Proceedings*,https://doi.org/10.1016/j.matpr.2020.10.133.

Roberts, J. A., Pullig, C., Manolis, C., (2015) I need my smartphone: A hierarchical model of personality and cell-phone addiction, *Personality and Individual Differences*, Pages 13-19, https://doi.org/10.1016/j.paid.2015.01.049.

Schulz V., Endert T., (2021) Addictive use of digital devices in young children: Associations with delay discounting, self-control and academic performance. *PLoS ONE* https://doi.org/10.1371/journal.pone.0253058

Smallwood, J., Fishman, D. J., Schooler, J. ., (2007). Counting the cost of an absent mind: Mind wandering as an underrecognized influence on educational performance. *Psychonomic Bulletin & Review, 14*(2), 230–236. https://doi.org/10.3758/BF03194057

Tang, S., Werner-Seidler, A., Torok, M., Mackinnon, J. A., Christensen, H. (2021), The relationship between screen time and mental health in young people: A systematic review of longitudinal studies, *Clinical Psychology Review*, https://doi.org/10.1016/j.cpr.2021.102021.

Wilcockson, T.D.W., Osborne, A.M., Ellis, D.A., (2019) Digital detox: The Effect of Smartphone Abstinence on Mood, Anxiety, and Craving, *Addictive Behaviors*, https://doi.org/10.1016/j.addbeh.2019.06.002.

Valentine, J., Pigott, T., & Rothstein, H. (2010). How many studies do you need? A primer on statistical power for meta-analysis. *Journal of Educational and Behavioral Sciences, 35, 215-247. https://doi.org/10.3102/1076998609346961*

Vizcaino, M., Buman, M., DesRoches, C. *et al.* Reliability of a new measure to assess modern screen time in adults. *BMC Public Health* 19, 1386 (2019). https://doi.org/10.1186/s12889-019-7745-6

Zimmerman, F. J., Ortiz, S. E., Christakis, D. A., Elkun, D., (2012) The value of social-cognitive theory to reducing preschool TV viewing: A pilot randomized trial,

Preventive Medicine, Pages 212-218, https://doi.org/10.1016/j.ypmed.2012.02.004

Zurcher, J. D., King, J., Callister, M., Stockdale, L., Coyne, S. M., (2020) “I can multitask”: The mediating Role of Media Consumption on Executive Function's Relationship to Technoference Attitudes,*Computers in Human Behavior.* https://doi.org/10.1016/j.chb.2020.106498.