

## **Associations Between Exposures and Education Outcomes**

**Learning**

Outcome	Specific Outcome	Exposure	Age Group	Population	Study Design	Lead Author, Date	r with 95% CI	I <sup>2</sup>	K	N	Indiv. Data	Eggers	Excess Signif.	
Learning	General	Screen-based intervention: With digital characters	Children	General	Experimental	Schroeder, 2013	0.28 [ 0.18, 0.37]	0%	5	348	✓	✗	✓	
	General	Video games: Educational (with competition)	Children	General	Experimental	Chen, 2020	0.32 [ 0.10, 0.50]	8	724	✗	—	—	—	
	General	Video games: Educational (with competition)	Adolescents	General	Experimental	Chen, 2020	0.21 [ 0.11, 0.28]	8	740	✗	—	—	—	
	General	Video games: Educational (with instructional support)	Adolescents	General	Experimental	Wouters, 2013	0.07 [-0.07, 0.20]	60%	13	471	✓	✓	✓	
	General	Video games: Virtual reality (Educational)	Mixed	General	Experimental	Merchant, 2014	0.25 [ 0.12, 0.36]	90%	13	3,081	✗	—	—	
	Literacy and numeracy	Screen use: Educational apps	Children	General	Experimental	Kim, 2021	0.10 [ 0.07, 0.13]	0%	36	5,447	✓	✗	✓	
	Literacy and numeracy	Screen-based intervention: Sesame Street	Children	General	Mixed or unspecified	Mares, 2013	0.14 [ 0.08, 0.20]	15	7,604	✗	—	—	—	
	Physical and social environment	Screen-based intervention: Sesame Street	Children	General	Mixed or unspecified	Mares, 2013	0.17 [ 0.09, 0.24]	13	7,797	✗	—	—	—	
	Programming skills	Screen-based intervention: Education (programming)	Children	General	Experimental	Scherer, 2020	0.43 [ 0.21, 0.65]	86%	6	317	✓	✗	✓	
	Programming skills	Screen-based intervention: Education (programming)	Adolescents	General	Experimental	Scherer, 2020	0.32 [ 0.12, 0.52]	88%	4	767	✓	✗	✓	
	School attendance problems	Internet use: Cyberbullying victimization	Adolescents	General	Cross-sectional only	Gardella, 2017	0.20 [ 0.18, 0.21]	0%	9	25,242	✓	✗	✓	
	Second language	Screen use: General (mobile phone for language learning)	Children	General	Experimental	Cho, 2018	0.26 [ 0.13, 0.38]	80%	7	1,192	✓	✗	✓	
	Second language	Screen use: General (mobile phone for language learning)	Adolescents	General	Experimental	Cho, 2018	0.20 [-0.13, 0.53]	84%	3	201	✓	✗	✓	
	Second language vocabulary	Screen-based intervention: English as foreign language	Children	General	Experimental	Hao, 2021	0.22 [-0.36, 0.79]	94%	3	147	✓	✗	✓	
	Second language vocabulary	Screen-based intervention: English as foreign language	Adolescents	General	Experimental	Hao, 2021	0.42 [ 0.25, 0.60]	90%	12	569	✓	✗	✓	
	Behavior	Video games: Educational (with competition)	Children	General	Mixed or unspecified	Arztmann, 2022	0.43 [ 0.28, 0.57]	70%	5	439	✓	✗	✓	
	Computational thinking	Computer use: Programming exercises	Children	General	Experimental	Li, 2022	0.19 [ 0.02, 0.36]	78%	4	682	✓	✗	✓	
	Computational thinking	Computer use: Programming exercises	Adolescents	General	Experimental	Li, 2022	0.33 [ 0.21, 0.45]	54%	8	493	✓	✗	✓	
	Educational achievement problems	Internet use: Cyberbullying victimization	Adolescents	General	Cross-sectional only	Gardella, 2017	0.15 [ 0.13, 0.17]	0%	7	7,768	✓	✗	✓	
	General	Screen use: General (in schools)	Children	General	Experimental	Chauhan, 2017	0.26 [ 0.23, 0.30]	86%	122	32,096	✗	—	—	
General	Screen use: General (mobile phone)	Mixed	General	Mixed or unspecified	Kates, 2018	-0.15 [-0.24, -0.05]	100%	8	179,186	✓	✗	✓		
General	Screen use: Video (vs face-to-face)	Young children	General	Experimental	Strouse, 2021	-0.26 [-0.32, -0.21]	76%	122	3,436	✓	✗	✓		
General	Screen use: Virtual reality simulations (Educational)	Mixed	General	Experimental	Merchant, 2014	0.20 [ 0.09, 0.30]	86%	29	2,553	✗	—	—		
General	Screen use: Virtual reality worlds (Educational)	Mixed	General	Experimental	Merchant, 2014	0.18 [ 0.14, 0.21]	78%	25	2,798	✗	—	—		
General	Screen-based intervention: Sesame Street	Children	General	Cross-sectional only	Mares, 2013	0.22 [ 0.10, 0.34]	3	615	✗	—	—	—		
General	Screen-based intervention: Sesame Street	Children	General	Longitudinal only	Mares, 2013	0.13 [ 0.08, 0.18]	21	9,981	✗	—	—	—		
General	Screen-based intervention: Sesame Street	Children	General	Mixed or unspecified	Mares, 2013	0.14 [ 0.10, 0.19]	24	10,596	✗	—	—	—		
General	Screen-based intervention: Augmented reality (in schools)	Children	General	Experimental	Garzón, 2019	0.33 [ 0.29, 0.36]	94%	19	1,207	✗	—	—		
General	Screen-based intervention: Augmented reality (in schools)	Adolescents	General	Experimental	Garzón, 2019	0.27 [ 0.22, 0.31]	96%	12	1,053	✗	—	—		
General	Screen-based intervention: Education (via computer)	Children	General	Mixed or unspecified	Liao, 2008	0.22 [ 0.15, 0.28]	48	5,121	✗	—	—	—		
General	Screen-based intervention: Education (via touch screen)	Children	Autism	Experimental	Aspiranti, 2020	0.35 [ NA, NA]	3	33	✗	—	—	○		
Outcome	Specific Outcome	Exposure	Age Group	Population	Study Design	Lead Author, Date	r with 95% CI	I <sup>2</sup>	K	N	Indiv. Data	Eggers	Excess Signif.	
Literacy	Decoding	e-Books: General	Children	General	Mixed or unspecified	Zucker, 2009	0.01 [-0.17, 0.20]	0%	2	109	✓	✗	✓	
	General	Screen use: General	Mixed	General	Cross-sectional only	Madigan, 2020	-0.14 [-0.21, -0.08]	24	8,868	✗	—	—	—	
	General	Screen use: General	Mixed	General	Longitudinal only	Madigan, 2020	-0.12 [-0.16, -0.07]	14	9,450	✗	—	—	—	
	General	Screen use: General (coviewing)	Mixed	General	Cross-sectional only	Madigan, 2020	0.19 [ 0.05, 0.33]	8	3,262	✗	—	—	—	
	General	Screen use: General (coviewing)	Mixed	General	Longitudinal only	Madigan, 2020	0.08 [ 0.01, 0.15]	4	2,821	✗	—	—	—	
	General	Screen-based intervention: Literacy	Mixed	Poor readers	Experimental	McArthur, 2018	0.16 [-0.01, 0.33]	54%	6	294	✓	✗	✓	
	General	Screen-based intervention: Education (general)	Mixed	General	Cross-sectional only	Madigan, 2020	0.14 [-0.04, 0.31]	90%	7	1,228	✓	✗	✓	
	General	Screen-based intervention: Education (general)	Mixed	General	Longitudinal only	Madigan, 2020	0.10 [ 0.00, 0.19]	6	727	✗	—	—	—	
	General	Screen-based intervention: Literacy videos	Children	General	Mixed or unspecified	Hurwitz, 2018	0.10 [ 0.07, 0.13]	0%	45	24,624	✗	—	—	—
	General	TV programs and movies: Coviewing	Mixed	General	Observational - mixed	Madigan, 2020	0.11 [ 0.01, 0.20]	9	3,376	✗	—	—	—	
	General	TV programs and movies: General	Mixed	General	Cross-sectional only	Adelantado-Renau, 2019	-0.09 [-0.18, 0.00]	96%	8	16,761	✓	✗	✓	
	General	TV programs and movies: General	Mixed	General	Observational - mixed	Madigan, 2020	-0.15 [-0.21, -0.09]	26	12,337	✗	—	—	—	
	General	TV programs and movies: General (in background)	Mixed	General	Observational - mixed	Madigan, 2020	-0.19 [-0.31, -0.06]	70%	5	2,792	✓	✗	✓	
	Listening comprehension	Screen-based intervention: Literacy (Abracadabra; in schools)	Children	General	Experimental	Abrami, 2020	0.11 [-0.01, 0.23]	92%	8	3,715	✓	✗	✓	
	Phonics	Screen-based intervention: Literacy (phonics; via computer)	Mixed	Poor readers	Experimental	McArthur, 2012	0.08 [-0.11, 0.27]	14%	4	124	✓	✗	✓	
	Phonemic awareness	Screen-based intervention: Literacy (Abracadabra; in schools)	Children	General	Experimental	Abrami, 2020	0.16 [ 0.11, 0.22]	68%	10	5,124	✓	✗	✓	
	Pronunciation	Screen-based intervention: Pronunciation	Mixed	General	Experimental	Hassan-Saleh, 2019	0.22 [ NA, NA]	82%	6	302	✗	—	—	○
	Reading	Screen-based intervention: Reading (in schools)	Mixed	General	Experimental	Cheung, 2012	0.08 [ 0.06, 0.10]	78%	84	60,553	✗	—	—	○
	Reading comprehension	Screen-based intervention: Literacy (Abracadabra; in schools)	Children	General	Experimental	Abrami, 2020	0.10 [ 0.03, 0.17]	82%	9	5,773	✓	✗	✓	
	Reading comprehension	e-Books: General	Children	General	Mixed or unspecified	Zucker, 2009	0.23 [ 0.10, 0.35]	44%	7	401	✓	✗	✓	
Reading fluency	Screen-based intervention: Literacy	Children	General	Mixed or unspecified	Blok, 2002	0.13 [ 0.07, 0.19]	58%	50	3,083	✓	✗	✓		
Reading fluency	Screen-based intervention: Literacy (Abracadabra; in schools)	Children	General	Experimental	Abrami, 2020	0.06 [-0.06, 0.17]	74%	5	1,745	✓	✗	✓		
Reading performance	Screen use: Reading (vs paper)	Mixed	General	Experimental	Clinton, 2019	-0.11 [-0.26, 0.03]	76%	9	760	✓	✗	✓		
Vocabulary knowledge	Screen-based intervention: Literacy (Abracadabra; in schools)	Children	General	Experimental	Abrami, 2020	0.04 [-0.07, 0.15]	94%	8	5,181	✓	✗	✓		
Vocabulary learning	e-Books: General	Young children	General	Experimental	Furenes, 2021	0.14 [ 0.07, 0.20]	0%	18	871	✓	✓	✓		
Writing	Screen-based intervention: Writing feedback	Children	General	Experimental	Graham, 2015	0.19 [ 0.08, 0.28]	0%	4	463	✗	—	—		
Outcome	Specific Outcome	Exposure	Age Group	Population	Study Design	Lead Author, Date	r with 95% CI	I <sup>2</sup>	K	N	Indiv. Data	Eggers	Excess Signif.	
Numeracy	General	Screen use: Educational apps	Children	General	Experimental	Kim, 2021	0.09 [ 0.06, 0.12]	0%	24	4,352	✓	✗	✓	
	General	Screen-based intervention: Mathematics	Children	Dyscalculia	Experimental	Kucukalkan, 2019	0.29 [ 0.24, 0.34]	86%	31	2,290	✗	—	—	
	General	Screen-based intervention: Cognitive training	Mixed	General	Experimental	Oldrati, 2020	0.15 [ 0.02, 0.29]	70%	11	693	✓	✓	✓	
	General	Screen-based intervention: Dynamic geometry software	Mixed	General	Experimental	Chan, 2014	0.43 [ 0.29, 0.57]	92%	9	1,174	✓	✗	✓	
	General	Screen-based intervention: Mathematics (in schools)	Mixed	General	Experimental	Cheung, 2013	0.07 [ 0.05, 0.09]	82%	73	56,891	✓	✗	✓	
	General	Screen-based intervention: Mathematics (via computer in classrooms)	Children	Math difficulties	Experimental	Kroesbergen, 2003	0.28 [ 0.13, 0.43]	7						

**Note:** Individual study data available for reanalysis.  
**Indiv. Data:** Individual study data available for reanalysis.  
**Eggers:**  $P > 0.05$  for Egger's test of asymmetry, or too few studies to analyse ( $K < 10$ )  
**Excess Signif.:**  $P > 0.05$  for test for excess significance