

## Supplementary Material

### Effectiveness of Climate Change Education – A Meta-Analysis

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#### Articles included in the meta-analysis

- Alexandar, R., & Poyyamoli, G. (2012). Activity-based water resources and climate change education among school students in Puducherry. In *Climate Change and the Sustainable Use of Water Resources* (pp. 557–578). Springer Berlin Heidelberg. [https://doi.org/10.1007/978-3-642-22266-5\\_20](https://doi.org/10.1007/978-3-642-22266-5_20)
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**Table A1**

*Combination of outcome variables investigated in the included studies*

<b>Outcome variable(s)</b>	<b>Number of studies</b>
Knowledge only	33
Knowledge - attitude	4
Knowledge - behavior	2
Knowledge - attitude - behavior	4
Attitude only	5
Attitude - behavior	4
Behavior only	1

**Table A2***Description of studies included in the meta-analysis*

Publication	Country	Population	N	Content			Duration	Teacher	Design	Outcomes
				Basics	Effects	Actions				
Alexandar & Poyyamoli (2012)	India	L. & u. secondary 13-15 years	70		CS, US, E	M, A		RT	Pre-post	knowledge, attitude, behavior
Arya & Maul (2016)	USA, Norway, China, New Zealand	L. & u. secondary 13-17 years	96	Yes	CS, US, BS	M	8 weeks	CT	Pre-post	behavior
Barata et al. (2017)	Portugal	L. secondary 11-15 years	418		US	M	4 months	CT	Pre-post	attitude, behavior
Ben-Zvi Assaraf & Orpaz (2010)	Israel	L. secondary	21	Yes	CS, US, BS		30 hours	CT	Pre-post	knowledge
Besson & De Ambrosis (2013)	Italy	U. secondary 15-18 years	121	Yes	CS, US			RT	Pre-Post	knowledge
Bopardikar et al. (2021)	USA	L. secondary 12-13 years	73	Yes	CS, BS		1 week	CT	Pre-Post	knowledge
Cartwright et al. (2021)	USA	L. secondary 12-14 years	47	Yes	CS		10 days	RT	Pre-Post	knowledge
Chang et al. (2018)	Singapore	U. secondary 15-16 years	32	Yes	CS		4 sessions	CT	Pre-Post	knowledge
Christensen & Knezek (2018)	USA	L. secondary	733		CS, US	M	3 weeks	RT	Pre-post	attitude, behavior
Covitt et al. (2021)	USA	L. & u. secondary	415	Yes	CS	M	4 hours	RT	Pre-Post	knowledge
Dawson & Carson (2020)	Australia	U. secondary	30	Yes	CS, BS	M	16 hours	RT	Pre-Post	knowledge

Publication	Country	Population	N	Content			Duration	Teacher	Design	Outcome
				Basics	Effects	Actions				
Deisenrieder et al. (2020)	Australia, Germany	L. & u. secondary 12-16 years	169	Yes	CS, BS, US		9 months	RT	Pre-Post	knowledge, attitude, behavior
Eggert et al. (2017)	Germany	U. secondary	158	Yes	CS, BS, US, E	A	2 hours		Pre-Post	knowledge
Flora et al. (2014)	USA	U. secondary	1241	Yes	CS	M	1 hour	ET	Pre-Post	knowledge, attitude, behavior
Gayford (1995)	UK	U. secondary 16 years	48	Yes	CS, US	M	2 hours	RT	Pre-Post	knowledge
Hallar et al. (2011)	USA	L. secondary	214	Yes	CS		3 days	RT	Pre-Post	knowledge, attitude
Harker-Schuch et al. (2020)	Australia, Germany	L. secondary 12-13 years	401	Yes	CS		1 hour	RT	Pre-Post	knowledge
Holthuis et al. (2014)	USA	U. secondary	742	Yes	CS, BS	M, A	4-5 weeks	RT	Pre-Post	knowledge
Hu & Chen (2016)	China	Primary/l. secondary 4-13 years	IG1:369 IG2: 234 CG: 565	Yes	CS, E	M	1 hour	RT	QE	attitude, behavior
Jin et al. (2013)	USA	Primary/ l. u. secondary	682	Yes	CS			RT	Pre-Post	knowledge
Karpudewan & Mohd Ali Khan (2017)	Malaysia	U. secondary 16 years	IG1: 32 IG2: 30	Yes	CS, US	M	12 hours	RT	Pre-Post	knowledge
Keller et al. (2019)	Austria, Germany	L./U. secondary	343		CS, BS, US		9 months	CT	Pre-Post	attitude
Klosterman & Sadler (2010)	USA	U. secondary	83	Yes	CS	M	15 hours	RT	Pre-Post	knowledge

Publication	Country	Population	N	Content			Duration	Teacher	Design	Outcome
				Basics	Effects	Actions				
Lester et al. (2006)	USA	L. secondary	420	Yes	CS	M	12 lessons	RT	Pre-Post	knowledge
Liu et al. (2012)	Taiwan	L. secondary	IG: 42 CG: 80		CS, US	M, A	240 min	RT	QE	knowledge
Lombardi et al. (2013)	USA	L. secondary	IG: 86 CG: 83	Yes	CS		90 min	RT	QE	knowledge
Mahat et al. (2014)	Malaysia	U. secondary 14-16 years	224			M		RT	Pre-post	knowledge, behavior
Markowitz et al. (2018)	USA	U. secondary 16-18 years	16		CS, BS		6 lessons	RT	Pre-Post	knowledge
Maurer et al. (2020)	Greece	L. secondary 11 years	132		CS	M	19 hours	RT	Pre-Post	knowledge
McNeill & Vaughn (2012)	USA	U. secondary 16-18 years	75	Yes	CS, US, E	M	20-30 lessons		Pre-Post	knowledge
Nussbaum et al. (2016)	USA	L. secondary	IG: 63 CG: 62	Yes	CS, US, E	M, A	24 min		RCT	knowledge
Petersen et al. (2020)	Denmark	L. secondary	IG1: 50 IG2: 52	Yes	CS		135 min	RT	Pre-Post	knowledge, behavior
Porter et al. (2012)	Canada	L. secondary	IG1: 31 IG2: 19 KG: 16	Yes	CS, BS		3 hours	IG1: RT IG2: ET	QE	knowledge
Praneetham & Thathong (2016)	Thailand	L. secondary 11-12 years	40		CS	M			Pre-Post	knowledge

Publication	Country	Population	N	Content			Duration	Teacher	Design	Outcome
				Basics	Effects	Actions				
Putland et al. 2021	Canada	L. & u. secondary 11-17 years		Yes	CS, BS, US	M, A	1 lesson	ET	Pre-Post	knowledge
Reinfried, Aeschbacher, & Rottermann (2012)	Switzerland	l. secondary 14 years	IG1: 122 IG2: 128 CG: 39	Yes	CS		75 min	ET	QE	knowledge
Rudd et al. (2020)	Wales	L. & u. secondary 12-15 years	180		CS, US	M	3 days	ET	Pre-post	attitude
Rule & Meyer (2009)	USA	L. & u. secondary	100		CS, BS, US, E		440 min		Pre-post	knowledge, attitude
Schauss & Sprenger (2019)	Germany	U. secondary 16-18 years	36		CS		3-6 months	ET	Pre-post	knowledge, attitude
Schneiderhan-Opel & Bogner (2021)	Germany	L. secondary	IG1: 204 IG2: 115 CG: 124	Yes	CS, BS, US	M	3 days		QE	knowledge
Schrot, Peduzzi, et al. (2021)	Austria, Italy	U. secondary 16-18. years	IG: 133 CG: 98		US	A	700 min + 2 days	CT	QE	attitude
Schrot, Traxler, et al. (2021)	Austria	U. secondary 17-18 years	41		CS, US, BS, E	M, A	600 min	ET	Pre-post	attitude
Sellmann & Bogner (2013b)	Germany	U. secondary 14-19 years	114,	Yes	CS, US, BS	M	1 day	CT	Pre-post	attitude
Sellmann & Bogner (2013a)	Germany	U. secondary 15-19 years	108	Yes	CS, US, BS	M	1 day	CT	Pre-post	knowledge

Publication	Country	Population	N	Content			Duration	Teacher	Design	Outcome
				Basics	Effects	Actions				
Siegner (2018)	USA	l. & u. secondary	100	Yes	CS, US	M	6 weeks	CT	Pre-post	knowledge
Smith et al. (2019)	USA	secondary	511		CS, E		2 lessons	RT	Pre-post	knowledge
Stevenson et al. (2018)	USA	L. secondary 11-15 years	IG: 634 CG: 407	Yes	CS, BS	M, A	4 lessons	RT	QE	knowledge, attitude, behavior
Svihla & Linn (2012)	USA	L. secondary 11-12 years	IG1: 67 IG2: 119	Yes	CS		5 days	RT	Pre-post	knowledge
Taber & Taylor (2009)	Australia	L. secondary 11-12 years	29	Yes	CS, US	M	8 weeks		Pre-post	knowledge, attitude
Varma & Linn (2012)	USA	L. secondary	190	Yes	CS	M	5 hours	RT	Pre-post	knowledge
Walsh & Cordero (2019)	USA	L. secondary	835	Yes	CS	M	4-8 weeks	CT	Pre-post	knowledge
Wang (2014)	Taiwan	L. secondary	IG1: 30 IG2: 27		CS, US, E	M		RT	Pre-post	attitude, behavior
Xie et al. (2014)	USA	U. secondary	526		SC, BS, US		75 hours	RT	Pre-post	knowledge

*Note.* U. secondary = upper secondary, L. secondary= lower secondary; N = number of students; IG = intervention group, CG = control group; QE = quasi experimental design; RT = regular teacher, ET = expert teacher (i.e., expert in climate change ), CT = co-teaching between regular teacher and expert in climate change; AC = anthropogenic causes of climate change, NC = natural causes of climate change; CS=climate system, US = utilization system, BS = biological systems, E = extreme events; M = mitigation, A = adaptation

**Table A3***Comparison of model configurations for the meta-analytic multilevel model*

<b>Model and outcome</b>	<b>AIC</b>	<b>BIC</b>	<b>logLik</b>	<b>LRT, p</b>
<i>Knowledge</i>				
<b>4-level Model</b>	198.63	210.13	-95.31	
<b>3-level Model</b>	200.33	208.95	-97.16	3.70, p = .05
<b>2-level Model</b> (variance between studies)	622.13	627.88	-309.07	427.51, p <.0001
<b>2-level Model</b> (variance within studies)	280.20	285.95	-138.10	85.57, p < .0001
<i>Attitude</i>				
<b>4-level Model</b>	67.45	74.67	-29.72	
<b>3-level Model</b>	71.09	76.51	-32.54	5.64, p < .05
<b>2-level Model</b> (variance between studies)	612.78	615.89	-304.14	548.83, p <.001
<b>2-level Model</b> (variance within studies)	78.48	82.10	-37.24	15.04, p < .001
<i>behavior</i>				
<b>4-level Model</b>	23.23	28.70	-7.62	
<b>3-level Model</b>	30.13	34.23	-12.06	8.90 p < .01
<b>2-level Model</b> (variance between studies)	201.33	204.07	-98.67	182.10, p <.0001
<b>2-level Model</b> (variance within studies)	34.27	37.00	-15.13	15.04, p < .001

*Note.* AIC: Akaike information criterion; BIC: Bayesian information criterion; logLik: log likelihood; LRT: likelihood-ratio test comparing the 2-level models and the 3-level model to the 4-level model