

Improving Algebra Readiness for Middle School Students: A Systematic Literature Review



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Research Question

What is the effect of mathematics interventions for middle-school students with learning difficulties or disabilities?

Inclusion Criteria

- Published 1992–2017
- Published in English
- Participants in grades 6, 7, or 8
- Participants with learning or mathematics difficulties or disabilities
- Mathematics intervention

Initially identified 1,965 studies with 47 meeting all inclusion criteria.

Summary of Studies

Table 1 Summary of Characteristics for Studies (N = 47)		
Characteristic	n	%
Publication year		
1990s	5	
2000s	15	
2010 - 2016	27	
Math content*		
Operations	26	
Fractions	14	
Problem solving	27	
General skills	5	
Algebra	4	
Geometry	1	
Sample size		
<25	22	
25 to 50	7	
51 to 100	7	
>100	11	
Total sessions		
<10	6	
10 to 20	16	
21 to 30	7	
31 to 50	6	
>50	4	
Total hours		
<10	20	
10 to 20	11	
21 to 30	4	
31 to 50	2	
>50	5	

* Several studies included more than one category.

Descriptions of Studies

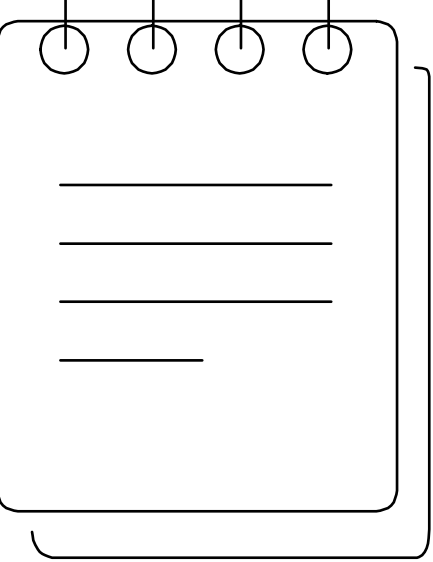
Table 2 Descriptions of Studies									
Study	Design	N	Grade	N/IEP	Math content	Interventionist	Description of conditions; Interventionist	Sessions	Hours
Burrett & Fish (2011)	Group	15	6, 7, 8	15	operations, problem solving	GEN Teacher	T1: chess intervention T2/C: BAU	30	25
Bonfield (1992)	SCRD; group	9	7, 8	0	operations, fractions, general skills	Researcher	T1: data-based instruction using CBA; data; content derived from error analysis of student work T2/C: CBA-probes only	6	2
Botge (1999)	Group	36	8	5	operations, problem solving	GEN Teacher	T1: contextualized math instruction T2/C: word problem instruction	10	NR
Botge et al. (2001)	Group	75	8	25	operations, problem solving	GEN Teacher, SPED Teacher	T1: enhanced anchored instruction, explicit instruction, procedural computation T2/C: BAU	12	18
Botge et al. (2010)	Group	54	6, 7, 8	54	operations, fractions, problem solving, general skills	SPED Teacher	T1: formal instruction, enhanced anchored instruction T2: informal instruction, enhanced anchored instruction	24	21.2
Botge et al. (2014)	Group	335	6, 7, 8	159	operations, fractions, problem solving	GEN Teacher	T1: enhanced anchored instruction, explicit instruction, procedural computation T2/C: BAU	94	94
Botge et al. (2015)	Group	471	6, 7, 8	134	operations, fractions, problem solving	GEN Teacher	T1: explicit instruction T2/C: BAU	68.5	85.63
Bosack et al. (2009)	SCRD	3	6	3	operations	GEN Teacher	T1: computer instruction T2/C: BAU	7	NR
Butler et al. (2003)	Group	115	6, 7, 8	42	operations, fractions, problem solving	SPED Teacher	T1: CRA T2/C: BAU	10	7.5
Butler (2014)	Group	47	7	26	operations, fractions	GEN Teacher	T1: enhanced anchored instruction, explicit instruction on procedural computation and problem solving	17	NR
Cude & Guster (2002)	SCRD	3	6, 7, 8	3	operations, general skills	GEN Teacher	T1: mnemonic instructional strategy T2/C: BAU	22	1.8
Chao (2017)	Group	57	7, 8	32	operations, fractions, problem solving	GEN Teachers	T1: enhanced anchored instruction T2/C: BAU	38	38
Crawford et al. (2016)	Group	51	4, 5, 6	22	operations	Computer	T1: computer-based instruction T2/C: BAU	18	12
Cuenca-Carrillo et al. (2016)	SCRD	6	6, 7, 8	6	operations	SPED Teacher	T1: mnemonic T2/C: BAU	48	13.5
Daniel (2003)	Group	18	6, 7, 8	18	operations	Researcher	T1: word problem solving T2/C: BAU	16	8
Elissa & Mustafa (2013)	Group	31	6	31	problem solving	GEN Teacher	T1: differentiated instruction scripted lessons T2/C: BAU	3	2.1
Fletcher et al. (2010)	SCRD	3	6, 7, 8	3	operations	SPED Teacher	T1: explicit instruction on TouchMath T2/C: BAU	16	2.7
Flores & Kaylor (2007)	Group	30	7	NR	operations, fractions	GEN Teacher	T1: direct instruction T2/C: BAU	14	7
Freeman-Green et al. (2015)	SCRD	6	8	6	operations	Researcher	T1: explicit instruction with mnemonics SOLVE strategy	28	17.5
Harris (2009)	Multiple treatment	43	6, 7	43	algebra	Researcher	T1: direct instruction, PALS, self-monitoring T2: direct instruction	10	15
Haynes (2011)	SCRD	4	7	4	general skills	Researcher	Phase 1: test-taking strategy instruction	NR	0.5–1.5/session
Hunt & Vazquez (2014)	SCRD	3	6, 7, 8	NR	fractions	Researcher	T1: abstract ration equivalency instruction T2/C: BAU	45	18.8
Jitendra et al. (2002)	Group	6	8	6	problem solving	SPED Teacher	T1: schema-based strategy instruction T2/C: BAU	8	5
Jitendra et al. (2016)	Group	148	7	15	operations, fractions, problem solving	GEN Teacher	T1: schema-based instruction with self-monitoring T2/C: BAU	10	6.7
Jitendra et al. (2017)	Group	399	7	NR	operations, fractions, problem solving	GEN Teacher	T1: schema-based instruction T2/C: BAU	30	23.8
Joseph & Hunter (2001)	SCRD	3	8	3	fractions, problem solving	SPED Teacher	T1: Self-monitoring cue cards T2/C: BAU	27	9
Krawiec et al. (2013)	Group	77	7, 8	NR	problem solving	GEN Teacher	T1: Solve It! T2/C: BAU	31	16.8
Maccini & Rinal (2000)	SCRD	3	8	NR	operations, problem solving	Researcher	T1: CSA instruction, problem solving strategies with self-monitoring strategies T2/C: BAU	31	16.8
Montague (1992)	SCRD	6	6, 7, 8	6	problem solving	Researcher	T1: cognitive strategy instruction T2: metacognitive strategy instruction	3	2.75
Montague (1993)	Group	72	7, 9	24	operations, problem solving	Researcher	T1: direct instruction on problem solving T2: explicit instruction on problem solving T3: combined T1 and T2	12	10
Montague et al. (2011)	Group	319	8	32	problem solving	GEN Teacher	T1: Solve It! T2/C: BAU	140	128.33
Montague et al. (2014)	Group	644	7, 8	NR	problem solving	GEN Teacher	T1: Solve It! T2/C: BAU	160	146.67
Monye (2016)	Group	106	7	NR	operations, problem solving	GEN Teacher	T1: direct instruction T2/C: BAU	18	13.5
Moore (2014)	Group	146	6, 7, 8	NR	operations	GEN Teacher	T1: direct instruction T2/C: BAU	36	47.9
Murthy (2016)	Group	69	6	NR	operations, problem solving	GEN Teacher	T1: self-monitoring T2/C: additional instruction	30	23

Na (2009)	SCRD	4	6, 7	4	problem solving	NR	Phase 1: problem schemata instruction Phase 2: problem solution instruction	4	2.67
Naglieri & Johnson (2000)	SCRD	19	6, 7, 8	19	operations, fractions	School Psychologist, Teacher	Phase 1: facilitating students' planning	NR	0.5/session
O'Melia & Rosenberg (1994)	Multiple treatment	171	6, 7, 8	68	NR	Teacher	T1: cooperative homework teams T2/C: no cooperative homework teams, all other conditions being similar	NR	NR
Root (2016)	SCRD	3	6, 7	3	problem solving	Researcher	Phase 1: modified schema-based instruction	NR	NR
Sherif & Boon (2014)	SCRD	3	6, 7, 8	3	problem solving	SPED Teacher	Phase 1: computer-based word problem solving	NR	0.33/session
Shin & Bryant (2017)	SCRD	3	6, 7, 8	3	problem solving	Researcher	Phase 1: computer-assisted instruction (modeling, guided practice, cognitive, and metacognitive strategies)	NR	0.5/session
Shumate et al. (2012)	SCRD	5	8	5	algebra, geometry	Teacher	Phase 1: culturally responsive instruction Phase 2: modified culturally responsive instruction (e.g., manipulatives, puzzles, increased number of culturally relevant examples)	NR	0.5–0.58/session
Talbot (2016)	Multiple treatment	27	8	25	algebra	Teacher	T1: online algebra intervention with virtual manipulatives T2/C: online algebra intervention	15	7.5
van Garderen (2007)	SCRD	3	8	3	general skills, problem solving	Researcher	Phase 1: explicit instruction about how to generate diagrams Phase 2: strategy instruction (one-step word problems) Phase 3: strategy instruction (two-step word problems)	NR	0.58/session
Watt & Therrien (2016)	Treatment comparison	32	6	15	fractions	Interventionist	T1: pre-teaching and CRA T2/C: supplemental reading group	10	5
Witzel (2005)	Treatment comparison	182	6, 7	49	algebra	GEN Teacher	T1: CRA T2: direct instruction using abstract equations	19	15.83
Xin et al. (2005)	Group	22	6, 7, 8	19	operations, problem solving	Doctoral Student, SPED Teacher	T1: schema-based instruction T2: general strategy instruction	12	60

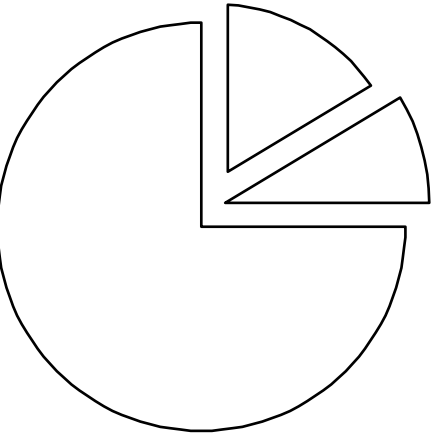
Discussion



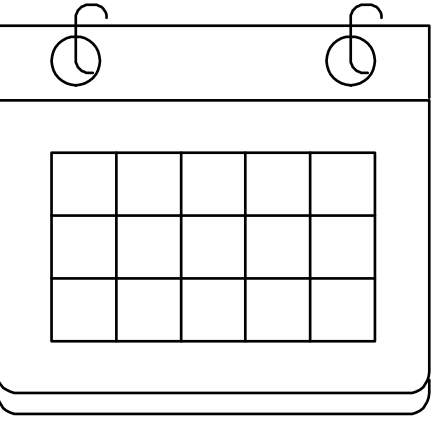
Using CEC’s Quality Indicators for group and single case research designs (see Cook et al., 2015), how robust are the interventions described in these studies?



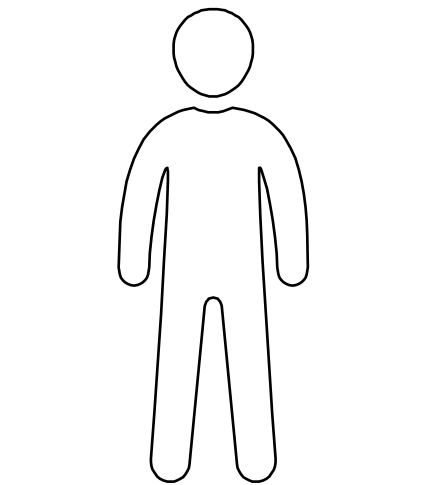
Investigating the interventions included more closely, how many unique interventions are represented in these studies?



While instruction aimed at operations and problem solving can support students in developing readiness for algebra, are there other skills or content areas (e.g., fractions) that warrant additional attention in the intervention literature?



Given the importance of intervention duration and dosage, while recognizing time constraints within schools, how can students spend increased time in intervention?



How can future research ensure that a range of school-based personnel are prepared to teach students who struggle?