

Reviewing the literature: Improving mathematics in primary school-aged children

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Why this project?

- Many children are underachieving in mathematics (DE, 2015, etc)
- Increased funding to produce this research
- Growth in literature on interventions (DfE, 2012)
- Lack of systematic synthesis of outputs

What is evidence based education?

- Education policy and practice should be guided by the best available evidence

How do children learn?

What factors affect children's achievement?



What is the impact of different types of teaching activity?

What it isn't:

- X Doesn't take away from expertise of teachers
- X Doesn't remove the "art" of teaching
- X Isn't a "recipe book" to follow

Researchers
explore and test
ideas about how
children learn

Teachers can
make informed
decisions about
what might work

“Evidence-based education is not a panacea, but is a set of principles and practices for enhancing educational policy and practice.”

Davies (1999)

Reviewing the evidence

- Focusing on *mathematical* interventions to improve *mathematical* outcomes in primary school-aged children
- Disparate and growing literature (Lortie-Forgues & Inglis, 2019)
- Systematic review to synthesise material
- Produce something that is useful

Definitions

- **In this study....interventions=**

“a deviation from existing teaching practice”

- **In this study... mathematical disabilities=**

“If a study screened children against a set criteria (e.g. mathematics achievement $<$ 25th percentile on standardized mathematical tests) in order to be included in the study it was not included.”

Reviewing the evidence

- Pre-registered with Campbell Library (and on PRISMA)

The screenshot displays the Campbell Collaboration website interface. At the top left is the logo for Campbell Collaboration with the tagline "Better evidence for a better world". A navigation menu includes links for "About Us", "Funding", "Research evidence", "For authors", "Campbell Library", and "News and Events".

The main content area is titled "The Campbell Collaboration online library" and features a "Featured reviews" section. Two featured reviews are shown:

- Individualised funding interventions to improve health and social care outcomes for people with a disability**: Includes download options for Protocol, Title, Review, and Plain language summary, plus an "Online supplements" button.
- Impact of financial inclusion in low- and middle-income countries**: Includes download options for Title, Protocol, Plain language summary, and Review.

Below the featured reviews is a "Full text keyword search" section with a search input field and a "Go" button. An "Advanced search" link is also present.

Two columns of content are displayed below the search section:

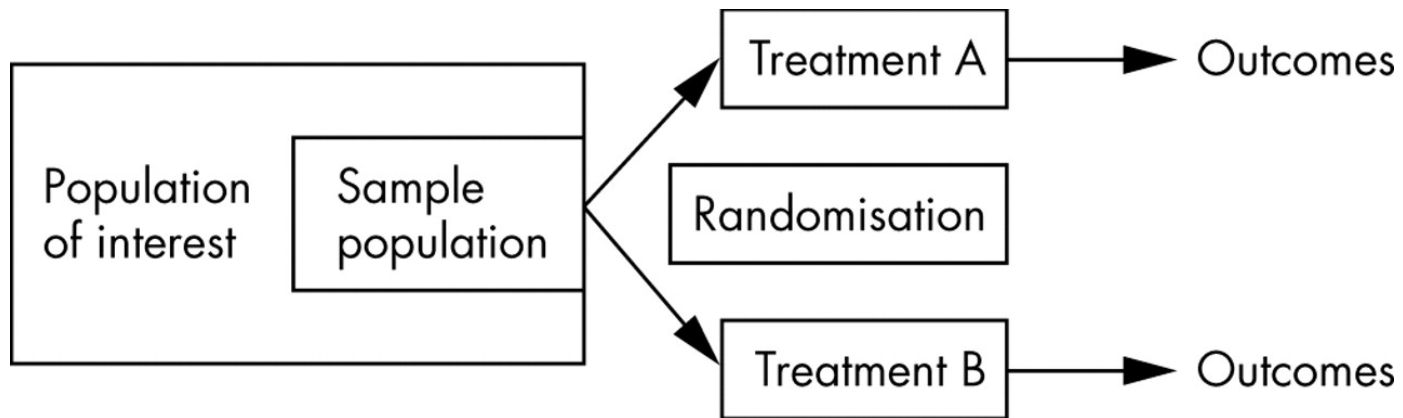
- Campbell systematic reviews**: "Browse by Coordinating Group" with categories: Crime and Justice, Disability, Education, International Development, Knowledge Translation and Implementation, Nutrition, and Social Welfare. A "See all reviews" link is at the bottom.
- Campbell plain language summaries**: "Browse by Coordinating Group" with the same categories as above. A "See all PLSs" link is at the bottom.

On the right side of the page, there is a vertical sidebar with several content tiles:

- Methods Serie
- Policies & Guidelines Serie
- Policy briefs
- Campbell innovation
- Your search history
- Frequently downloaded
- Published volumes, by year
- About

“Rigorous” evidence

- Randomised control trials
- Quasi-experimental



Our review

- Included:
 - Primary-school children (4-11 year-olds)
 - In class interventions
 - Variety of delivery methods (one-to-one, group)
 - Must have a control group
 - Must have pre and post test assessments
 - Must have been published between 2000-2017

Population	((Primary OR Elementary OR Kindergarten* OR "Grade 1" OR "Grade 2", "Grade 3", "Grade 4", "Grade 5") AND (school* OR educat* OR class* OR teach* OR learn* OR instruct* OR train* OR program*))
Intervention	(Math* OR "Number Sense" OR Numer* OR Arithmetic* OR counting OR addition OR subtraction OR multiplication OR division OR Adding OR Geometry OR fractions OR algebra OR "place value")
Outcomes	(Achieve* OR "Standard* Test" OR Anxiety OR Attitud* OR "Self-Efficacy" OR Confidence OR Enjoyment)
Methods	(Trial OR RCT OR Quasi OR Random* OR "Control Group" OR "Post Test" OR experimental)

ProQuest Dissertations and Thesis
 Dissertation Abstracts International
 Conference Proceedings Citation Index
 Websites of charitable and funding organisations
 Government departments
 WHO trials website and clinicaltrials.gov
 Google and Google Scholar
 OpenGrey

Total identified in preliminary search: n=10,042

Number of duplicates removed: n=1,959



Total screened at title and abstract level: n=8,083

Total excluded at title and abstract screening level: n=7,552



Total screened at full text level: n=531

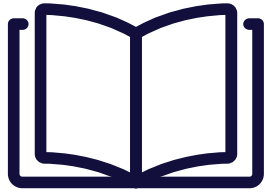
Total excluded at full text screening level: n=451



Final total included: N=80

What did we find?

80
STUDIES
IDENTIFIED



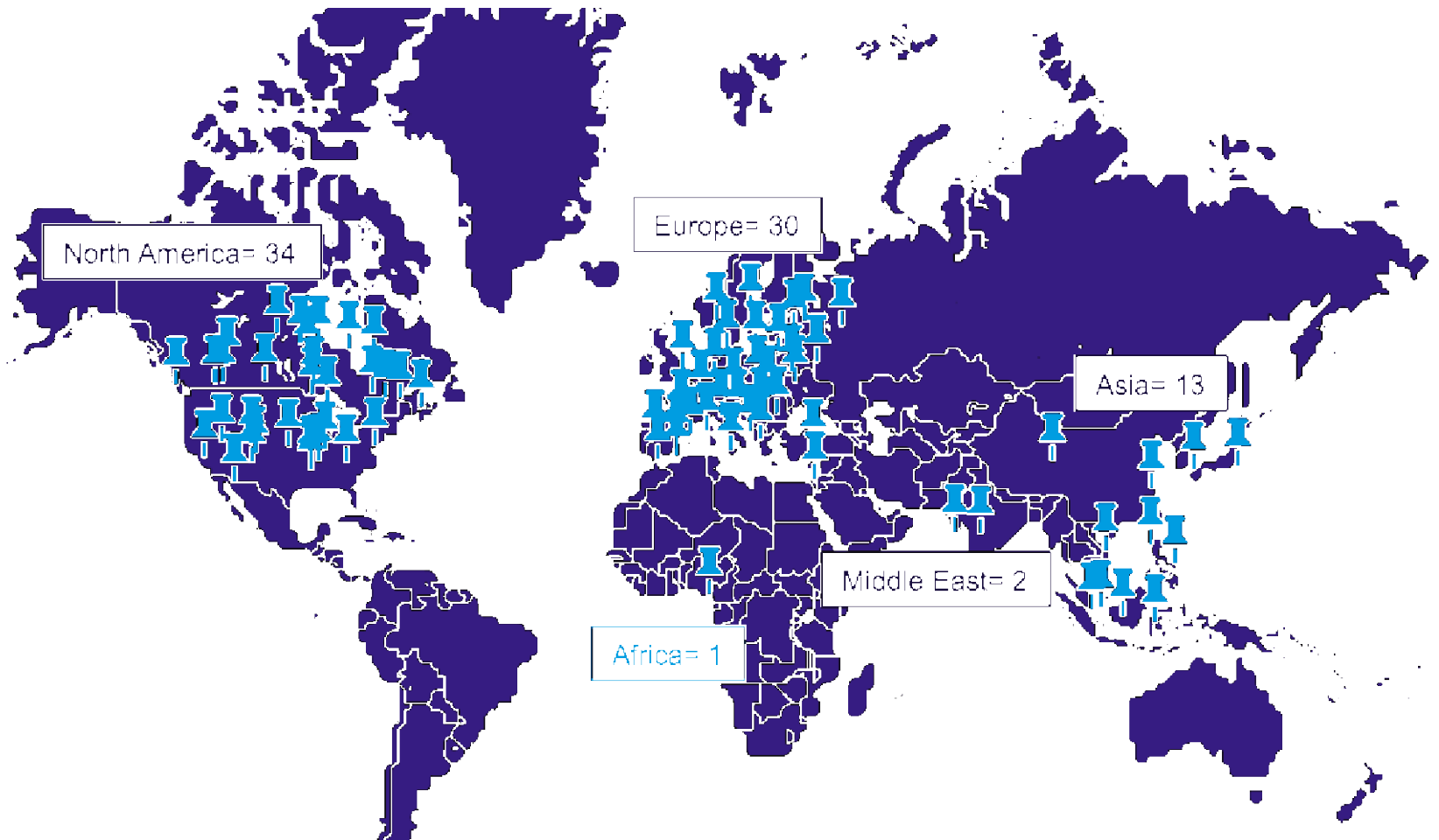
14,198
CHILDREN INVOLVED



72
POSITIVE
IMPACT



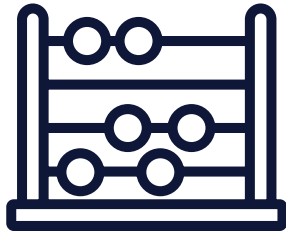
What did we find?



What did we find?

Theme	Subtheme	Studies that...	Number of studies
Topic areas in mathematics	Conceptual understanding	...focus on understanding the principles that underlie a domain, i.e., knowing why something works	14
	Magnitudes	...aim to improve knowledge of how whole or rational numbers fit together in a system	4
	Basic number skills	... target fundamental number skills, such as number sense, quantity comparison or counting skills	7
	Practice for fluency	...encourage fast access to mathematical facts to aid recall and problem solving	7
	Strategy use	... develop optimal approaches to solve a problem or task	12
Methods of instruction	Manipulatives	...use objects as learning aids	5
	Feedback	...change information content or format to improve learning	3
	Technology for engagement	...present information in computer-game format to encourage children's engagement	11
	Delivery contexts	...use of varied approaches to deliver content, such as group work, physical activity or songs	17

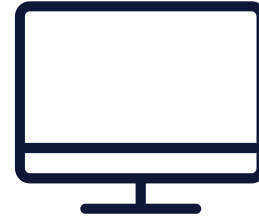
61 studies (76%) had author-generated outcome measures



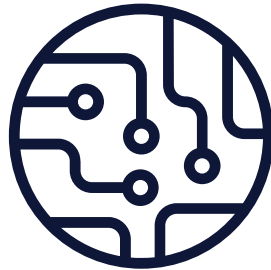
9

**USED
EVERYDAY
CLASSROOM
OBJECTS**

10



**USED
COMMERCIAL
SOFTWARE**



42

**REQUIRED
TECHNOLOGY**

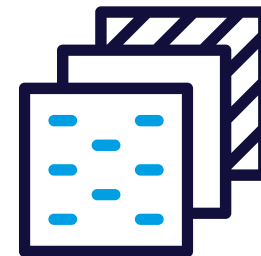
14

**REQUIRED
SPECIALIST
TRAINING**



31

**USED EASILY
MADE MATERIALS**



Quality of studies

Paper	Random sequence generation	Allocation concealment	Blinding of participants	Blinding of instructor	Blinding of outcome assessors	Incomplete outcome data	Selective outcome reporting
Al-ebous 2016	-	-	-	-	-	L	-
Alibali et al. 2009	-	-	L	-	-	L	-
Bakker et al. 2015	-	-	L	-	-	H	-
Barner et al. 2016	-	-	H	-	-	H	H
Baroody et al. 2016	-	-	-	H	H	L	-
Barzilai & Blan 2014	-	-	-	L	L	H	-
Betsch et al. 2015	-	-	-	H	H	L	-
Burns et al. 2016	-	-	L	H	H	L	-
Carr et al. 2011	-	-	-	L	L	L	-
Casey et al. 2008	-	-	L	-	L	L	-
Caviola et al. 2016	-	-	H	L	L	-	-
Chang et al. 2008	-	-	-	-	-	L	-
Chu et al. 2013	-	-	-	L	-	L	-
Darkin & Rittle-Johnson 2012	-	-	L	-	-	L	-
Erkfritz-Gay 2009	L	-	-	-	-	L	-
Faber et al. 2017	-	-	L	-	-	L	-
Fazio et al. 2016	-	-	L	-	-	L	-
Foster et al. 2016	-	L	L	L	L	L	-
Fyfe & Rittle-Johnson 2016	-	-	L	-	-	L	-
Gabriel et al. 2012	-	-	L	-	-	L	-
Gonzalez-Castro et al. 2014	-	-	L	-	-	-	-
Gurbuz et al. 2010	L	-	L	-	-	L	-
Hattikudur & Alibali 2010	-	-	L	-	H	L	-
Hugger 2014	-	-	L	H	-	-	-
Jitendra et al. 2007	-	-	H	-	L	L	-
Kuhn & Holling 2014	-	-	-	L	-	L	-
Kim & Ke 2017	-	-	L	L	-	L	-
Kocabas 2009	-	-	-	-	-	-	-
Mascia et al. 2015	-	-	L	-	-	-	-
Mason & Scrivani 2004	-	-	L	H	-	-	-
McNeil et al., 2015	-	-	H	H	H	L	-
McNeil et al. 2012	-	-	L	-	L	L	-
Mullender-Wijnsma et al. 2015	L	-	H	H	-	H	-
Obersteiner et al. 2013	-	-	H	L	-	H	-
Onu et al. 2012	L	-	L	-	-	L	-
Pahwal 2013	-	-	L	L	-	L	-
Park & Nunes 2001	-	-	L	H	H	-	-
Fløger & Høet 2009	-	-	-	-	-	L	-
Praet & Desoete 2014	-	-	H	-	H	-	-
Ruiter et al. 2015	L	-	L	H	H	L	-
Rutherford et al. 2014	-	-	L	-	-	L	-
Sood & Mackey 2015	-	-	L	-	L	-	-
Wang et al. 2015	-	-	-	-	-	L	-
Yoon 2015	-	-	H	-	-	-	-
van der Heuvel-Panhuizen et al. 2016	L	-	L	-	L	L	-

Note: H= High risk, L= Low risk, = Unclear (not enough information to make judgement)

Conclusions

- Issues with quality (or reporting) of studies
- Lack of comparable measures
- Some interventions not grounded in learning theory
- Majority not openly accessible or interpretable

BUT...Conclusions



- Evidence for...
 - Fluent grasp of mathematical facts
 - Wide bank of strategies and know when to apply them
 - Appropriate use of objects as learning aids
 - Effective and timely feedback
 - Technology that has been developed with clear understanding of how children learn
 - Variation in how mathematical content is delivered in the classroom

Recommendations: teachers and researchers

- Decision-making should be made with caution
- Support to evaluate evidence to inform their practice

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Interventions to improve mathematical achievement in primary school-aged children

Mathematical achievement is important for children's future educational success, employment opportunities and health outcomes.

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Interventions to improve mathematical achievement in primary school-aged children

Mathematical achievement is important for children's future educational success, employment opportunities and health outcomes. However, it is recognised that there is substantial underachievement in this subject. There is a growing body of evidence that assesses the impact of interventions on mathematical achievement.

In this project we carried out a rigorous review of research that investigated the outcomes of classroom-based mathematical interventions that were targeted at primary school-aged children. The review assessed whether the interventions had an effect on mathematical achievement, attitudes or anxiety. Importantly, these interventions did not focus on children with mathematical learning difficulties, instead the information from this review is relevant for the majority of children in mainstream classroom settings.

This project was led by Dr Victoria Simms (Ulster University) with Dr Camilla Gilmore (Loughborough University), Dr Seaneen Sloan (University College Dublin) and Dr Clare McKeaveney (Queen's University Belfast) and was funded by the Nuffield Foundation.


www.ulster.ac.uk/mathsinterventions

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What is a Systematic Review?

A systematic review is a rigorous process that allows researchers to identify and synthesise studies on a specific topic.

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What is a Systematic Review?

Research & Impact

- Our research
- Collaboration and Innovation
- Doctoral College
- Research Institutes**
- Art and Design Research Institute
- Arts & Humanities Research Institute
- Biomedical Sciences Research Institute

What is a Systematic Review?

A systematic review is a rigorous process that allows researchers to identify and synthesise studies on a specific topic. By following a stringent process a systematic review can help draw conclusions about a body of high quality research. Systematic reviews can be useful to assist in decision making for policy and practice.



Dr Seaneen Sloan discusses systematic reviews and how they are conducted

Recommendations: researchers

Evidence-based education operates on two levels:

1. “to utilise existing evidence from worldwide research and literature on education and related subjects”
2. “to establish sound evidence where existing evidence is lacking or of a questionable, uncertain, or weak nature”

(Davies, 1999)

Recommendations: researchers

- Encourage funding of rigorous studies to assess the impact of well-developed interventions
- Work together to develop coherent outcome measures: e.g. CONSORT process
- Encourage standard reporting practices



Thanks

Questions?????

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