Ulster University

# 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

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# 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?

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https://bold.expert/how-can-educational-research-translate-to-the-classroom/

# What it isn’t:

- ✗ Doesn’t take away from expertise of teachers
- ✗ Doesn’t remove the “art” of teaching
- ✗ 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

https://bold.expert/how-can-educational-research-translate-to-the-classroom/

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

Davies (1999)

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# 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

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# 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."

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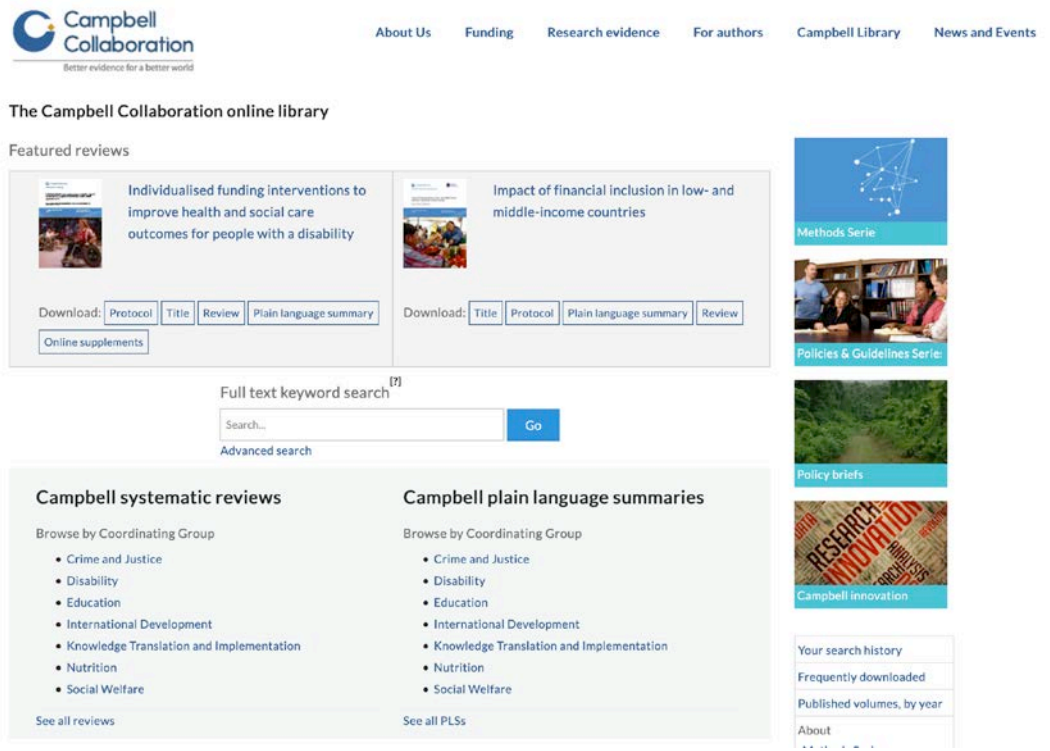
# Reviewing the evidence

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

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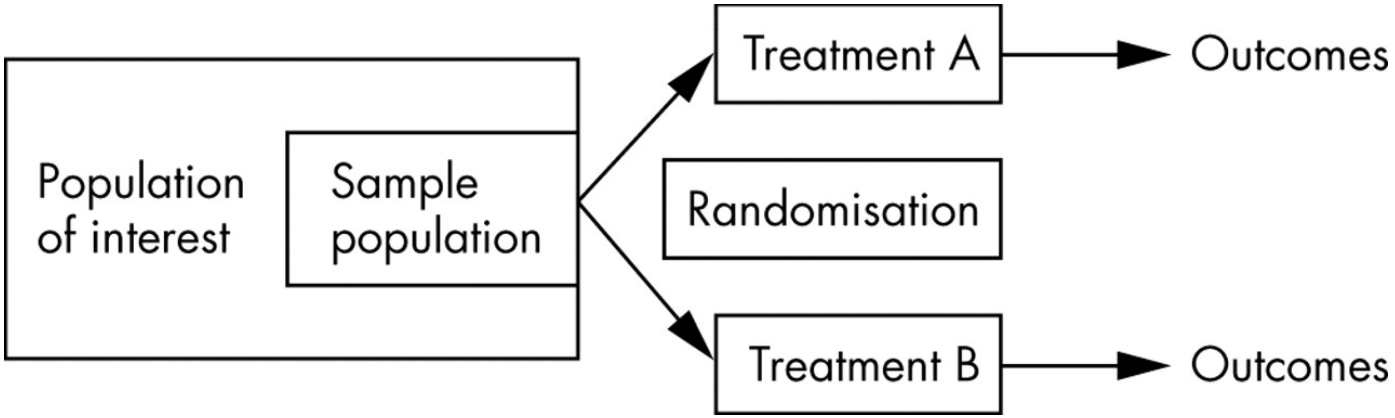
# “Rigorous” evidence

- 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

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| | |
|---|---|
| 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 “Standardi* 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

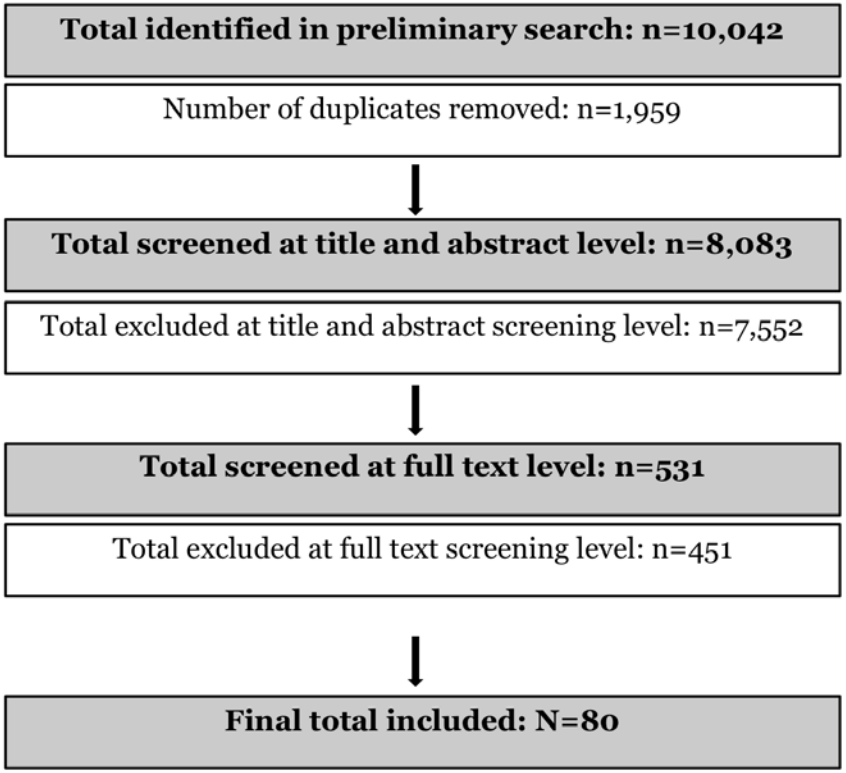
Websites of charitable and funding organisations

Government departments

WHO trials website and clinicaltrials.gov

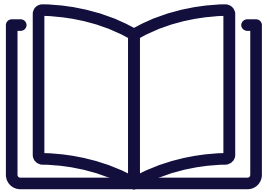
Google and Google Scholar

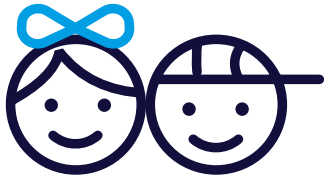
OpenGrey


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**

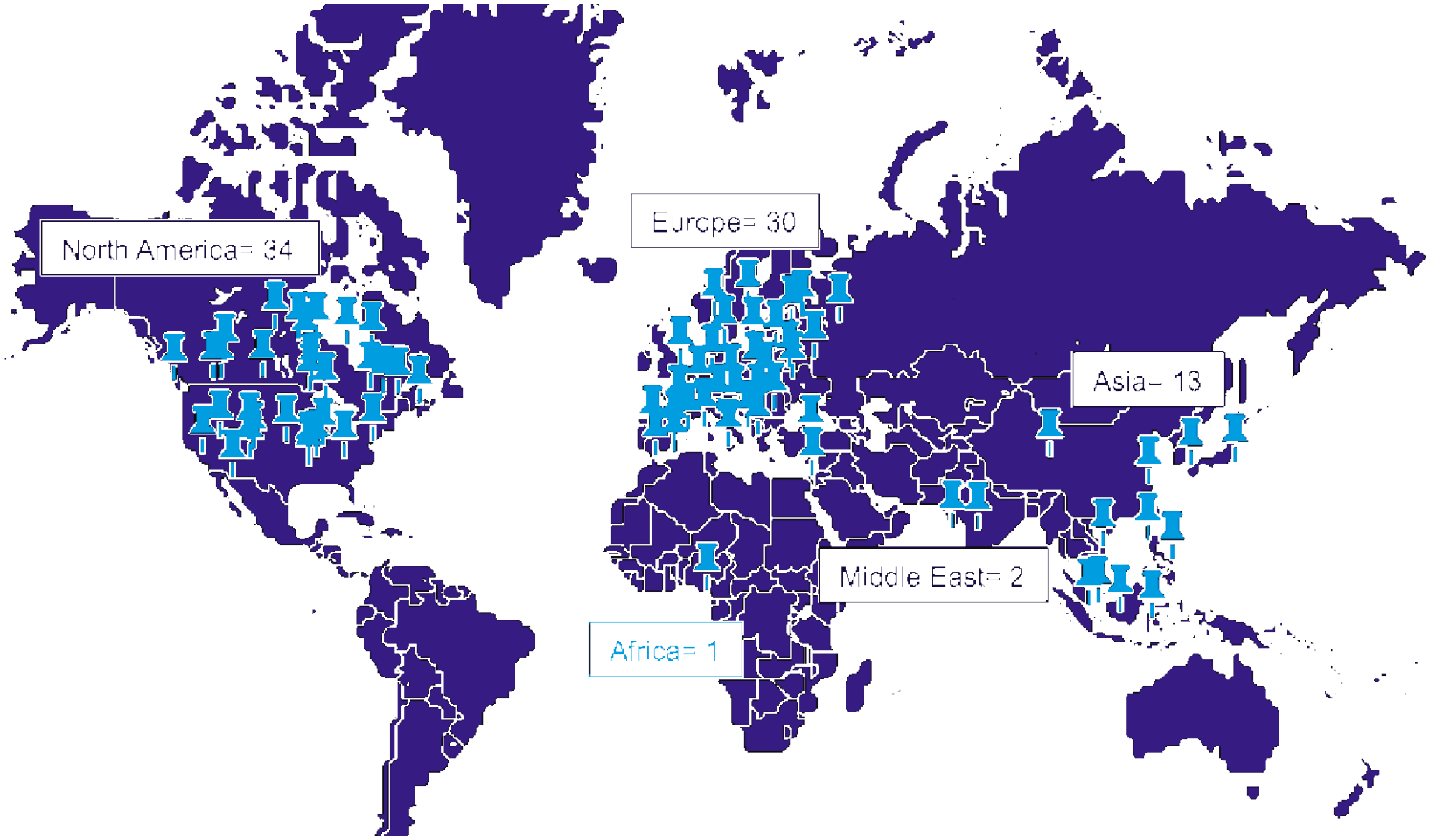




**14,198**
**CHILDREN INVOLVED**

**72**
**POSITIVE IMPACT**

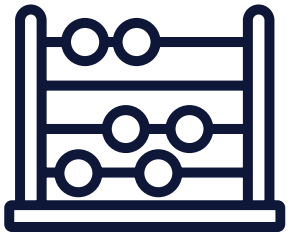
# What did we find?



# 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 |
| **Methods of instruction** | 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 |
| | 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 |

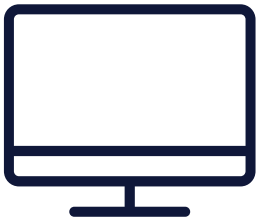
61 studies (76%) had author-generated outcome measures



**9**

USED EVERYDAY CLASSROOM OBJECTS

**10**



USED COMMERCIAL SOFTWARE

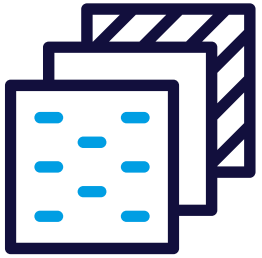
**42**

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 & Blau 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 | - |
| Durkin & 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 | - | - | - |
| Jitndra 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 | - |
| Oberstreiner et al. 2013 | - | - | H | L | - | H | - |
| Onu et al. 2012 | L | - | L | - | - | L | - |
| Paliwal 2013 | - | - | L | L | - | L | - |
| Park & Nunes 2001 | - | - | L | H | H | - | - |
| Ploger & Hect 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 | - |
| Youn 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

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# 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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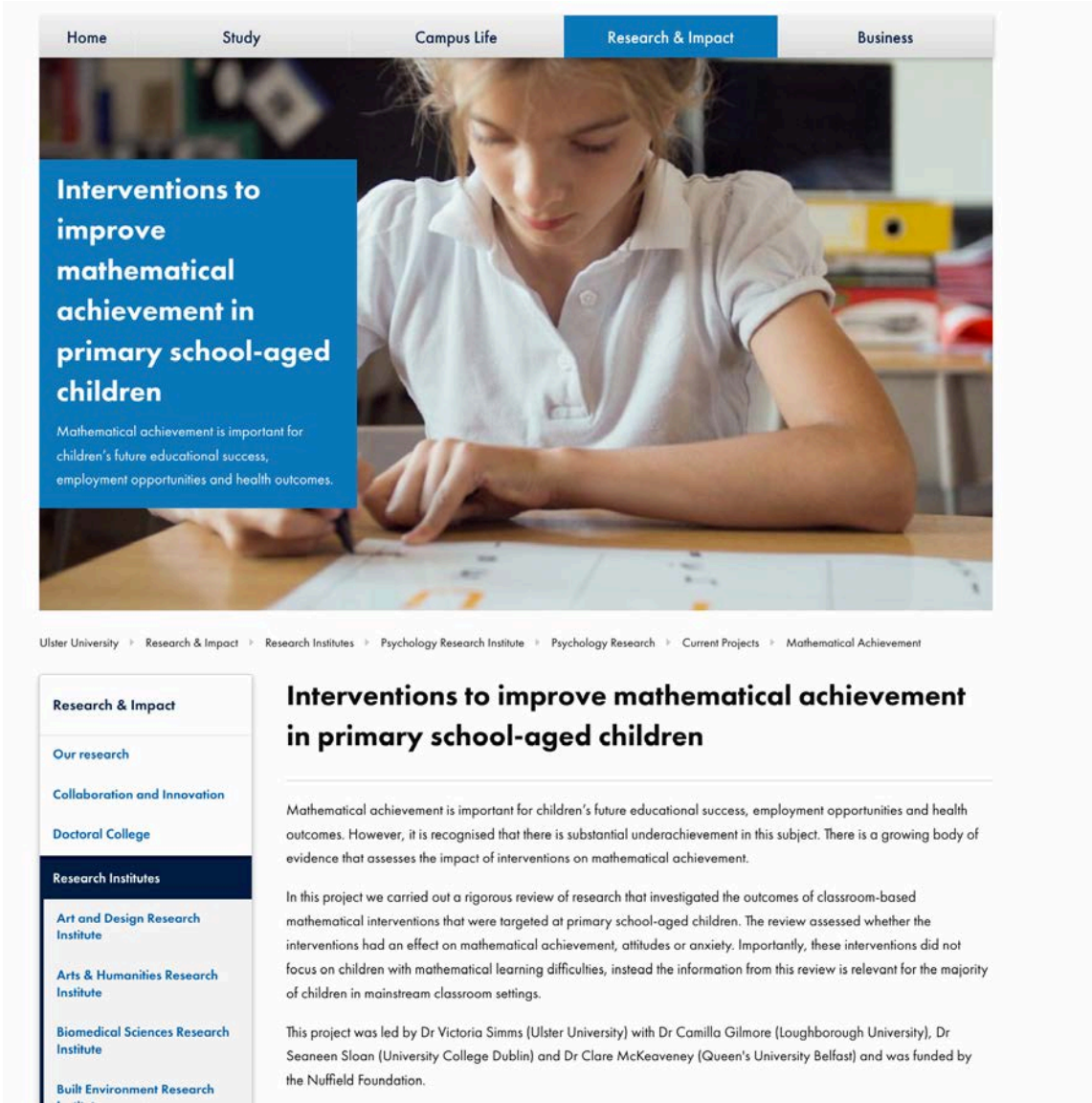
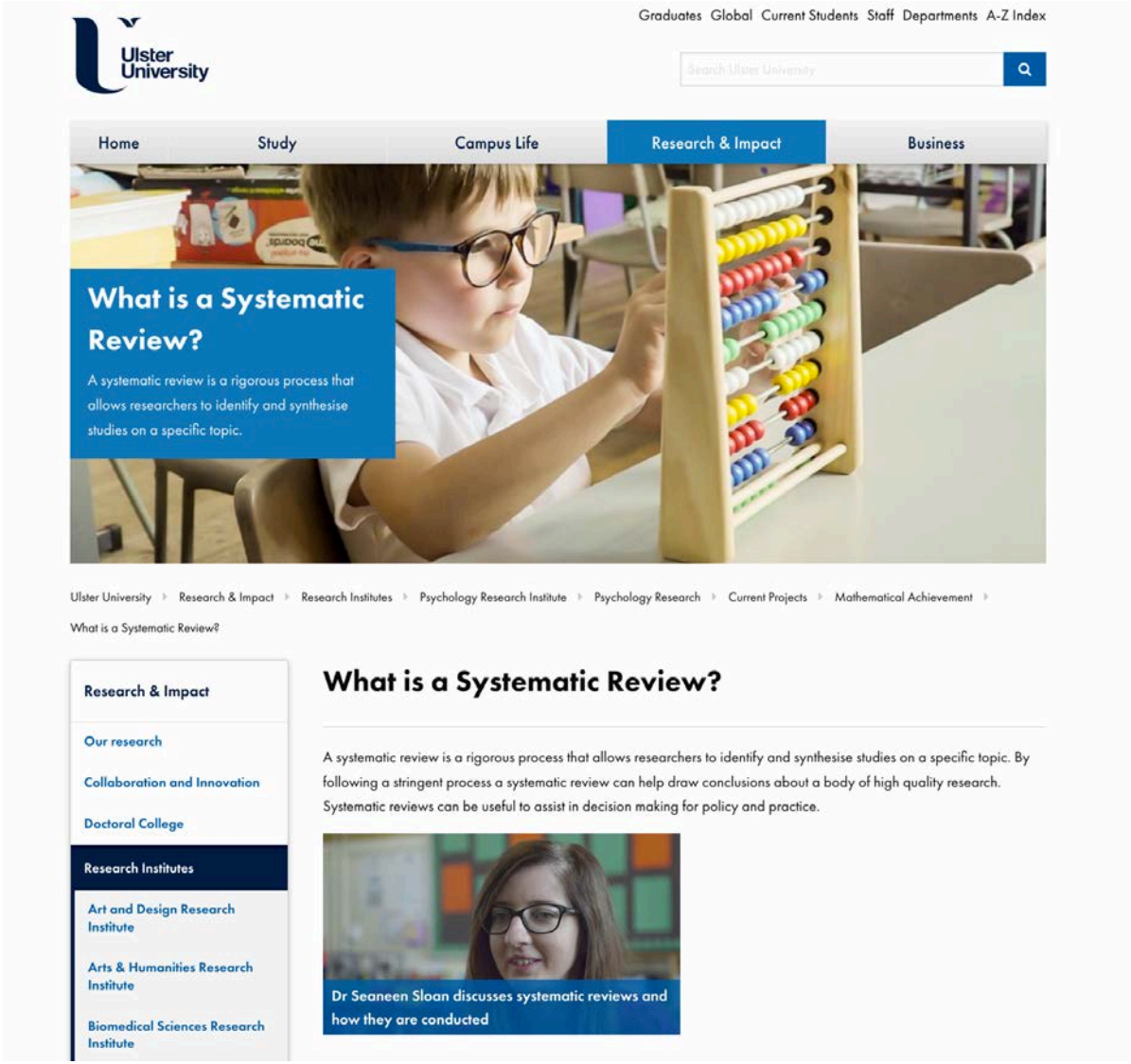
# www.ulster.ac.uk/mathsinterventions



# www.ulster.ac.uk/mathsinterventions



# 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

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# Thanks

Questions?????

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