DRK-12 RESEARCH METHODS WEBINAR SERIES | SEPTEMBER 2020

AN INTRODUCTION TO SYSTEMATIC LITERATURE REVIEWS

MAKING RESEARCH RELEVANT

Jeffrey Valentine, Ph.D.| Emily Tanner-Smith, Ph.D.

AIR®

Welcome!

Take a moment to introduce yourself in the chat box.

Please tell us: your name, organization, and affiliation with the DRK-12 program (e.g., principal investigator [PI], project team member, evaluator, aspiring PI).

DRK-12 Research Methods Webinar Series

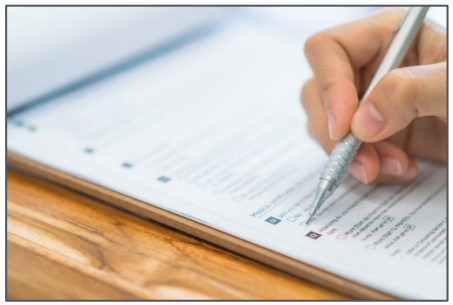
Melissa Rasberry, Ed.D.
Senior Technical Assistance Consultant

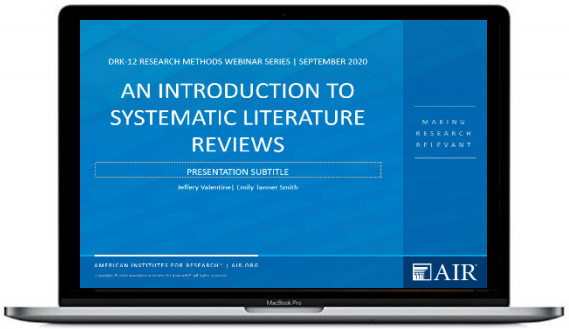
Learning outcomes

Following this session, participants will be able to:

- Understand systematic review terminology
- Identify the importance and benefits of systematic reviews
- Understand key considerations for the literature search, screening, and coding in systematic reviews
- Consider ways systematic reviews techniques could further new learning in STEM education

Today's webinar





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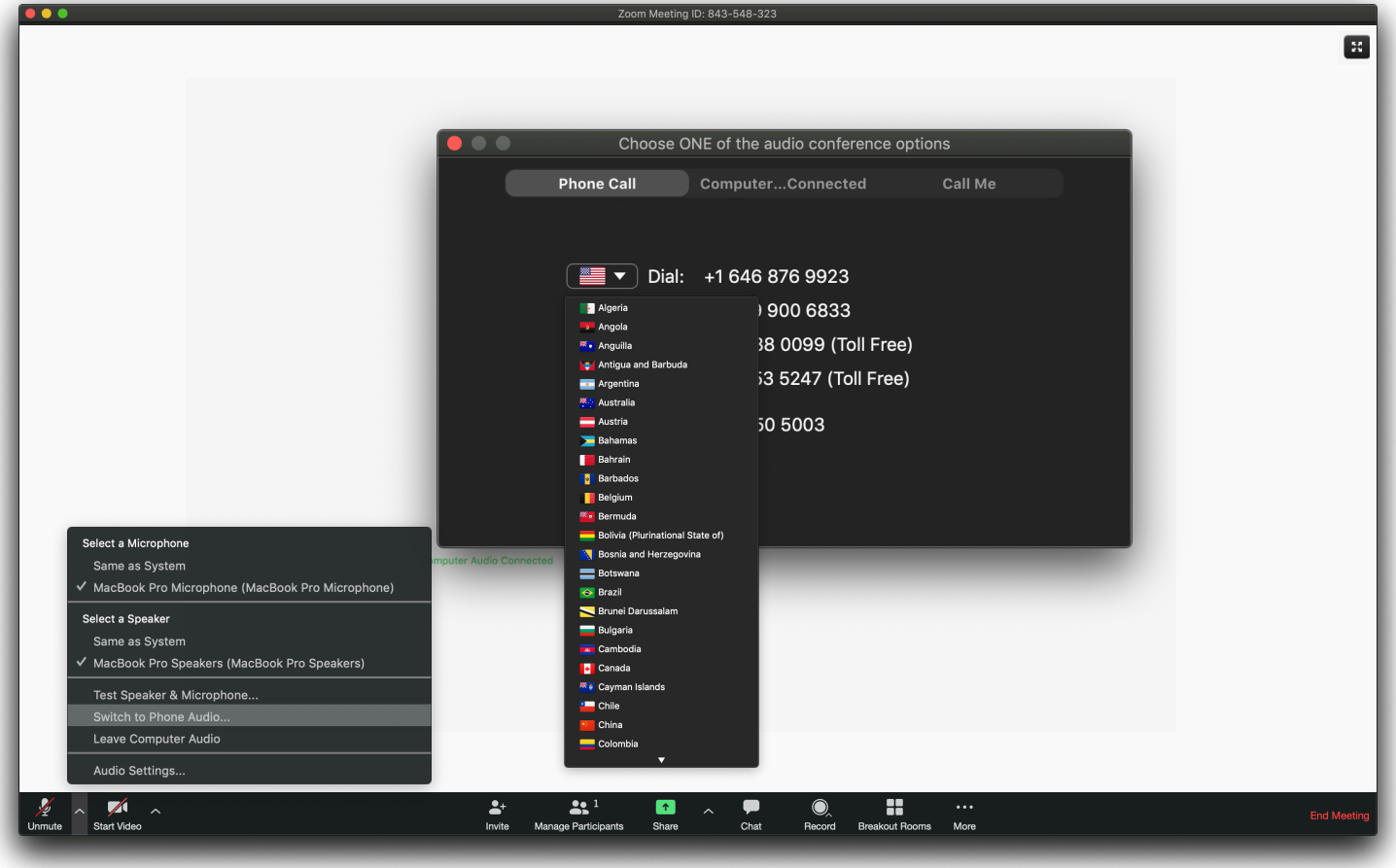
How to use Zoom



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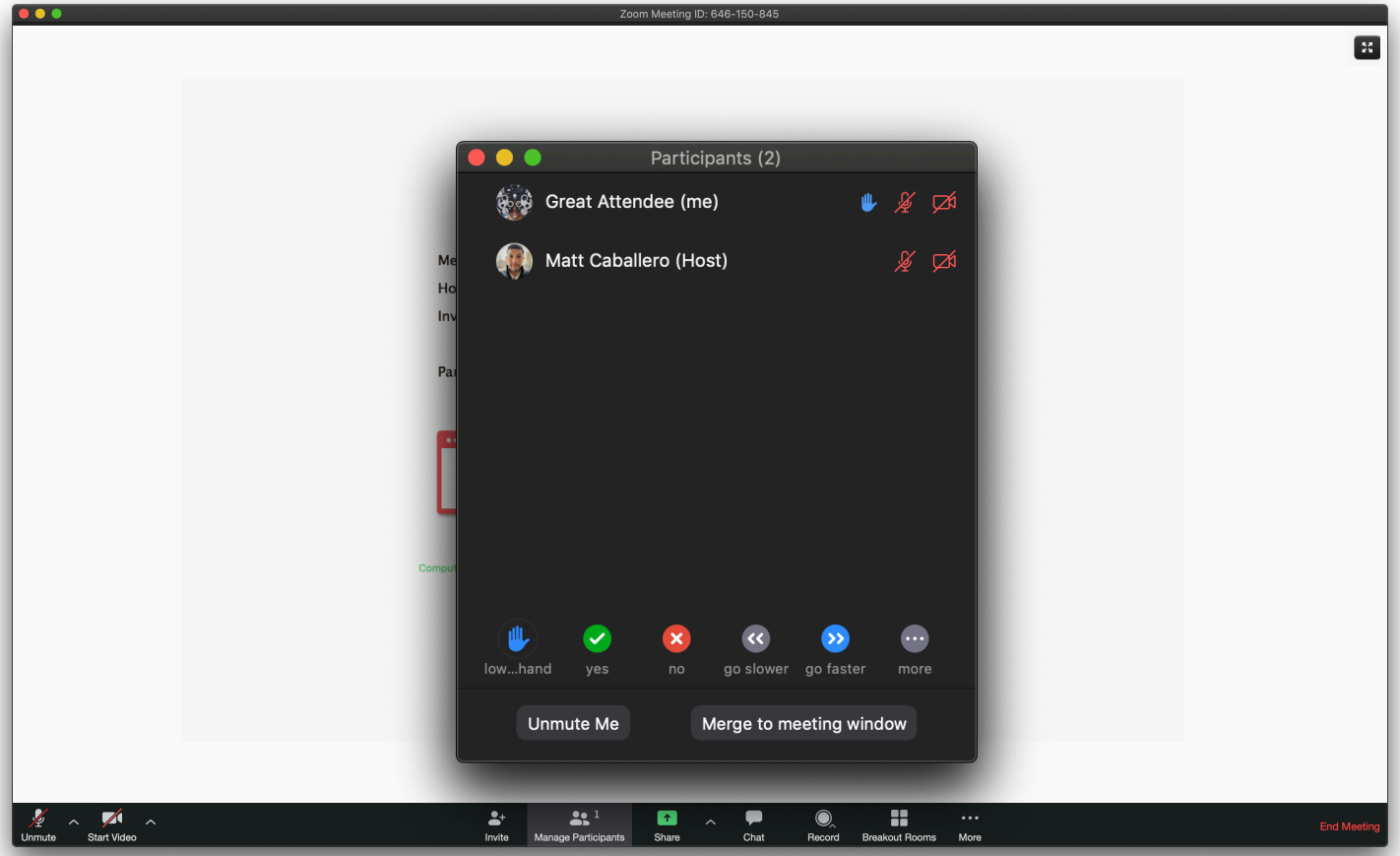

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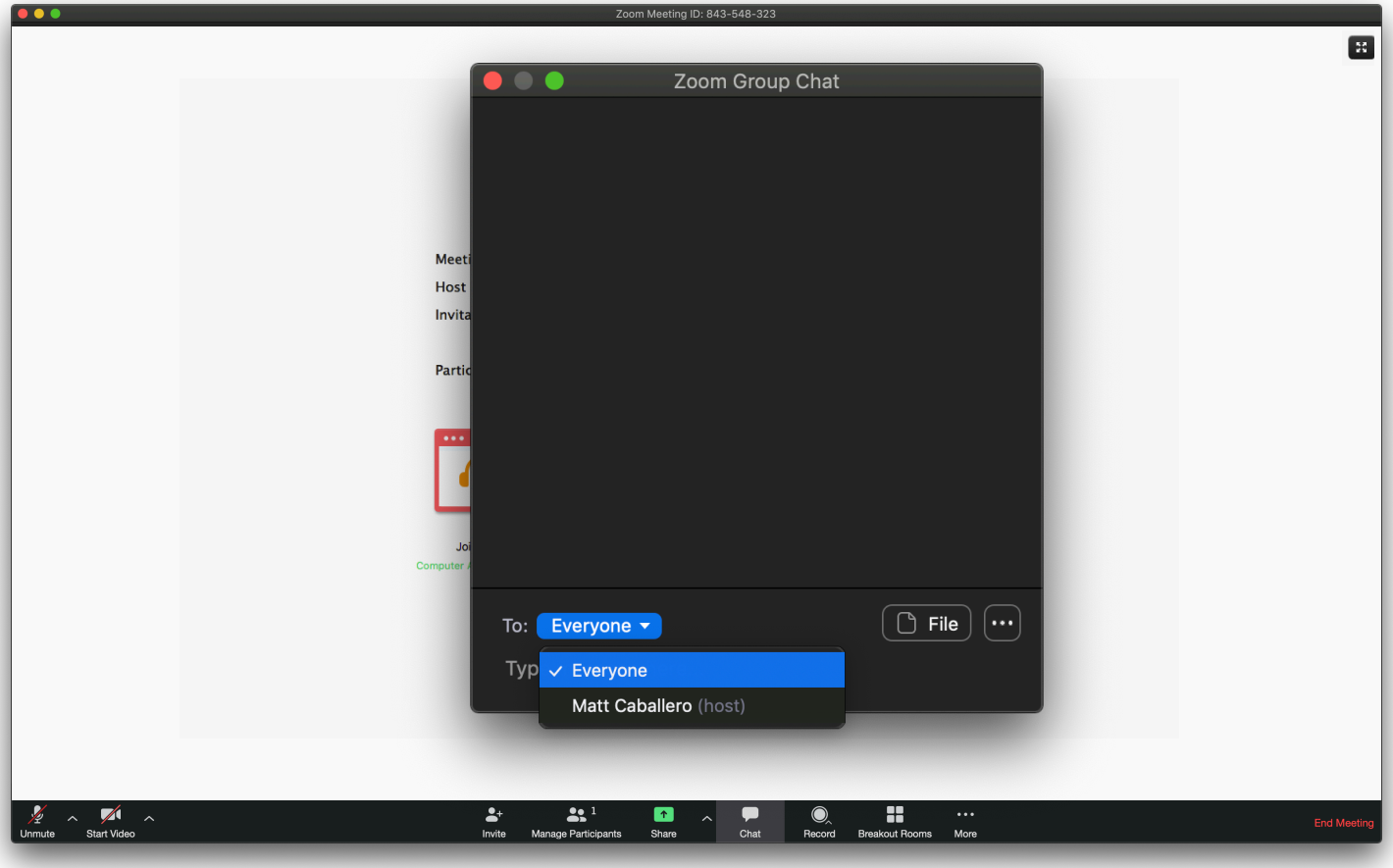
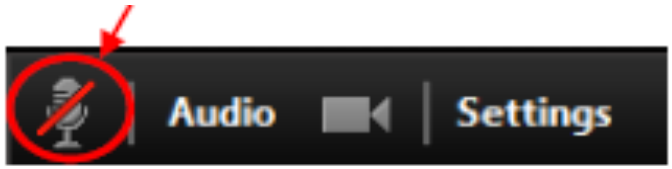


How to use Zoom

Mute your mic. This helps to minimize audio feedback. Mute your audio by clicking on the microphone icon located in the lower left-hand corner of the menu bar.



Audio is muted

Use chat. Connect with participants via private chat or comment to everyone.

Ask questions. If you have a technical question, leave your message in the chat.

Meet the presenters

Emily Tanner-Smith, Ph.D.

University of Oregon
etanners@uoregon.edu

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University of Louisville
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Overview of today's webinar

1. Introduction to systematic reviews and problem formulation

2. Data collection for systematic reviews

3. Evaluating the credibility of studies for a systematic review

Introduction

Jeff Valentine, Ph.D.

Systematic review and meta-analysis are distinct

Systematic review

Summary of the research literature that uses **explicit**, **reproducible** methods to **identify, extract** information from, and **analyze** relevant studies

Meta-analysis

A meta-analysis involves **statistically combining** the results of studies

Systematic review

Summary of the research literature that use **explicit**, **reproducible** methods to **identify, extract** information from, and **analyze** relevant studies

Systematic review

Summary of the research literature that use **explicit**, **reproducible** methods to **identify, extract** information from, and **analyze** relevant studies

Literature reviews can be treated as a form of survey research (Lipsey); they follow the basic steps in the research process (Cooper)

The goal is to limit bias in the identification, evaluation, and synthesis of the body of relevant studies that address a specific research question

Why do we need systematic reviews?

To deal with the increasing volume of research

To escape the cult of the isolated study

To limit bias in the identification, evaluation, and synthesis of studies used in literature reviews

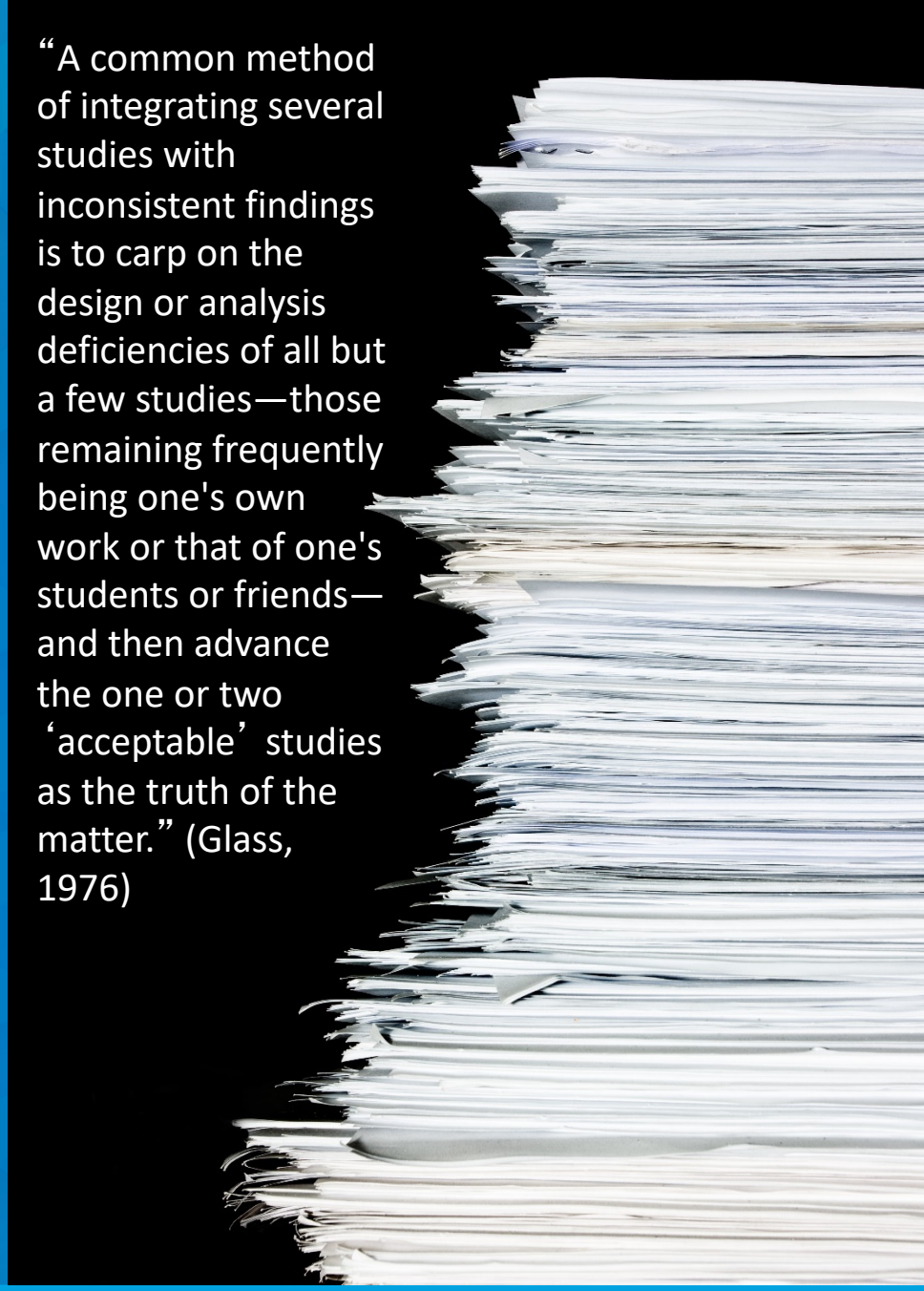
Why do we need systematic reviews?

Research volume

Global scientific output **doubles** (about) every decade (Bornmann & Mutz, 2014)

At some point, humans are cognitively incapable of processing information in a consistently unbiased way

"A common method of integrating several studies with inconsistent findings is to carp on the design or analysis deficiencies of all but a few studies—those remaining frequently being one's own work or that of one's students or friends—and then advance the one or two 'acceptable' studies as the truth of the matter." (Glass, 1976)



Why do we need systematic reviews?

The cult of the isolated study

(Nelder, 1986)

The replication crisis is, in part, a reporting crisis.

All study results are conditioned on context, so interpreting studies in isolation is a huge mistake.

Treating studies in isolation makes it very difficult to recognize these problems.

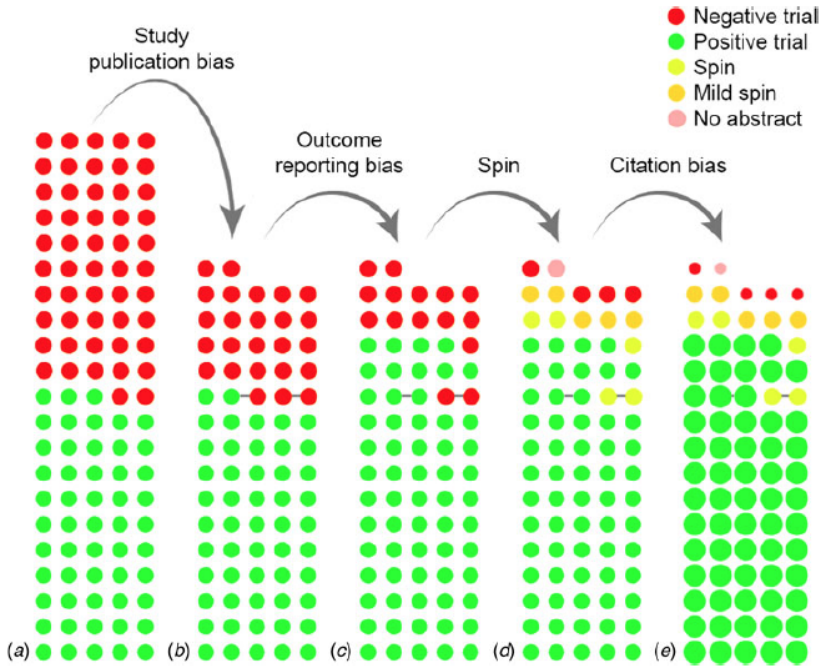


Figure from de Vries, Y. A., Roest, A. M., de Jonge, P., Cuijpers, P., Munafò, M. R., & Bastiaansen, J. A. (2018). The cumulative effect of reporting and citation biases on the apparent efficacy of treatments: The case of depression. *Psychological Medicine 48*, 2453–2455. https:// doi.org/10.1017/S0033291718001873

Why do we need systematic reviews?

To limit bias in the identification, evaluation, and synthesis of studies used in reviews

Literature reviews should be

- ✓ Based on all relevant evidence

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Literature reviews should be

- ✓ Based on all relevant evidence
- ✓ Thoroughly assessed for credibility

But most literature reviews are based on convenience samples of studies and are subjected to (at best) vague and idiosyncratic credibility assessment

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Literature reviews should be

- ✓ Based on all relevant evidence
- ✓ Thoroughly assessed for credibility

But most literature reviews are based on convenience samples of studies and are subjected to (at best) vague and idiosyncratic credibility assessment

- ✓ Synthesized using fair and reasonable criteria

But, often use vote counting or cognitive algebra

Why do we need systematic reviews?

To limit bias in the identification, evaluation, and synthesis of studies used in reviews

Vote counting

Almost always based on statistical significance with little attention given to the effect size

Statistical power decreases as the number of studies increases (Hedges & Olkin, 1985)

Cognitive algebra

Idiosyncratic perspectives that individuals bring to a judgment (Valentine & Cooper, 2008)

To reduce bias and error, we suggest

Developing a detailed protocol and making it public prior to beginning work

Setting explicit inclusion criteria *a priori*

Developing and documenting strategies for locating all relevant studies regardless of publication status

Double coding information in studies

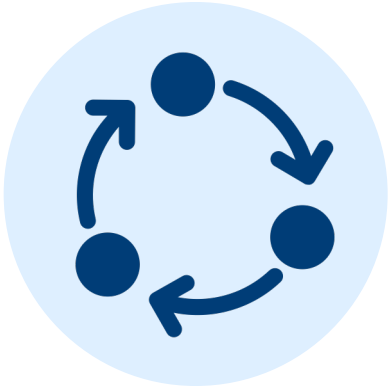
Conducting a formal study quality assessment

Using meta-analysis to synthesize results across studies

Assembling a team for a systematic review

At least **two** people (typically 4–6 for us)

Someone with a high degree of **expertise in the research question** (e.g., an expert on middle school math)



Someone with a high degree of **expertise in systematic reviewing and meta-analysis**

A **professional librarian** (at least as a consultant)

How much time does a high-quality systematic review take?

A LOT!

Rough estimate is about **1,500 person hours** for a small review

About **15 hours per person per week for 49 weeks**, assuming a team of two people

Larger reviews require more time

Q&A

Problem Formulation

Jeff Valentine, Ph.D.

Systematic reviews vary in scope

Narrow questions
"Augmented reality"

Broad questions
"Simulations for STEM learning"

Possible topics	Examples
Rates and trends	Systematic review of research trends in robotics education
Correlates	Relationships between motor proficiency and academic performance
Effects of interventions	A systematic review of the literature on mathematics manipulatives to support students with disabilities
Methods and measures	Surveys assessing students' attitudes towards statistics
Qualitative	Mathematics experiences of black learners
Theoretical	Towards conceptual coherence in the research on mathematics learner education

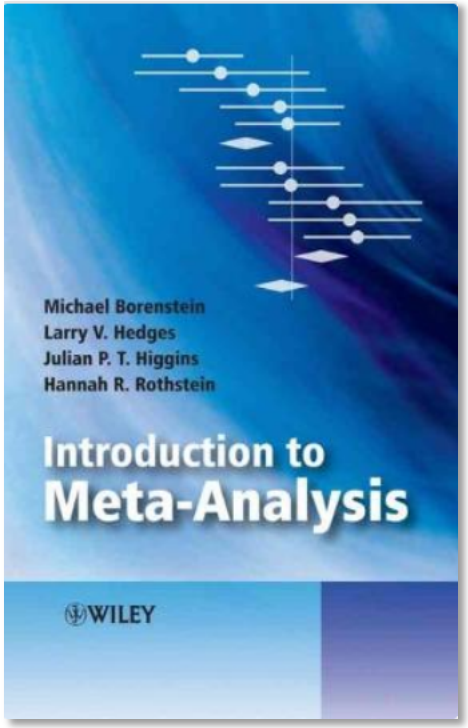
Steps in problem formulation

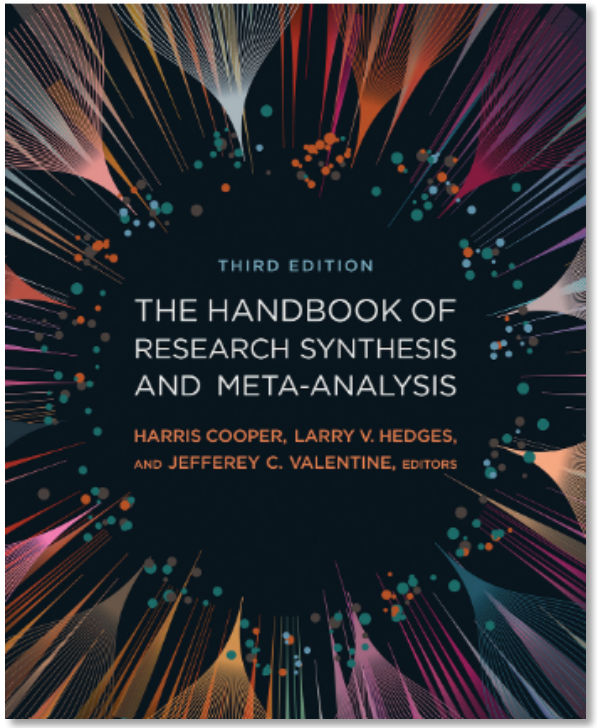
Determine the **conceptual** and **operational** definitions that are relevant to the research

Set the review parameters (PICOS)

- **P**opulations/participants
- **I**nterventions (if applicable)
- **C**omparison condition (if applicable)
- **O**utcomes (what classes and specific operations?)
- **S**tudy designs (should fit purpose)

Recommended Resources





Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2011). *Introduction to meta-analysis*. Chichester, UK: John Wiley & Sons.

Cooper, H., Hedges, L. V., & Valentine, J. C. (Eds.). (2019). *The handbook of research synthesis and meta-analysis* (3rd ed). New York: Russell Sage Foundation

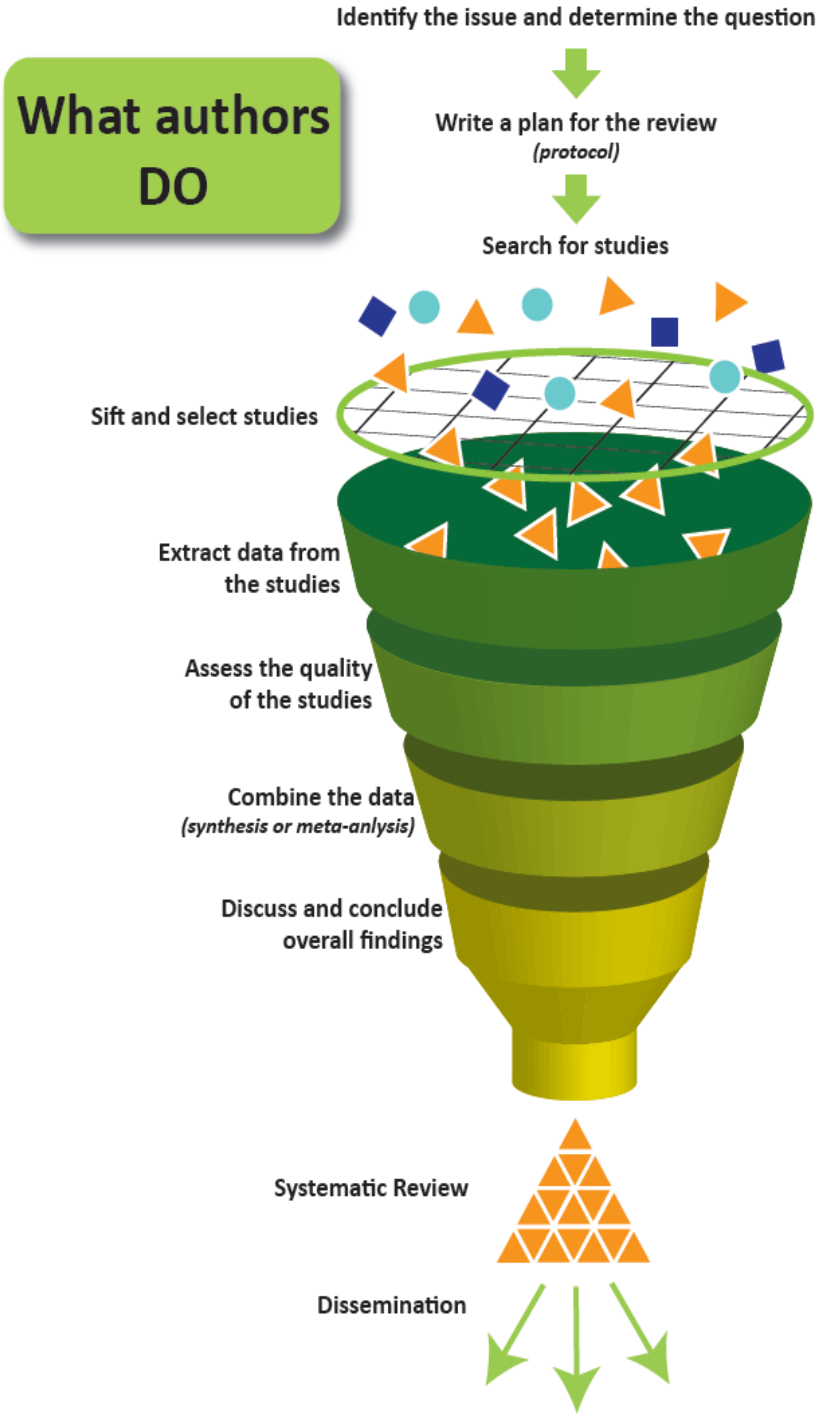
Q&A

Data Collection for Systematic Reviews

Emily Tanner-Smith, Ph.D.

The Concept of a Systematic Review

What authors DO



Designed by Jessica Kaufman, Cochrane Consumers & Communication Review Group, Centre for Health Communication & Participation, La Trobe University, 2011.

Systematic literature searching

Goal is to uncover **all** relevant studies that meet eligibility criteria

Key components of a good literature search are

- Reproducibility (documentation, transparency)
- Diversity (coverage)

Steps in the literature search

Step	Action	Description
1	Develop search terms relevant to your research question	Categorize search terms by key concepts (e.g., population, intervention, comparison, outcome, study design)
2	Choose databases/literature sources	Choices depend on topic, research questions, timeline, and resources
3	Create search strategies for each source	Create search strategies for each source and add relevant search filters if desired/possible; carry out the searches
4	Review results and revise search as necessary	If too many irrelevant hits, or missing relevant references, revise search strategies; may need to consider additional sources
5	Process references	Export all search results from databases, import into reference manager software, remove duplicates
6	Log and report the search	Keep track of all decisions made in the search process to ensure transparency and accurate reporting
7	Update search, as needed	As needed, update the search to capture newly available reports

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Choosing databases and literature sources

Primary Sources

Electronic bibliographic databases. Academic Search Premier, CINAHL, Cochrane Central Register of Controlled Trials, Embase, ERIC, Gale Academic OneFile, International Bibliography of the Social Sciences, PsycINFO, PubMed/MEDLINE, Web of Science

Gray literature sources. ClinicalTrials.gov, WHO International Clinical Trials Registry Platform, ProQuest Dissertations & Theses Global, organization websites, conference proceedings

Secondary Sources

- Contact with experts
- "Hand" searching journal tables of contents
- Forward citation searches (Web of Science, Google Scholar, Scopus)
- Footnote chasing/reference harvesting

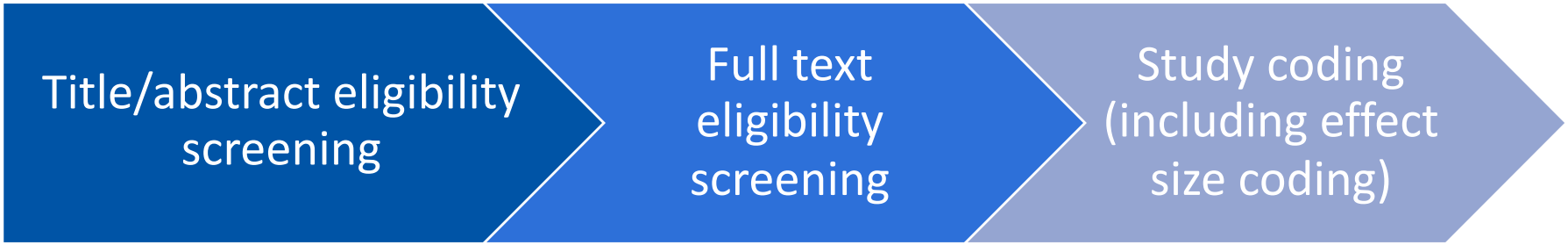
Best practice guidelines for literature searching

- Consult with librarians/information retrieval specialists
- Document all steps in the search process
  - Information sources, dates covered, date last searched
  - All search terms for each database, any limits used in search
- Search multiple/diverse electronic databases
- Search for gray and unpublished literature
- Balance sensitivity and specificity of search terms

Data extraction (coding)

After completing the literature search, data extraction involves coding information from the identified reports.

Stages of data extraction



Data extraction should always follow a standardized coding protocol.

A great source of example coding protocols can be found in protocols published in Campbell Systematic Reviews (see https://onlinelibrary.wiley.com/journal/18911803).

Common domains included in coding protocols

General study information and context
Bibliographic information and metadata, location, setting, research design

Participant characteristics
Demographics, risk or severity level, other relevant participant information

Intervention group characteristics
Program features/elements, duration, implementation quality, efficacy/effectiveness

Outcome characteristics
Construct, measurement features, informant, time frame of measurement

Effect size information
Aggregate statistics needed to estimate effect sizes and their variances

Study quality/risk of bias
Risk of bias items, attrition, contamination, crossover, statistical analysis approaches

Best practice guidelines for data extraction

Use Tools

Use software and tools to facilitate the extraction process

Abstrackr, Covidence, FileMaker Pro, Google Sheets, Rayyan, REDCap, RevMan

Pilot Test

Pilot test and refine coding protocol with several example studies

Avoid subjective coding items

Code items at the highest level of measurement possible (e.g., continuous)

Use prior coding protocols as exemplars (e.g., Campbell Systematic Reviews)

Use Multiple Coders

Extract data in duplicate at each stage in the process

Train Coders

Conduct extensive training and ongoing monitoring of coders (avoid "drift")

Watch for Multi-Report Studies

Attend to multiple publications resulting from the same study

Reporting systematic review data collection

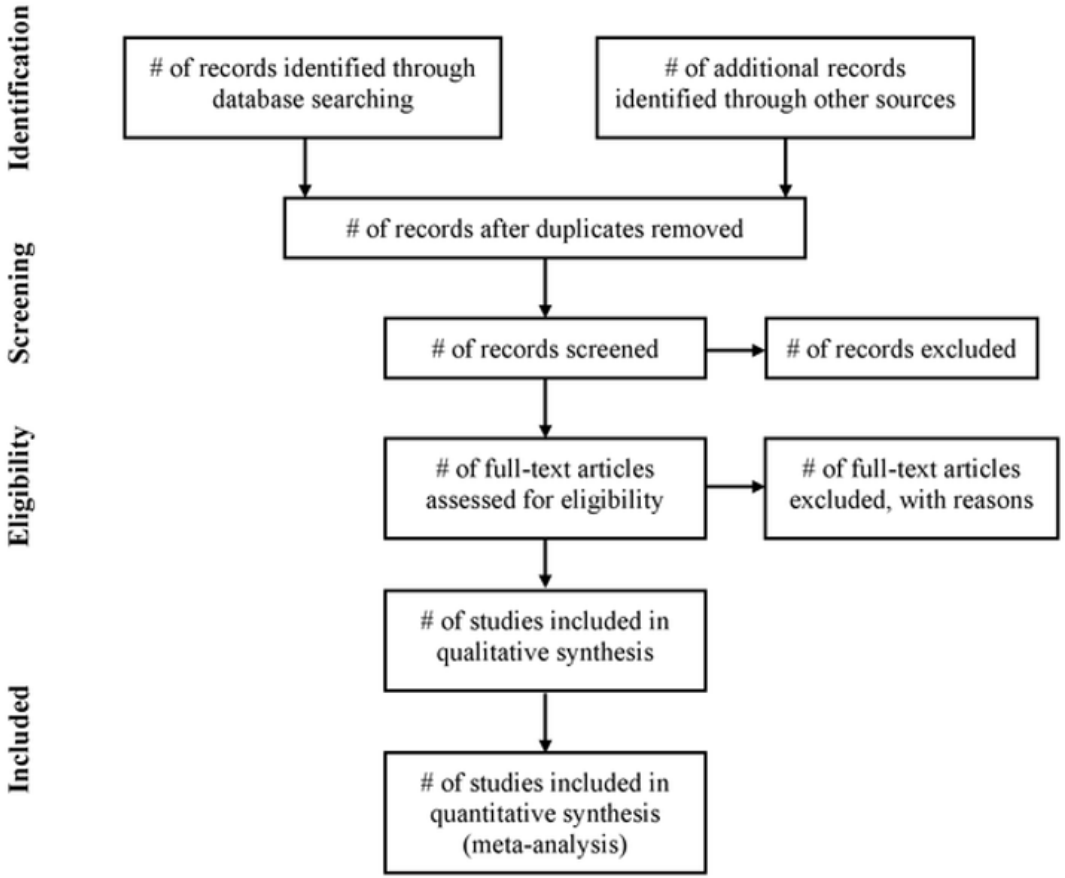


Figure 1. Flow of information through the different phases of a systematic review.

Source: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) website, http://prisma-statement.org/PRISMAStatement/FlowDiagram

Recommended resources

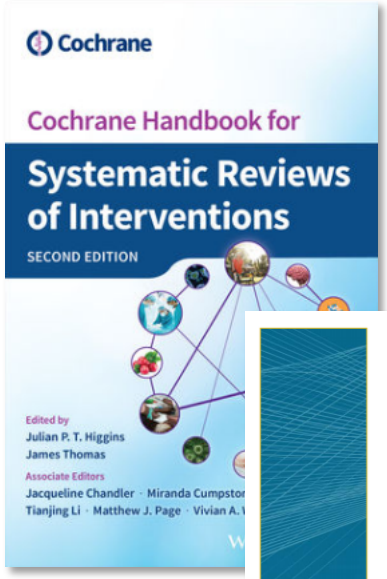
Campbell Collaboration (n.d.). *Evidence synthesis tools for Campbell authors*. https://campbellcollaboration.org/research-resources/resources.html

Center for Evidence Synthesis in Health (n.d.). *Software*. https://www.brown.edu/public-health/cesh/resources/software

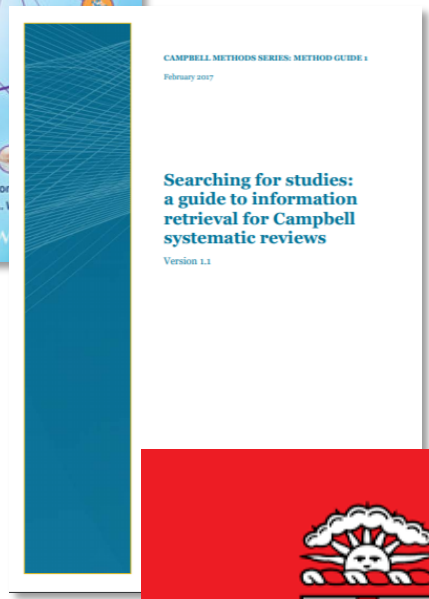
Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Editors) (2019). *Cochrane handbook for systematic reviews of interventions*, version 6.0 (updated July 2019). Cochrane. Available from www.training.cochrane.org/handbook

Kugley, S., Wade, A., Thomas, J., Mahood, Q., Jorgensen, A-M. K., Hammerstrom, K., & Sathe, N. (2017). Searching for studies: A guide to information retrieval for Campbell systematic reviews. *Campbell Systematic Reviews, 13*, 1-73. https://doi.org/10.4073/cmg.2016.1

PRISMA (n.d.). *Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) website*. http://www.prisma-statement.org/



Campbell Collaboration



PRISMA

BROWN
School of Public Health

Q&A

Assessing Study Quality

Jeff Valentine, Ph.D.

Thinking about study quality in a systematic review

Study quality can be conceptualized as the extent to which a study's design and implementation support the types of inferences that the systematic reviewer wants to make.

Two key challenges in assessing study quality

Identifying the relevant study quality indicators for a particular research question

Relevant = biases the effect size

Measuring these study quality indicators

While avoiding arbitrary cutoffs and weighting and

Without relying on the cognitive algebra of the judges

Reminder: Transparency and reproducibility are key principles.

Study quality scales (Jüni et al., 1999)

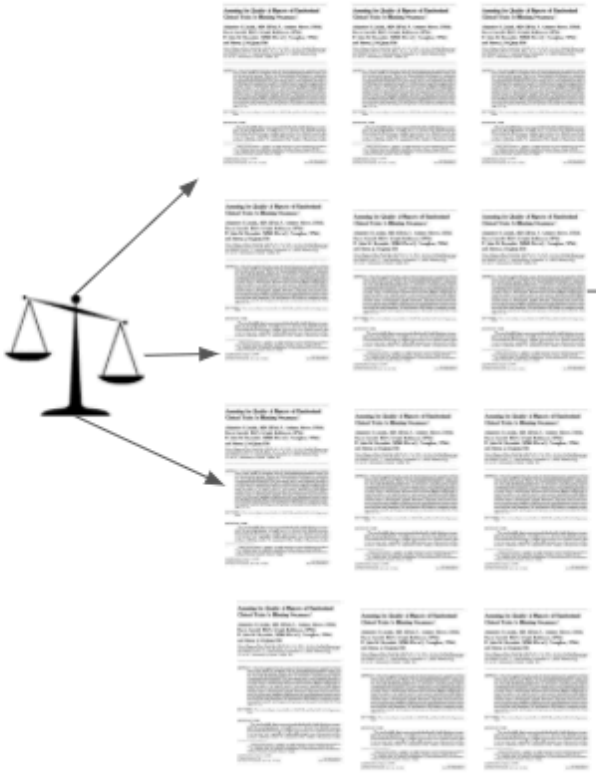
Started with an existing meta-analysis on the effects of different types of heparin in post-operative DVT

Found 25 study quality scales; most (24 of 25) published in peer-reviewed medical journals

Conducted 25 separate meta-analyses

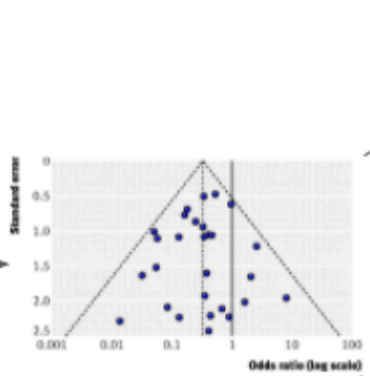
Study quality scales (Jüni et al., 1999)

Started with 25 study quality scales



They chose one

They applied it to each study in an existing meta-analysis, creating "good study" and "bad study" categories based on the quality scale



What do the "good" studies say?

What do the "bad" studies say?

They re-did the meta-analysis, asking what the "good" studies said vs what the "bad" studies said.

Then they did it all over again!

What did Jüni et al. (1999) find?

% of Meta-Analyses	"High" vs "Low" Study Conclusions
About 50%	Agreed
About 25%	Disagreed: High-quality studies say new is better
About 25%	Disagreed: High-quality studies say new is not better

The conclusion about the effectiveness of the new version of heparin depended (in part) on the specific quality scale chosen.

EITHER
The study quality does not matter for this research question (unlikely)

OR
The study quality scales were so bad that they masked the effects of study quality (likely)

Weaknesses of study quality scales I: Scale characteristics

Study quality scales differ widely in the number of items on the scale	There is no empirical evidence for weighting schemes	Scales rely on a single score to represent study quality
The range was 3 to 34	One scale in the Jüni et al. paper (Brown, 1991) gave 14% of points to randomization and 5% to masking outcome assessors Another (Beckerman et al., 1992) gave 12% of points to masking outcome assessors and 4% to randomization	Study A: high internal validity and low external validity = 80 Study B: low internal validity and high external validity = 80

Weaknesses of study quality scales II: Item characteristics

Items tend to be imprecisely worded and open to interpretation by users

Rely on cognitive algebra, less likely to be reproducible

Items tend to invoke arbitrary thresholds

Like weighting schemes, these have little empirical support

Maryland Scale:

"Control for effects of attrition"

1 = Attrition is greater than **50%** and no attempt was made to adjust for the effects of attrition

5 = **Careful** controls were used to adjust for the effects of attrition

Establishing an evidence base on the effects of study quality indicators is harder than it seems

Fundamental problem: the important study quality characteristics probably vary by research area

The relevant characteristics for a evaluating an elementary school science program probably differ from those for evaluating a college engineering program

In medicine, many meta analyses of meta-analyses have been performed

These "meta meta-analyses" suggest:

- Items indicating low study quality tend to show either no association or a positive association with effect size
- Even if positive, effect sizes tend to be smaller than one might expect
- Nonrandomized experiments tend to be associated with larger effect sizes than randomized experiments

Thinking about study quality as a consumer of systematic reviews

Some study quality indicators likely co-vary with effect size

All systematic reviews should have a thorough assessment of study quality (but not all do)

As a consumer, ask if the systematic reviewers thoughtfully considered the likely impact (direction and magnitude) of different study quality indicators relevant to their research question

If the systematic review authors believe that one or more characteristics co-vary with effect size, did they take this into account?

Recommended resources

Campbell Collaboration (n.d.). *Evidence synthesis tools for Campbell authors*. https://campbellcollaboration.org/research-resources/resources.html

Higgins, J. P. T., Thomas, J., Chandler, J., Cumpston, M., Li, T., Page, M. J., & Welch, V. A. (Editors) (2019). *Cochrane handbook for systematic reviews of interventions*, version 6.0 (updated July 2019). Cochrane. Available from www.training.cochrane.org/handbook

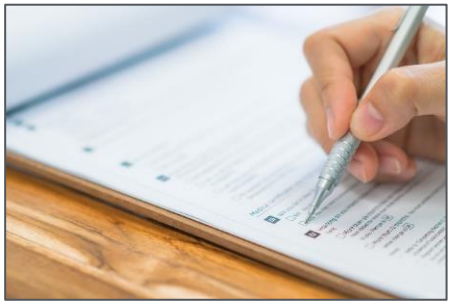
Johnson, B. T., Low, R. E., & MacDonald, H. V. (2015). Panning for the gold in health research: Incorporating studies' methodological quality in meta-analysis. *Psychology & Health*, *30*(1), 135–152.

Valentine, J. C. (2019). Evaluating study quality. In H. Cooper, L. V. Hedges, & J. C. Valentine (Eds.), *The handbook of research synthesis and meta-analysis, 3rd edition*.

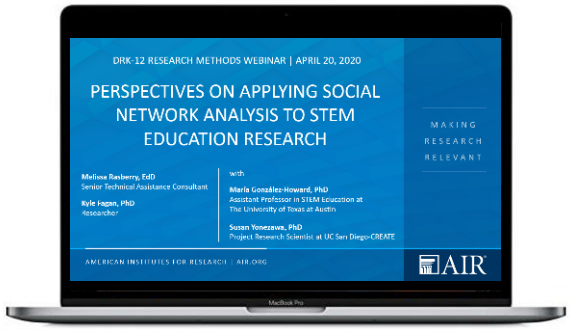
Q&A

Looking forward

Looking forward



Please fill out a feedback survey following the webinar.



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Recording will be available soon on the CADRE website.

Register for the webinar on meta-analytic techniques (September 28, 2020_