AN INTRODUCTION TO SYSTEMATIC LITERATURE REVIEWS

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

75 minutes

http://cadrek12.org/
How to use Zoom
How to use Zoom
How to use Zoom
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.

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.
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etanners@uoregon.edu

Jeffrey Valentine, Ph.D.
University of Louisville
jeff.valentine@louisville.edu
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.

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
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.
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
- 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”

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


Data Collection for Systematic Reviews

Emily Tanner-Smith, Ph.D.
The Concept of a Systematic Review

What authors DO

1. Identify the issue and determine the question
2. Write a plan for the review (protocol)
3. Search for studies
4. Sift and select studies
5. Extract data from the studies
6. Assess the quality of the studies
7. Combine the data (synthesis or meta-analysis)
8. Discuss and conclude overall findings

Systematic Review

Dissemination
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

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Choosing databases and literature sources

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<th>Primary Sources</th>
<th>Secondary Sources</th>
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<tr>
<td><strong>Electronic bibliographic databases.</strong> Academic Search Premier, CINAHL,</td>
<td>• Contact with experts</td>
</tr>
<tr>
<td>Cochrane Central Register of Controlled Trials, Embase, ERIC, Gale Academic</td>
<td>• “Hand” searching journal tables of contents</td>
</tr>
<tr>
<td>OneFile, International Bibliography of the Social Sciences, PsycINFO,</td>
<td>• Forward citation searches (Web of Science, Google</td>
</tr>
<tr>
<td>PubMed/MEDLINE, Web of Science</td>
<td>Scholar, Scopus)</td>
</tr>
<tr>
<td><strong>Gray literature sources.</strong> ClinicalTrials.gov, WHO International Clinical</td>
<td>• Footnote chasing/reference harvesting</td>
</tr>
<tr>
<td>Trials Registry Platform, ProQuest Dissertations &amp; Theses Global, organization</td>
<td></td>
</tr>
<tr>
<td>websites, conference proceedings</td>
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</tbody>
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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

- Title/abstract eligibility screening
- Full text eligibility screening
- Study coding (including effect size coding)

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.

- **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”).

- **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).

- **Watch for Multi-Report Studies**: Attend to multiple publications resulting from the same study.
Reporting systematic review data collection

Recommended resources

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


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.

- Widely accepted that study quality is likely related to study results.
- Study quality judgments are much, much harder than they seem.
- As a consumer, be very skeptical of study quality scales.
- A very large number of these have been developed. Almost none have had their validity examined in a serious way.
Two key challenges in assessing study quality

Identifying the relevant study quality indicators for a particular research question

Measuring these study quality indicators

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
- 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?

<table>
<thead>
<tr>
<th>% of Meta-Analyses</th>
<th>“High” vs “Low” Study Conclusions</th>
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<tbody>
<tr>
<td>About 50%</td>
<td>Agreed</td>
</tr>
<tr>
<td>About 25%</td>
<td>Disagreed: High-quality studies say new is better</td>
</tr>
<tr>
<td>About 25%</td>
<td>Disagreed: High-quality studies say new is not better</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Study quality scales differ widely in the number of items on the scale</th>
<th>There is no empirical evidence for weighting schemes</th>
<th>Scales rely on a single score to represent study quality</th>
</tr>
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<tbody>
<tr>
<td>The range was 3 to 34</td>
<td>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</td>
<td>Study A: high internal validity and low external validity = 80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Study B: low internal validity and high external validity = 80</td>
</tr>
</tbody>
</table>
### Weaknesses of study quality scales II: Item characteristics

<table>
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<th>Items tend to be imprecisely worded and open to interpretation by users</th>
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<td>Rely on cognitive algebra, less likely to be reproducible</td>
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<th>Items tend to invoke arbitrary thresholds</th>
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<tr>
<td>Like weighting schemes, these have little empirical support</td>
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<tr>
<td>Maryland Scale: “Control for effects of attrition”</td>
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<tr>
<td>1 = Attrition is greater than 50% and no attempt was made to adjust for the effects of attrition</td>
</tr>
<tr>
<td>5 = Careful controls were used to adjust for the effects of attrition</td>
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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 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


Looking forward
Looking forward

Please fill out a feedback survey following the webinar.

Recording will be available soon on the CADRE website.

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