CEED-ACEG Institute for Engineering Education Research

Systematic Reviews for Engineering Education Research

An Emerging Methodology - Part 1

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Learning objectives

● Describe the systematic review methodology and how it applies to engineering education
● Construct a question appropriate for a systematic review
● Identify protocols and inclusion and exclusion criteria in a systematic review
● Appraise the quality of systematic reviews
Systematic Review methodology

"A systematic review attempts to identify, appraise and synthesize all the empirical evidence that meets pre-specified eligibility criteria to answer a given research question. Researchers conducting systematic reviews use explicit methods aimed at minimizing bias, in order to produce more reliable findings that can be used to inform decision making."

Source: Cochrane Handbook for Systematic Reviews of Interventions
Systematic Review methodology

- Used in the health sciences - Cochrane Collaboration
- How it differs from other types of reviews
  - Literature review
  - Scoping review
  - Meta-analyses
Key characteristics of a systematic review

- a clearly defined question
- an explicit, reproducible methodology with clear inclusion and exclusion criteria for studies
- a systematic search that attempts to identify all studies that would meet the eligibility criteria;
- an assessment of the validity of the findings of the included studies, for example through the assessment of risk of bias; and
- a systematic presentation, and synthesis, of the characteristics and findings of the included studies, which includes the search methodology.

From UBC Library’s guide to Systematic Reviews http://guides.library.ubc.ca/SystematicReviews
Systematic Review - Engineering Education

Key article:

Systematic Reviews:
- Help inform practice and/or policies
- Develop theory or evaluate an existing theory
- Identify gaps suggesting areas that need further research
Steps in a systematic review

1. Develop and refine the research question, determining the inclusion/exclusion criteria
2. Develop and refine the search. Select the databases you will use for your search (Part 2 of workshop)
3. Select the studies that meet the eligibility criteria to be included
4. Appraise. Assess the validity of the findings
5. Synthesize. Report your findings
Step 1 - Develop the research question

PICO Framework

P - Population or problem
I - Intervention or Issue
C - Comparison
O - Outcome

PICO is one framework. There are many others including: CHIP, PEO, SPICE, SPIDER, WWH

Activity 1 - Develop the research question

Using the sample research topic or your own research topic, develop the research question using the PICO framework.

- Population
- Intervention/Issue
- Comparison
- Outcome(s)
Has it been done before?

Supporting Organizations:

Health Sciences:
- Cochrane Database
- Joanna Briggs Institute

Education and more:
- Campbell Collaboration
- EPPI-Centre - Evidence for Policy and Practice Information
- WWC - What Works Clearinghouse
Step 2 - Develop and refine the search

Once you have refined your research question, your next steps are to:

- Select the databases you will search
- Consider whether to include grey literature, and if so, which sources to search
- Meet with a librarian

Developing a protocol for your systematic review is highly recommended. It outlines how you will conduct your review.

Protocol registration is optional, but recommended. One place you can register is Open Science Framework (http://osf.io)
Develop the protocol

These two guides are helpful in writing a protocol:

- prisma-statement.org/Extensions/Protocols.aspx
- www.campbellcollaboration.org/research-resources/writing-a-campbell-systematic-review.html

Key areas to include in your protocol:

- The reason for the review; the rationale and objectives (PICO)
- Your methods - includes:
  - your eligibility criteria
  - the information sources you intend to use - databases, etc.
  - your search strategy with a sample search to demonstrate reproducibility
  - how you will keep track of your searches, make the selections, and manage the data you collect
Activity 2 - Develop the protocol

Using the sample research topic or your own research topic, consider what the inclusion and exclusion criteria will be for including studies in your systematic review.

Item 8 from the PRISMA-P statement addresses eligibility criteria:

“Specify the study characteristics (such as PICO, study design, setting, time frame) and report characteristics (such as years considered, language, publication status) to be used as criteria for eligibility for the review.”
Step 3 - Study selection

After you’ve completed your database and grey literature search, you’ll need to determine whether the articles you’ve found meet your eligibility criteria. Best practice is to work with a partner or team to screen articles to minimize bias.

Software can make the screening process easier:

- Citation management tools (such as Mendeley, Zotero, RefWorks, Endnote, etc) can collect all your references in and automatically remove duplicates
- Systematic Review tools (such as Rayyan, Covidence, DistillerSR, etc) can support the process of screening through articles. These are optional - many people opt to just use Excel
Step 4 - Appraise

Once you’ve screened articles for eligibility and identified the ones you will include, you’ll need to appraise each article and identify what data you want to extract for your systematic review.

There are many checklists available for assessing the quality of articles. Some can be found here: www.campbellcollaboration.org/resources-international/methods-resources.html
Activity 3 - Evaluating Systematic Reviews

Working in pairs, skim the systematic review you’ve been given and complete the assessment checklist.
Further reading

Resources

- Margaret Foster - Systematic Reviews Service guide. Multiple resources within this guide to help you with all of the steps throughout the review: tamu.libguides.com/c.php?g=574702&p=3963347
- UBC Library’s Systematic Reviews Search Methodology guide. An overview of the steps to conduct a systematic review with links to relevant resources: guides.library.ubc.ca/SystematicReviews
- PRISMA. Transparent reporting of systematic reviews: www.prisma-statement.org/Default.aspx
- HLWIKI Software for Systematic Reviews: hlwiki.slais.ubc.ca/index.php/Software_for_systematic_reviewing

Articles on reviews in engineering education research

Conducting a Systematic Review in Engineering Education - Part 2

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Learning objectives

- Develop a structured and reproducible search
- Gain familiarity with databases and searching grey literature sources
- Develop best practices for managing and screening references
- Distinguish the various publication guidelines for systematic reviews
Activity 1

What is your understanding of the systematic review methodology?

- *In pairs discuss what you know about systematic reviews.*
- *Have you done one?*
- *Are you currently working on one?*
- *What questions do you have about systematic reviews?*
Systematic Review Definition

"A systematic review attempts to identify, appraise and synthesize all the empirical evidence that meets pre-specified eligibility criteria to answer a given research question. Researchers conducting systematic reviews use explicit methods aimed at minimizing bias, in order to produce more reliable findings that can be used to inform decision making."

Source: Cochrane Handbook for Systematic Reviews of Interventions
Other review types

*Scoping review* - also called “mapping review” - tends to be broader in “scope” looking for gaps in the literature for future research. Does not assess quality of included studies. A scoping review may lead to a systematic review.

*Literature review* - “an evaluative report of information found in the literature related to your selected area of study. The review should describe, summarise, evaluate and clarify this literature.”
Steps in a systematic review

1. Develop and refine the research question, determining the inclusion/exclusion criteria
2. Develop and refine the search. Select the databases you will use for your search
3. Select the studies that meet the eligibility criteria to be included
4. Appraise. Assess the validity of the findings
5. Synthesize. Report your findings
Develop a structured reproducible search

Separate out the key concepts of your research question using the PICO framework.

Consider your inclusion and exclusion criteria.

PICO framework helps structure your search

Population or Problem

Intervention or Issue

Comparison

Outcome(s)
Search strategy Step 1: Select keywords

Sample topic: Do computer games have positive impacts and outcomes for learning in users age 14 years and older?

PICO framework helps structure your search

Population or Problem

Intervention or Issue

Comparison

Outcome(s)
Activity 2 - Develop a search strategy

Use your own topic or select from the list of sample topics.

Working in pairs or on your own:

- Develop a search strategy using the PICO framework
- Use the worksheet provided to list related terms to be used in your search
Search Strategy Step 2: Select databases

Subject databases
- Compendex Engineering Village
- Web of Science or Scopus
- ERIC (Education specific)

Publisher databases
- IEEE, ACM

Grey literature
- Google Scholar
Search techniques

Common techniques:
- Boolean operators “computer games” OR “video games”
- Phrase searching “computer games”
- Truncation (or wildcards) – game* searches game, games, gaming

Some databases support adjacency:
computer NEAR/3 game*

The help section of each database will indicate what features will work in that database
Search techniques

Keywords and Subject Headings

- Some databases have controlled vocabularies.
  - Easier to search one concept if your PICO term has a subject heading
  - Compendex and ERIC have subject headings
  - Web of Science is a keyword search
5 matching terms

computer games

- Computer games
- Educational robots
- Personal computing
- Rendering (computer graphics)
- Serious games
TS=("computer gam*" OR "serious gam*" OR "online gam*" OR "video game*") AND
TS=("learning outcome*" OR "learning effectiveness" OR "student engagement" OR "student learning" OR education* OR "education* outcome*" OR "outcome measures")
Activity 3 - Database searching

Apply your search strategy as developed in the previous activity using one of the databases listed or one selected for your topic:

- Compendex Engineering Village - Comprehensive coverage including engineering education
- Web of Science Core Collection - Multidisciplinary database
- ERIC - Education database

You might also want to try some grey literature searching.
You will run your search, then keep track of all the results you find (even irrelevant ones) and document the screening stages:

- Total number of records
- Number after duplicates removed
- Screen - title and abstract (with a partner/team)
- Screen - full text (with a partner/team)
- Number of studies included

www.prisma-statement.org/
Step 3 - Study selection

After you’ve completed your database and grey literature search, you’ll need to determine whether the articles you’ve found meet your eligibility criteria. Best practice is to work with a partner or team to screen articles to minimize bias.

Software can make the screening process easier:

- Citation management tools (such as Mendeley, Zotero, RefWorks, Endnote, etc) can collect all your references in and automatically remove duplicates
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Citation management software

Best practice is to export all search results from databases to citation management software such as Mendeley, Zotero, RefWorks, or EndNote.

These tools can remove duplicate references, giving you the number you need to report in your PRISMA flow diagram. You can then proceed with the first stage of screening titles and abstracts - either within the software, or by exporting to Excel or custom systematic review software.

More information: guides.library.ubc.ca/SystematicReviews/methods
Documenting your searches

Most major databases such as Compendex and Web of Science allow you to save your search history. For other sources, you can keep track of the search terms you’ve used in a Word document or Excel spreadsheet. This will be important when writing your systematic review, as it is critical in ensuring reproducibility of your work.
Activity 4 - Screening and selecting

Work with a partner. Review the abstracts provided to determine whether they meet the following inclusion criteria*:


- includes empirical evidence relating to the impacts and outcomes of playing games
- date from January 2004-February 2009
- include participants over the age of 14 years

For each article, would you definitely include it, definitely exclude it, or would you need to read the full text to decide? Discuss with your partner - are you in agreement on all of the articles?
The PRISMA checklist includes 27 items to report in a systematic review: www.prisma-statement.org/PRISMAStatement/Checklist.aspx

Typically, the database search is described broadly in the Methods section, and a detailed, reproducible search strategy for at least one database is reported in an appendix.

Note that the grey literature search will be documented differently than the other databases. Searches of Google Scholar, individual websites, and papers found through reference lists are accounted for in the “other sources” box of the PRISMA flow diagram:
Further reading

Resources

- Margaret Foster - Systematic Reviews Service guide. Multiple resources within this guide to help you with all of the steps throughout the review: tamu.libguides.com/systematicreviews
- UBC Library’s Systematic Reviews Search Methodology guide. An overview of the steps to conduct a systematic review with links to relevant resources: guides.library.ubc.ca/SystematicReviews
- PRISMA. Transparent reporting of systematic reviews: www.prisma-statement.org/Default.aspx
- HLWIKI Software for Systematic Reviews: hlwiki.slais.ubc.ca/index.php/Software_for_systematic_reviewing

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