

Demystifying the Selection of a Literature Method: A novice researcher learning journey

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Abstract

Engineering education is an interdisciplinary field of research that borrows from a variety of areas to build its toolset. From theories to research methods the field is in constant evolution in its adaptation of established practices in other fields to the context of engineering education. One of the challenges faced by novice researchers is the need to decide if engage with one method versus another, and to devise the transferability of methods learned. In the early stages of training of engineering education researchers, we get acquainted with different strategies to conduct literature reviews. Systematic Literature Reviews (SLRs) and Scoping Reviews (SR) have gained popularity as approaches to engage more in depth with existing research in a chosen topic. One question that we face is: when to decide to conduct one versus the other? In this paper, I illustrate the learning process generated through such questioning while generating a literature review about the marginalized lived experiences of Asian American students in engineering. I will discuss the different approaches for SRs and SLRs, how they transfer to the context of engineering education, and which adjustments were considered necessary in order to make approaches more useful. The Five-Stage, PICO, and SPIDER frameworks are discussed to depth considering their transferability and adjustments needed to make their optimal utilization in the engineering education context. The exercise is illustrated by the results of the intended literature review.

The goal of this paper is to make transparent the decision-making process through which novice researchers go through when selecting a type of literature review to engage with. It is intended to demystify processes inherent to research endeavors and provide heuristics through which such decision-making can be executed. Initial thoughts about implications for this in the preparation of new engineering education researchers are discussed.

Introduction

This full paper discusses Systematic Literature Reviews (SLRs) and Scoping Reviews (SRs) and their applications for research, the goal is to share this knowledge as a *trick of the trade* that early doctoral students might find useful. For many novice researchers, entering a research field can be overwhelming with the vast number of options available for research methods and theories. This can be further complicated by the specific field they are entering and their previous background, as is often the case for new trainees in engineering education research with a traditional engineering background. In learning to engage with literature, a novice researcher usually becomes familiar with different types of approaches to generate thorough reviews of the literature; in which two are most recognized: *systematic* and *scoping* literature reviews. These two methods are particularly useful forms of reviewing what is already written and known about the topic, identifying research gaps, and in some cases, and analyzing existing literature.

Scoping Reviews and Systematic Literature Reviews are similar and different in their own ways. For example, a scoping review may be utilized for understanding the “breadth” of a research topic, but a systematic literature review may be utilized for understanding the “depth” and appraise the literature of a topic [1]. Both of these literature reviews are helpful for novice researchers when they are beginning a project or want to explore the potential of a particular

research topic. Research gaps may come up in the literature when conducting the review, which may lead to a dissertation or research project.

Most of what is known about systematic literature reviews and scoping reviews originate from the psychological, health, and social sciences fields [2], [3], and while there are existing frameworks for these two types of literature reviews, they may not be directly transferable to the engineering education field. This realization made evident that this process is likely a general experience among novice researchers. Therefore, the goal of this paper is to discuss the applications of both types of literature reviews with reflections from a novice researcher, discussing the importance of engaging in literature reviews, and adaptations of these different methods into engineering education. It is important to note that while other forms of literature reviews exist, such as narrative literature reviews, this paper will only focus on systematic literature reviews and scoping reviews. The context of this learning experience was with the goal of exploring the state of the art on the experiences of Asian Americans in engineering, which took a variety of shapes throughout the time of this exercise. Therefore, it is referred to through this description.

Scoping vs Systematic Literature Reviews

I start this piece by presenting the big picture comparison between both literature review approaches. As I started this literature review endeavor, I first became familiar with the nuances of both methods, so I could decide which path to take. In my review of both methods, I found that there are similarities and some differences between the two. The steps for each method are derived from literature [1], [2], [4]. To contribute to the comparison between both methods, I offer a mapping between them observations about their contrasts for each of their established steps in Table 1; I expand on these observations in the following sections.

Table 1: A comparison between Scoping Reviews & Systematic Literature Reviews

Steps for a Scoping Review according to [4]	Steps for a Systematic Literature Review according to [2]	Observations
<ol style="list-style-type: none"> 1. Identifying the Research Question 2. Identifying Relevant Studies 3. Study Selection 4. Charting the Data 5. Summarizing, Collating, and Reporting the Results 	<ol style="list-style-type: none"> 1. Determining the need for a SLR 2. Forming the Research Question/Focus 3. Exclusion & Inclusion Criteria 4. Literature Search 5. Appraising the Studies 6. Synthesizing Evidence 7. Assessing the Heterogeneity of Evidence & Bias 8. Dissemination of Review 	<p>SLRs have three additional steps compared to SRs, which can be attributed to the rigor of SLRs.</p> <p>Identifying the RQ</p> <ul style="list-style-type: none"> ➤ Scoping Review RQs should cover the important points of a topic and keep in mind the ambiguities of certain terms. ➤ Systematic Literature Review RQs should be <i>useful</i>; this RQ can be further refined with the input of shareholders and experts. It should generally consider the Population, Intervention, Comparison, and Outcome (PICO) of the study. <p>Identifying Relevant Studies/Literature Search</p> <ul style="list-style-type: none"> ➤ Both SR and SLR methods include the use of well-constructed search strings, and various physical and

		<p>electronic databases. SLRs advocate for keeping a record of information about where and how the studies were found.</p> <p>Study Selection/Exclusion & Inclusion Criteria/Appraising the Studies</p> <ul style="list-style-type: none"> ➤ In Scoping Reviews, an Exclusion & Inclusion Criteria will be formed at this stage and applied to the literature found. ➤ For Systematic Literature Reviews, this step occurs before the identification of studies. These criteria specify the needs and outcomes of a SLR. ➤ The Inclusion & Exclusion Criteria should be applied to the studies found. Software such as Covidence is an option for expediting the process. <p>Charting the Data/Synthesizing Evidence</p> <ul style="list-style-type: none"> ➤ Both SRs and SLRs recommend tabulating relevant and important information of each study. ➤ Some of this information include setting, participants, findings, summary of study, journal, etc. <p>Summarizing, Collating, and Reporting Results/Synthesizing Evidence/Dissemination of Review</p> <ul style="list-style-type: none"> ➤ Scoping Reviews summarize and state the results of findings. Levac et al. [1] recommend keeping the implications of the findings within the context of the broader context [1, pp.7]. ➤ Systematic Literature Reviews provide several ways of synthesis, including narrative synthesis and best evidence synthesis. SLRs also requires the consideration of bias and heterogeneity.
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Scoping Reviews

Scoping Reviews originated in the early 2000's [5] in the Social Sciences field when Hilary Arksey and Lisa O'Malley published the first methodological framework in their work, "Scoping Studies: Toward a Methodological Framework" [4]. Since then, this framework has been critiqued, modified, and heavily adopted into the health sciences and psychology fields [1], [5], [6]. While there are slightly varying definitions of this type of literature review, the main essence is to capture the "extent, range, and nature of research activity" [4, p. 21]. In other words, the "breadth" of the research topic with varying degrees of depth in its literature.

Arksey and O'Malley's framework [4] outlines six stages in a scoping review (five required, and one optional additional). Which are described more to depth next.

Identifying the Research Question

When beginning a scoping review, it is important to identify the Research Question that will help guide the process. This research question should cover the important facets that may be relevant to the selected topic, such as the population of interest. As such, it is critical to address the ambiguities that may appear, such as different definitions of a term. In my experience, I was aware of the different definitions of the term “marginalization” and made it clear in the study selection process to exclude non-relevant studies that have alternative definitions of this term. At this stage, other parameters may be established when considering research questions and relevant topics.

Levac et al. [1] also suggest that the researcher keep in mind the purpose of the scoping study. Put forth by Arksey & O’Malley [4], there are three main purposes a scoping study may be undertaken: 1) determine the extent, range, and nature of research activity, 2) to assess for the necessity of a systematic literature review, and 3) disseminate the findings of the scoping review [4, p. 21].

As I was interested in learning more about the experiences of Asian engineering students in the United States and understanding the current state of knowledge in describing such experiences in the engineering education context, I found intriguing that the gauging for the need of a SLR was part of the SR process. In the case of Asians and Asian Americans, a group often viewed as the “Model Minority”, and the individual marginalized experiences are more likely to be overlooked as a result, particularly for those of multiple underrepresented Asian ethnic groups [7], it made sense that such steps were needed. As such, my research question was “What has the research shown about the marginalized lived experiences of Asian Americans in engineering?”. The ultimate goal of the literature review was to understand the extent of the research being done on the topic and to identify potential research gaps in the literature.

Identifying Relevant Studies

There are multiple methods for acquiring the relevant studies for the scoping review. I employed an electronic search through digital databases available to me through University Libraries (See Table 2). Other methods for identifying relevant studies include using reference lists, hand-searching key journals, and grey literature such as dissertation proposals and conference proceedings [4].

In many cases, a good place to start with for novice researchers is to use the researcher’s institutional library database. This is also a good time to start constructing and revising search string combinations that will be used to find relevant studies. I highly recommend novice researchers to consult with a librarian at this step to ensure that the search string accurately captures the parameters of the scoping review.

At this stage, it is important to note that *not all* the studies found may be relevant to the purpose of the scoping review, but that process of removing irrelevant studies will be addressed in the Study Selection stage. As such, a scoping review may start with a large number of studies and be reduced to a much smaller value.

For example, I had no prior training with literature reviews and used the search string “Asian American” AND “Marginalization” AND “Engineering Education” in nine electronic databases that resulted in some irrelevant studies, particularly relating to the ambiguity of the term marginalization and “Asian”. Table 2 categorizes the databases by their associated topics based on my institution’s Libraries guide [8]. Table 3 includes the terms used in the search

strings. In some results, engineering projects in Asia appeared rather than papers focused on the experiences of Asian Americans in Engineering Education because of the use of the term “Asian” and a misinterpretation of the term “marginalization” due to the various definitions of the term. Table 4 shows the summary of criteria outcomes based on paper relevance to the literature review.

Table 2: Database Topics and Names

Topic	Database Name
Engineering Databases	Compendex (Engineering Index)
	Web of Science
	IEEE Xplore
Education Databases	ERIC
	Educational Source
	Academic Source Complete
Educational Psychology Databases	APA PsycARTICLES
	APA PsycINFO
	Psychology and Behavioral Sciences Collection

Table 3: Search Strings Employed

Search String Number	Search String
1	“Asian American” AND “Marginalization” AND “Engineering”
2	“Asian American” AND “Marginalization” AND “Engineering Education”

Table 4: Search Results and Selection

Total Results	Removing Duplicates	Title and Abstract Screening	Applying Selection Criteria
165	Duplicates Found: 97	Irrelevant Papers: 55	Irrelevant Papers: 6
	Remaining Papers: 68	Remaining Papers: 13	Identified Papers: 7

The scoping literature review yielded 165 results with the search strings, with a final value of 7 papers being relevant to what I was looking for in my review.

Study Selection

In the previous stage, relevant studies were acquired from various sources (Table 2). Not all of these studies will be pertinent to the parameters of the scoping review, and this is where the creation of an Inclusion/Exclusion criteria becomes crucial. Some literature that was excluded from my scoping review process included studies that took place in “non-United States settings” and studies that were “engineering projects” (such as advances in engine technology) as I was concerned with the lived experiences of Asian engineering students in the US during their engineering education journey in higher education contexts.

Both Arksey & O’Malley [4] and Levac et al. [1] recommend the use of two (or more) reviewers during this process. The reviewers will conduct their own process of removing the irrelevant studies from the scoping review and compare their results. This will ensure that the studies selected for the review are a good fit and limit any bias that may arise. This was a limitation in my own scoping review since I was unable to work in a team, and not able to incorporate this process in my work.

In my own scoping review, I used the following Inclusion and Exclusion Criteria, illustrated by Table 4:

Table 4: Inclusion and Exclusion Criteria

Include	Exclude
<ul style="list-style-type: none"> • Asian/Asian American populations • USA Setting • Engineering majors • All levels of post-secondary education and beyond • University/College • Industry • Academia • Justice, Equity, Diversity and Inclusion (JEDI) Context for “marginalization” • Engineering Education • Lived Experiences in Engineering Spaces 	<ul style="list-style-type: none"> • Non-Asian populations • International Settings • Non-engineering majors • K-12 education • Other contexts for the term “marginalization” • Margin • Engineering Projects • Institutional-Specific studies

Charting the Data

After the process of applying the Inclusion/Exclusion criteria is completed, it is critical to record the relevant information regarding these studies. Arksey & O’Malley [4] recommend recording the following: Author(s), year of publication, study location, Intervention Type and comparison, duration of intervention, Study Population(s), Aims of the study, Methodology, Outcome measures, and Important results. Note that many of these parameters are more relevant towards health sciences and psychology fields, such as “Intervention Type” and “Outcome measures”. This will be further discussed in the later sections. In my experience, I found it helpful to record the following information from each study: Author information, Database in which it was found, Methods used, and Year of publication.

The study population was not recorded in this particular scoping review as the results were all of the same population (Asian engineering students in the USA), and it would have been redundant. This population included students of both domestic and international backgrounds attending college in the United States and of all engineering backgrounds. While this redundancy appeared for this particular scoping review, I still strongly recommend recording the Study Population in scoping reviews where this may not be the case.

Collating, Summarizing and Reporting the Results

At this stage, the findings from the previous stages can be presented. However, Arksey & O’Malley [4] do not present much detail on how to proceed with this step. They are clear, however, that this step should not be simply “synthesizing” the results as the scoping review does not assess the quality of the studies. Fortunately, Levac, et al. [1] provided three distinct steps to take at this stage: Analyzing the data, Reporting Results and Applying meaning to the results. They recommend that descriptive and thematic analysis be undertaken in order to provide a summary of results.

In the case of Arksey & O’Malley [4], they took a narrative analysis approach, but from my perspective, it seems that this step is relatively flexible and should fit within *the purpose* of the scoping review. In my experience, this step was the most difficult to approach when reading the Arksey & O’Malley description. In order to get an idea of how to begin this stage, I reviewed other Scoping Review papers, particularly the guide presented by Levac et al. [1]. I engaged in a narrative synthesis of the papers in order to understand the themes emerging from the selected review papers. Some of the findings that this review yielded include the importance of

undertaking more extensive research into the marginalized lived experiences of Asian engineering students, particularly for Asian women and underrepresented Asian ethnic groups.

Systematic Literature Reviews

Similar to Scoping Reviews, a Systematic Literature Review (SLR) involves a rigorous process of formulating a Research Question, acquiring relevant literature/studies, assessing the studies, collating the results, and summarizing the findings. Like Scoping Reviews, they are more prevalently used in health sciences and psychology fields. In an article discussing SLRs, it was discussed that they were first used in the 1700's, with the first example of an SLR used in 1753 by James Lind. However, not much of it was used until the 20th century in order to "improve the state of evidence synthesis" [9].

There are various types of SLR frameworks, a commonly used one being the PICO Framework [2], [3], [10]. This framework breaks down the SLR Research Question into four main components: Population, Intervention, Comparison, and Outcome. This is most useful for clinical and other health related questions, especially for drug testing. It is less relevant for Engineering Education, as oftentimes there are no "Interventions" or expected "Outcomes". This is not to say that these categories are completely irrelevant, as certain papers may highlight interventions such as Class Modifications and outcomes such as Enhancing Retention. Other frameworks include Sample, Phenomenon of Interest, Design, Evaluation and Research Type (SPIDER), Population, Concept, and Context (PCC), and Setting, Perspective, Intervention, Comparison, Evaluation (SPICE) [11]. In my experience, all these different frameworks can become confusing, and determining which framework to use may be difficult to narrow down. In my experience, I found that focusing on the purpose of my literature review helped me realize that I should be conducting a scoping review instead of a systematic literature review. This is because I wanted to determine the scope of research being conducted rather than assessing the literature in the research topic.

One of the main differences between the two literature reviews is the rigor of SLRs. In addition to finding and selecting relevant papers, SLRs are also used to appraise the quality of the literature that was selected in the process. There may be a large number of literature published on the topic of interest, but it is important to address that not all literature is good literature, or all studies published (particularly gray literature) are done well. This case was highlighted in Smela et al.'s discussion of COVID-19 SLR publishing spikes, but upon further analysis, the study they referenced [12] found that nearly 62% was of "critically low quality" using A Measurement Tool To Assess Systematic Reviews (AMSTR-2) [3]. For this reason, properly conducted SLRs are often more time consuming, require a larger team, and more funding. In other words, Scoping Reviews consider the "breadth" of available information on a topic, whereas Systematic Literature Reviews consider the "depth" of the studies. In my experience, research tools such as Covidence can help expedite the process by automatically removing duplicates from search results, streamlining the literature review process, and allow for interrater reliability by allowing multiple researchers to collaborate and conduct their own literature screening on the project.

I had originally planned to conduct a systematic literature review but switched over to conducting a scoping review upon reflecting on the purposes of my review. Since I was interested in finding out about the scope of the research being conducted on the lived experiences of Asian engineering students in the US, I had found that a scoping review was more fitting. Munn et al. [13] identified that researchers may conduct SRs when the goal is to scope a body of

literature. The decision to conduct an SR was also influenced by the limited time, resources, and funding for the project. Since SRs and SLRs still held many similarities, Covidence was still a useful tool in conducting my Scoping Review, and I was able to easily import my references (literature), screen their title and abstracts, and conduct a full text review.

Scoping Reviews and Systematic Literature Reviews in Engineering Education

There is still yet to be an official methodology for Scoping Reviews and Systematic Literature Reviews in Engineering Education. However, there are steps that are being taken to modify the existing methodologies into the field of Engineering Education. One such example is presented by Borrego et al. [10]. They reiterate the importance of conducting SLRs and provide tailored advice towards constructing Research Questions, finding Studies, and Synthesis of a SLR. This is a good place to start for novice researchers who may be unfamiliar with Systematic Literature Reviews, or even as a refresher for experienced researchers. Borrego et al. draws attention to the differences between engineering education and health sciences fields by highlighting the inherent interdisciplinary nature of engineering education and how this will affect the inclusion criteria and analysis [10, p. 49]. For engineering education, that may mean that a scoping review may need to be conducted prior to a full systematic literature review in order to understand the scope of the literature in a chosen discipline.

Many of the existing frameworks and methodologies available are not tailored to Engineering Education, and it is oftentimes up to the researcher to determine what to include in the process. In my experience, I had trouble identifying literature for a SLR as it had a variety of methodologies to choose from and switched to a Scoping Review method. I also found that it was difficult to narrow down the Research Question to balance between being “broad” and “specific” enough to cover the possible literature that will be selected. In using Scoping Reviews, I was able to achieve my main goals of understanding the “breadth” of the literature surrounding my research topic, which helped me identify research gaps and novel research findings.

In addition to using a scoping review method, I also engaged in using Covidence, a popular Systematic Review tool. Covidence helps streamline the review process by automatically removing duplicates from all the imported literature searches, saving the researcher considerable time from doing the task manually. This tool also allowed me to conduct Title and Abstract Screening, where I was able to remove irrelevant texts based on the abstract content and cite the exclusion (e.g., Engineering Project). After this step, the remaining texts go through the Full Text Review, where I read them fully and exclude texts that were irrelevant from the review. Covidence also allows the researcher to “Extract” this Systematic Review by mapping the process.

With consultation with the University librarian who provides insightful guidance with conducting SR and SLRs, I learned about the available SLR software and discussed possible AI tools for conducting SLRs. At this time, I do not currently have an AI recommendation for conducting systematic literature reviews or scoping reviews. While AI is a useful tool, I would discourage the use of AI in the process of literature reviews and caution novice researchers against using AI tools. This is due to concerns about the accuracy of the results, and if novice researchers did use these tools, it is recommended that they double-check the results. However, checking the results may end up taking longer than necessary, and novice researchers lose a valuable opportunity to learn and engage in conducting scoping reviews and systematic literature reviews.

Conclusions

Scoping Reviews and Systematic Literature Reviews are both useful research tools in evaluating the existing evidence for a research topic. Scoping Reviews are often shorter and can provide insight into the existing studies related to a topic, possible research gaps, and the need for a Systematic Literature Review. Similarly, Systematic Literature Reviews can provide valuable insight into the research topic and the literature surrounding it. SLRs also evaluate and appraise the selected literature for quality. Oftentimes, SLRs are longer and require a larger team and additional funding and time.

For novice researchers, I recommend that Scoping Reviews are used to start the literature review process. During this process, the novice researcher can determine whether or not a more detailed Systematic Literature Review is necessary. Scoping Reviews are helpful for determining “what’s out there”, and this may be helpful for topics that may not be as extensively researched. It is helpful in identifying research gaps, which can inform projects such as a research proposal or dissertation topic. In scoping reviews, the research questions can be broader, and scoping reviews can prove to be a productive learning exercise to get into the practice of conducting literature reviews before moving onto larger SLR studies. It is also a good choice due to the lower time and monetary cost associated with the review.

Recommendations:

Novice researchers may find the following recommendations helpful:

- Engage in discussions with your university librarian or equivalent expert in literature reviews on resources for conducting scoping reviews based on your level of understanding of the topic and available resources.
- Work in teams of two or more researchers to ensure reliability and limiting biases that may appear.
- Use available research tools such as Covidence to streamline the literature review process and save time.
- Consult published scoping reviews and systematic literature reviews in the topic area of interest to learn from other researchers’ work!
- Document the learning experience for reflection for future research and reference. This can help guide future literature reviews and provide an opportunity for you to address areas of improvement from your initial literature review.

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