Open Science Practices in Early Childhood Special Education: A Systematic Review and Conceptual Replication

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Abstract

Open science practices have expanded to many fields in the natural and social sciences, though it is unclear the extent to which they have permeated early childhood special education research, particularly when looking across the range of methodologies (e.g., quantitative, qualitative, mixed methods). Before making suggestions on what researchers in this field should be doing, one must first understand what practices are currently being used and what potential barriers or supports there might be to use. To this end, we will systematically review empirical research (qualitative, mixed methods, and quantitative) in the early childhood special education literature. We will code each study for the inclusion of open science practices (e.g., preregistration; shared material, data, code; open access). We will then calculate descriptive statistics to explore the implementation rates of open science practices, including the most used practices and differences across study characteristics (e.g., journal, year) and methodologies (quantitative, qualitative, and mixed methods). We will also compare implementation rates of open science practices to a previous study on K-12 special education to begin to understand potential differences across specialization areas in education. This systematic review is a first step in identifying potential determinants for broader implementation of open science practices across a range of research and specialty areas.

Keywords: open science, early childhood special education, Part C services, infants and toddlers, preschool, education, implementation science

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Rationale

Open science practices have been identified as one way to propel all scientific fields, including education, toward more rigorous and transparent research (Nosek et al., 2015). Indeed, educational research has been affected by issues with replication, access to data and findings, and overall research quality (e.g., Adelson et al., 2019; Cook et al., 2018; Makel et al., 2021; van Dijk et al., 2020). The majority of popular open science practices, including pre-registration, registered reports, open data and code, have largely been developed with quantitative, lab-based researchers in mind (Hagger, 2019; Lyon, 2016; Powers & Hampton, 2018). These practices do not always align with the values of educational researchers, and particularly early education and disability-focused researchers, who often work with qualitative data or data gathered in applied settings. For example, popular open science practices include efforts to prevent selectively finding and publishing statistically significant results (e.g., Head et al., 2015), a scenario which does not apply to qualitative projects because qualitative researchers sample purposively and think about transparency, rigor, validity, and reliability differently. We are aware of conversations around open science with quantitative methods in education (e.g., Mayo-Wilson et al., 2022), but less is known about what researchers are doing in terms of open science for qualitative and mixed methods research in the field. In addition, little is known about the differences in open science practice used across varied specialization areas within educational research. Therefore, it is critical to begin examining the practices in-depth across all the methodologies.

This gap in the research and practical application of recommended open science practices has led to an increase in scholarly discourse on open science practices that might apply across methodologies (quantitative, qualitative, mixed methods), but it has also led to conversations about the ethical implications of open science practices for a range of populations (e.g., Haven & Van Grootel, 2019; Johnson & Cook, 2019; Makel et al., 2021; Sakaluk, 2021; Steltenpohl et al., 2021). Studies that examine potential barriers to the use of open science practices have also emerged (e.g., participant perceptions of open data sharing in qualitative research). For example, a study by Kirlova and Karcher (2017) examined the willingness of qualitative research participants to allow sharing of their data in a repository. The majority of participants noted that they were willing to have their data shared, including those with highly sensitive data related to abortion. Participants' reasons included wanting to contribute to more open scientific practices, helping others, and improving outcomes (Kirlova & Kartcher, 2017). This research ultimately begins to dispel longtime arguments that participants in qualitative research would not allow data sharing. Although many concerns related to qualitative data sharing remain, such as the potential for reidentification if protections are not in place, research scholarly literature and even governmental support for integrating open science practices across all methodologies has continued to grow. For example, in January of 2023, a multitude of United States Government agencies joined together to declare 2023 the Year of Open Science (The White House. 2023 January). In addition, key international leaders have also focused heavily on improving the use of open science practices by clarifying the definition of open science and also providing large scale plans for improving implementation and broader scale use of open practices (e.g., UNESCO, 2021). However, open science practices remain underutilized (e.g., Cook et al., 2023; Makel et al., 2021). This study can help identify supports and barriers related to the implementation of open science practices across the range of methodologies. This understanding will lay the foundation for future research and identification of supports necessary for scaling up open science practices.

Theoretical Reasoning

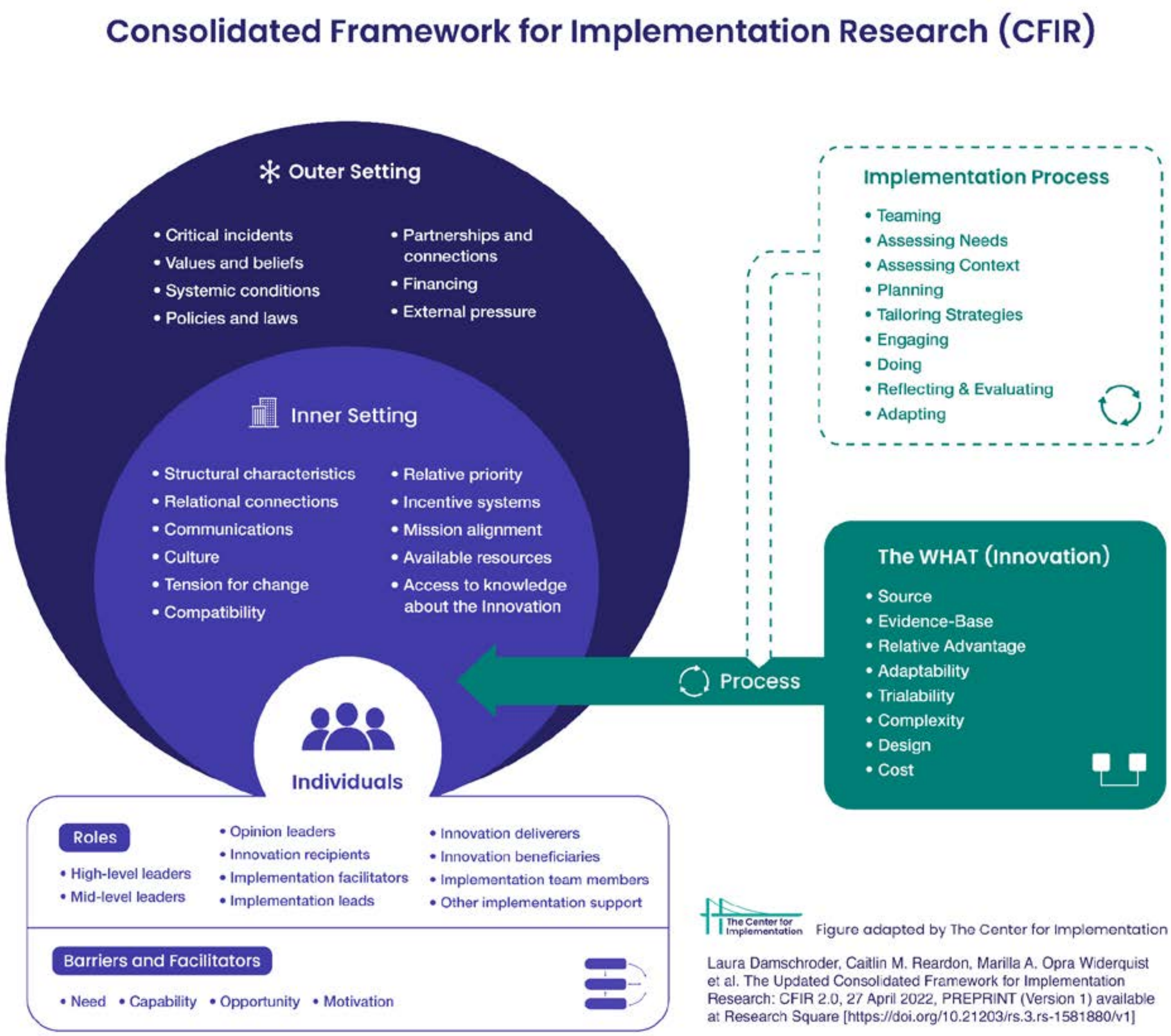
Research in implementation science demonstrates that merely knowing an evidence-based practice holds the potential for positive impact is often not enough to foster change (Cook & Odom, 2013; Morris et al., 2011). In fact, it takes an average of 17 years for interventions or evidence-based practices identified through research to be implemented in real world settings (Morris et al., 2011) and fewer than 50% of those interventions ever make it to full scale use (Balas & Boren, 2000). Therefore, making evidence-based practices clear and actionable to promote uptake is arguably as important as the practices themselves.

Open science is, unfortunately, a sterling example of how detached research recommendations can be from implementation practices. Despite scholarly articles focused on the importance of and need for open science practices in research (e.g., Cook et al., 2023; Makel et al., 2021; Nosek, 2015), increasingly, leaders throughout the world are still looking for ways to effectively promote the large scale uptake and consistent use of open science practices (e.g., The White House, 2023 January; UNESCO, 2021). Ideological mismatches, structural barriers (e.g., institutional support) and personal hesitations (e.g., time, knowledge, theoretical or methodological training, supports) are just a few of the human factors hindering practice implementation (e.g., Allen & Mehler, 2019). The Transparency and Openness Promotion (TOP) Guidelines for journals and editors were an attempt to defy these logistical and attitudinal barriers and promote the use of open practices. These guidelines facilitate transparency and open science practices in scientific publications and journals, aiming specifically to “align scientific ideals with practices” (Center for Open Science, n.d., subtitle). Hence, examining usage rates of open science practices, as well as the barriers and supports for the uptake through an implementation science framework, is a natural and necessary lens for advancing understanding and future recommendations.

Implementation Science

Implementation science is the study of strategies and methods to (a) promote the use of research findings in practice and (b) improve the adoption of those evidence-based practices in real world settings (Eccles & Mittman, 2006). Specifically, studies in implementation science examine the uptake (i.e., implementation) of evidence-based practices rather than the impact or effect of the practices themselves. A foundational step in improving implementation is to identify the potential determinants - barriers and supports - for the intervention (e.g., Damschroder et al., 2022; Khan, 2021). This includes understanding how current practices are implemented across contexts, settings, and individuals (Dawson-McClure et al., 2017). Frameworks have been developed to assist researchers in thinking systematically about the potential barriers and supports related to the implementation of a recommended practice, such as open science practices in research. For example, the Consolidated Framework for Implementation Research (CFIR; Damschroder et al., 2022) examines five aspects foundational to the scale-up and adoption of what they term the *innovation* (i.e., the intervention or evidence-based practice). For the purposes of this study, the innovation is open science practices and the real world setting for the use of these practices is early childhood special education research.

Figure 1. Consolidated Framework for Implementation Research 2.0 (Damschroder et al., 2021 - figure adaptation for The Center for Implementation, 2022)



Note. Used with permission from the Center for Implementation.

The five domains of the CFIR include (1) the *innovation domain* that focuses on aspects of the practice itself that may impact implementation success, (2) the *individuals domain* that examines roles and characteristics of individuals (e.g., individual beliefs, knowledge or evidence-based practice, self-efficacy) that may impact the success of implementation, (3) the *inner setting domain* which examines the organizational contexts in which the intervention is implemented, (4) the *outer setting domain* that examines the broader contexts that may impact the practices of the inner setting (e.g., country or locale), and (5) the *implementation process domain* that focuses on the processes used to implement the innovation. When considering these domains relevant to open science practices (i.e., the innovation), and early childhood special education research (i.e., the real world setting in which we aim to see uptake of the open science practices), it quickly becomes evident that there could be a range of barriers and supports related to uptake. The CFIR is helpful for thinking systematically about what the barriers and supports for uptake might be across the five domains. For example, when considering the *individuals domain* of the CFIR relevant to open science practices in early childhood special education research, it would be helpful to understand characteristics related to the researchers and authors of the scholarly publications (e.g., their field of study, methodological expertise). Or when considering the *implementation process domain* of the CFIR, it would be helpful to understand if processes put into place to help implement the open science practices (e.g., TOP guidelines) may be impacting uptake. For example, is a description of and recommendation for open science practices in a journal's author guidelines related to the increased use of open science practices in published research articles?

Moving Forward

The first step in advancing the conversation about the implementation and scaling of open science practices in educational research is to examine what researchers are currently doing (i.e., implementation rates) and how those implementation rates are aligned with key open science practices, such as data citation, data transparency, analytical code transparency, materials transparency, reporting guidelines use/design and analysis transparency, study preregistration, analysis plan preregistration, and replication (Fecher & Frisike, 2013; Society for the Improvement of Psychological Science, n.d.). Knowing what is already happening in the field may be among the best ways to avoid what Seymour Sarason (1997) termed "predictable problems" (p. 176). In addition, we must begin to understand the potential determinants, supports and barriers, across critical areas that may impact the uptake of open science practices, including the five domains of the CFIR. To that end, the purpose of this study is to explore the implementation rates and determinants of open science practices in published research on early childhood special education.

We hone in on the subfield of early childhood special education (ECSE) for this review due to (a) the high level of interest in the ECSE population given many recent funding and policy initiatives to scale-up services, (b) the inherent need for a range of research methodologies including quantitative, qualitative, and mixed methods research in ECSE due to the specialized needs and diverse settings of infants, toddlers, and preschoolers with disabilities and their families, and (c) the ethical need to provide increased access to research, information, and evidence-based interventions for educators, children, and their families due to the chronic underfunding of supports in ECSE compared to other disciplines in education and beyond.

Early Childhood Special Education (ECSE)

Increases in funding and legislation for scaling up early childhood education have emerged in recent years across a range of countries. For example, in the U. S., many states have increased funding for preschool and home visiting services, and there has been increased federal support for early childhood initiatives (Jessen-Howard, 2019). In fact, the most recent federal budget proposal for fiscal year 2023 includes funding increases for both the Individuals with Disabilities Education Act Part C home visiting services, as well as Part B preschool services that support infants, toddlers, and young children with disabilities (U. S. Department of Education, 2022). In addition, the World Health Organization's declaration that early developmental supports are an essential human right has increased attention to and support for high quality early education (World Health Organization, 2020). This increased attention to and funding for these initiatives is largely due to the widely reported positive impacts of early education and early intervention, particularly when there may be a disability or delay in development. Although inconsistent across settings, much of the research cites a significant cost-to-benefit payoff of at least $2-$4 for every dollar invested in high quality early childhood programs due to lifelong outcomes in health, education, and post-school attainment metrics such as maintaining a job or obtaining a secondary degree (e.g., Bartik, 2015; Magnuson & Duncon, 2016). Specifically, young children who receive specialized services through early intervention home visits or early childhood special education are over 40% less likely to need special education in kindergarten and beyond (Hebbeler et al., 2007).

Yet, despite the importance of early interventions and education, wages and rates of ECSE education access, quality, and employee-retention remain low compared to K-12 education in the U. S. (e.g., Garcia & Weiss, 2019; McDonald et al., 2018; Whitebrook et al., 2014) and throughout the world (e.g., OECD, 2018). In addition, despite long standing legislative support for early childhood education in some countries (e.g., Australia, UK, New Zeeland, Quebec), access and quality issues remain due to varied funding structures and oversight issues (White & Friendly, 2012). This arguably leads to an even greater need for resources, research, and data to be openly available, not only from an ethical standpoint, but also to maximize access to research in these underfunded and complex environments for policymakers and practitioners. Without access to research and data to identify what works, for whom, and under what conditions, vulnerable populations are potentially missing the benefit of effective interventions, strategies, and learning innovations. Hence, understanding whether open science practices are being used to improve access to and quality of information and research, becomes critically important for early educational practice and research.

Objectives

We have two main objectives in this study (1) to identify implementation rates of key open science practices in educational research within the specific subfield of early childhood special education, and (2) to examine potential determinants, including supports and barriers, critical to the scale-up of evidence-based practices according to the Consolidated Framework for Implementation Research (CFIR; Damschroder et al., 2022). To achieve these aims we will systematically review the existing literature by replicating and building on the methods of a prior study by Cook et al. (2023). This research studied the implementation of open science practices across the broader context of special education research. The replication will not only provide a rigorous study design, but will also allow for comparisons across the studies and populations. This depth of understanding across research domains and methodologies will be a foundational step in developing systems that support behavioral change related to the use of open science practices. For this study, we define *key open science practices* as the eight practices promoted in the Transparency and Openness Promotion (TOP) guidelines, including data citation, data transparency, analytical code transparency, materials transparency, reporting guidelines use/design and analysis transparency, study preregistration, analysis plan preregistration, and replication. We also add a ninth practice that stems from qualitative research but holds immense potential to benefit all types of research, researcher reflexivity. Specifically, we will code whether or not the authors (a) included a positionality or reflexivity statement, and (b) whether that statement includes a reflexive acknowledgement (e.g., a description of the relationship of their positionality to possible impacts on the study). We argue this is another measure of transparency that has value across all methodologies (e.g., Sacks, 2015; Steltenpohl et al., 2023). We acknowledge there are few researchers outside of qualitative research currently including reflexivity (e.g., positionality statements). However, recommendations in the literature have advocated for the use of these statements across all research methodologies, including quantitative (Jamieson et al., 2022).

Objective #1: Implementation Rates

1. What are the implementation rates of the nine key open science practices reported in early childhood special education research from the publication of the TOP Guidelines in January 2015 through December 2022?
    a. Percentage of articles that fall into each of these categories:
        i. 0 key open science practices reported (no usage)
        ii. 1-3 key open science practices reported (low usage)
        iii. 4-6 key open science practices reported (moderate usage)
        iv. 7-9 key open science practices reported (high usage)
2. What is the scope of key open science practices reported in early childhood special education research as measured by the total type and frequency of key open science practices reported?
    a. Which of the key open science practices are represented in the articles?
    b. What is the frequency of use of each of the key open science practices as measured by the percentage of articles that report the use of each of the nine key open science practices? (Cook et al. [2023]; Table 1).

   c. What are the most and least common key open science practices reported in the articles?
   d. How has the frequency of these practices changed over time (i.e., increased, decreased, or stayed stable)?
3. Are the most and least commonly reported open science practices between the two fields of specialization (i.e., early childhood special education and special education broadly in Cook et al., 2023), the same or different? (See Table 1).

Objective #2: Determinants Critical to Uptake Using the Consolidated Framework for Implementation Research (CFIR)

4. ***Individual Characteristics Domain***. Are the implementation rates and the scope of key open science practices predicted by the researcher's methodological expertise (i.e., qualitative, quantitative, or mixed methods study)?
5. ***Inner Setting Domain.*** Are the implementation rates and the scope of key open science practices predicted by the journal characteristics (i.e., impact factor; Cook et al., 2023)?
6. ***Outer Setting Domain.*** (a) Are the implementation rates and the scope of key open science practices predicted by country (i.e., country of the lead author reported on the article author contact information)?
7. ***Implementation Process Domain.*** What are the implementation rates of TOP Guidelines in the journals reported in the review?
   a. What percentage of journals in this review name and/or describe the key open science practices as a *recommendation* in their author guidelines? (0, 1, 2, 3, 4, 5, 6, 7, 8. 9 practices)
   b. What percentage of journals in this review name and/or describe the key open science practices as a *recommendation* in their author guidelines?
      i. 0 key open science practices described in the author submission guidelines (no usage)
      ii. 1-3 key open science practices described in the author submission guidelines (low)
      iii. 4-6 key open science practices described in the author submission guidelines (moderate)
      iv. 7-9 key open science practices described in the author submission guidelines (high)
   c. What percentage of journals in this review name and/or describe the key open science practices as a *requirement* in their author guidelines? (0, 1, 2, 3, 4, 5, 6, 7, 8. 9 practices required)
   d. What percentage of journals in this review name and/or describe the key open science practices as a *requirement* in their author guidelines?
      i. 0 key open science practices described in the author submission guidelines
      ii. 1-3 key open science practices described in the author submission guidelines

iii. 4-6 key open science practices described in the author submission guidelines
iv. 5-6 key open science practices described in the author submission guidelines
v. 7-9 key open science practices described in the author submission guidelines

e. What percentage of the journals in this review reference the TOP Guidelines specifically on their author submission guidelines page?

Table 1

Open science practices reported in Cook et al. (2023)

Open science practice	**Percentage of articles**
Conflict of interest statements	66%
Funding statements	64%
Open access	23%
Open materials	21%
Open data	7%
Replications	4%
Registered Reports	0%
Open peer review	0%

In line with our desire to broaden the discussion about open science practices in education research, we will also create emergent codes to capture and describe other ways in which ECSE researchers engage in transparent research. For example, a researcher may disclose their research ethics approval process or engage in thick description. Our registered report, data, and coding information will be available on Open Science Framework https://osf.io/q2cfr/?view_only=8769eb6449e243a2a3561c2f9036a4aa (***Note - we will provide the repository citation and remove this de-identified link upon acceptance*). Using the code *additional transparency practices*, we will describe other practices not captured by the nine key open science practices that may meet similar goals of transparency and openness, particularly in qualitative research.

Method

To examine the landscape of open science practices in early childhood special education, this systematic review will follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Page et al., 2021) guidelines. Specifically, we will use an *a priori* scoping review methodology (Levac et al., 2010) and the associated PRISMA for scoping reviews guidelines (i.e., PRISMA-ScR; Tricco et al., 2018) since the Cochrane Systematic Review procedures for questions exploring intervention implementation recommend this type of review (Noyes et al., 2022). Reporting will follow the guidelines and checklist for PRISMA-ScR (Tricco et al., 2018). The coding methods will replicate the Cook et al. (2023) review of open science practices and expanded to include additional codes that also capture qualitative and mixed methods practices along with traditional quantitative practices. We will also draw on reviews of open science practices in psychology (Hardwicke et al., 2022) and social science broadly (Hardwicke et al., 2020) in establishing and refining our coding and search criteria.

Protocol and Registration

All study information, including the registered report, coding frames, code book definitions, R statistical programming code, and other study related information will be available on the Open Science Framework (OSF) website. We have started a repository at https://osf.io/q2cfr/?view_only=8769eb6449e243a2a3561c2f9036a4aa. We will add the registered report number to this manuscript and repository upon acceptance.

Data Archiving

All manuscripts identified in the search will be archived in a private repository due to publishing and article access restrictions. However, a detailed bibliography that includes linked digital object identifiers (DOI)s will be included along with all search procedures, codebook descriptions, and coding procedures on OSF as part of our repository. If we are able to identify a process to openly share the repository of reviewed articles that is in alignment with publisher allowances, we will make the data (i.e., articles in this systematic review) publicly available.

Search Procedures

To draft the registered report, we did an initial search to determine whether our proposed methods would work with the literature available. We have not screened or read any articles identified as a result of these searches nor have we begun any kind of categorization. Our initial searches were only to ensure we captured key ECSE journals in our searches (e.g., *International Journal of Early Childhood Special Education, Journal of Early Intervention, Journal of Child and Family Studies, Topics in Early Childhood Special Education*). We will conduct all searches and begin screening, examining, and coding individual articles once the protocol is approved.

Search Criteria

The initial search for literature will begin with empirical research (qualitative, mixed methods, and quantitative research, including single case research designs) in early childhood special education (i.e., early intervention, birth to three home visiting services for infants and toddlers with disabilities, and early childhood special education preschool related services). The scope is limited to English-language published articles due to language of the research team and recent research noting little difference between outcomes of systematic reviews when limited to English compared to including non-English research, given the offsets of time, feasibility, and accuracy (Nussbaumar-Streit et al., 2020). In addition, this will also allow us to best compare with the study upon which this replication is based (Cook et al., 2023) since it also limited the screening criteria to English-language published articles. We will search for articles published from January 2015 to the present to provide a baseline for open science practices. We selected a start date just before the publication of the Open Science Collaboration (2015) and the Nosek et al. (2015) article in *Science,* as these are critical change points in the discourse due to the concrete supports these publications provided for implementing open science practices in research.

Search Terms

We will search the terms "early childhood special education" OR "ECSE" OR "Part C" within abstracts and the full text. ECSE is the acronym commonly used for Early Childhood Special Education and Part C is a common term for the Individuals with Disabilities Education Act - Part C Regulations in 34 CFR Part 303 that focuses on birth to age three home visiting supports and services for infants and toddlers with or at risk of disabilities in the United States (see Table 2). To export bibliography information from each database, we will use online software (e.g., Rayyan.ai) for the screening process. We will scan bibliographic information for duplicates. The actual review and categorization of articles will only commence once the approval process is complete for the registered report. We will not restrict our searches by country.

Eligibility Criteria

To meet inclusion, articles should:

1. Be focused on the population of early childhood special education (birth to kindergarten, infants, toddlers, or young children with disabilities receiving specialized educational services). This includes studies focused on child, parent, practitioners or systems as long as the study includes services, supports, or related services in early childhood special education.
2. Be empirical, including qualitative (e.g., case study, phenomenology), mixed (combining both quantitative and qualitative data collection and analyses), and quantitative methods (including single case designs). We will include studies that examine secondary data, systematic reviews, meta-analyses, research briefs, errata, and corrigenda (corrections of production errors or author errors).
3. Be written in English.
4. Be published in a peer-reviewed journal.

Exclusion criteria will include:

1. Research Posters
2. Abstracts
3. Lists of reviewers
4. Editor's notes and previews
5. Non-empirical articles
6. Literature reviews not clearly identified as empirical

Information Sources

The electronic databases to be searched within this review are: Web of Science, Educational Resources Information Center (ERIC), APA PsychINFO, and CINAHL. These databases were chosen to optimally capture population-specific research in early childhood that spans both education and health domains due to the early development and disability focus, as well as potential differences across countries and states. Each search will be limited to empirical, peer-reviewed journal articles.

Table 2

Keyword Search Strategy - Planned Terms and Databases

Database	Key terms	Other Criteria	Returns
Web of Science	ALL=("EARLY CHILDHOOD SPECIAL EDUCATION" OR "ECSC" OR "PART C") AND WC=(Education & Educational Research OR Education, Scientific Disciplines OR Education, Special OR Psychology, Educational)	All Fields; Article	TBD
ERIC	"EARLY CHILDHOOD SPECIAL EDUCATION" OR "ECSE" OR "Part C"	Anywhere; Peer reviewed; Scholarly Articles; subjects: Early intervention, early childhood education, special education	TBD
APA PsycINFO	"EARLY CHILDHOOD SPECIAL EDUCATION" OR "ECSE" OR "Part C"	Anywhere; Academic Journals, Subject: Major heading: early intervention, special educations, early childhood development	TBD
CINAHL Complete	"EARLY CHILDHOOD SPECIAL EDUCATION" OR "ECSE" OR "Part C"	Academic Journals; Subject: Major heading: Early childhood intervention, “education, special”, early intervention	TBD
		Total	TBD

Selection of Sources of Evidence

We will follow PRISMA-ScR Guidelines for screening and selecting articles to include in the review (see Figure 1).

Initial Identification and Screening Procedures

After the searches are conducted (see Table 2) duplicate articles will be removed and numbers recorded and reported in the PRISMA Flow Diagram (see Figure 1). We will use artificial intelligence (AI) software to assist with removing duplicates and abstract and title screening (e.g., Rayyan.ai or similar). AI software or machine learning algorithms can provide accuracy and expediency in the initial screening process of large-scale systematic reviews. However, the highest levels of accuracy are achieved when there is also human oversight (e.g., Blaizot et al., 2022), hence we will also include human review. Once duplicates are removed, the title and abstract of each article will be scanned for the inclusion criteria. We will use Rayyan.ai and a research team member in the abstract screening process, resulting in the dual screening of all abstracts and titles. Specifically, in addition to Rayyan.ai's abstract screening capabilities, two to four research team members (pending the number of articles) will equally divide up all the titles and abstracts for screening, ultimately creating dual abstract and title screening, with Rayann.ai screening 100% and human research team screeners also screening 100% of the titles and abstracts. In the case of inconsistencies between the human screener and the AI, the discrepancy will be solved through negotiated agreement between the human research team members until consensus is obtained. In the case of continued disagreement, a research team member with expertise in early childhood will be consulted to make the final decision.

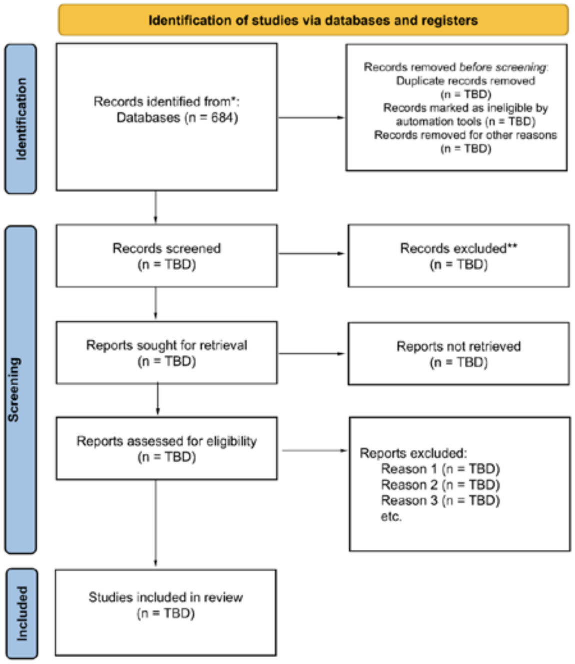
Assessing Full Articles for Eligibility

Next, the researchers from the phase one inclusion process will divide up and independently screen the full-text articles for inclusion (totaling 100% of the articles being screened independently). The articles will be screened by a second trained human screener resulting in all of the articles being dual screened. Once the full articles have been dual screened by human research team members, the two researchers who screened each article will meet to discuss any discrepancies in inclusion or exclusion recommendations until consensus is reached. Again, in the case that disagreement remains after discussion, another research team member with expertise in early childhood will be consulted to settle the discrepancy. The numbers of articles excluded along with reasons for exclusion will all be recorded and reported in Figure 1.

We plan to include all articles resulting from these procedures unless the final number of articles is over 300. We will then follow the methods of Cook et al. (2023) who used a random selection of 250 articles due to funding and team capacity. Random selection would still theoretically allow us to gain insights on practices in the field while also balancing the depth of information to be coded. In replicating Cook et al. (2023), we will also use a package in R statistical programming language to identify a random sample of 250 articles if random selection is needed (e.g., blockrand or RandomizeR).

Figure 1

PRISMA Flow Diagram - Data Charting Process



Note. Adapted from Page et al., 2021.

Data Charting Process and Coding Procedures

To code each of the included articles, we will adapt a protocol based on previous reviews of the use of open science practices in special education research (Cook et al., 2023). The coding protocol of Cook et al. (2023) documented whether authors used open practices by having a preprint, preregistration, or registered report of the study; included data in a repository or archive; included aspects of their methodology or reviewer comments openly (e.g., code, protocols, resources); disclosed limitations and conflicts of interest; or published the article in an open access format. We will also add a ninth open science practice to our coding scheme, positionality/reflexivity statements, which have historically been used in qualitative research. Additionally, we will add codes for each journal's use of TOP Guidelines. Specifically, we will document whether the journals in this review name and/or describe the key open science practices as either a *recommendation* or *requirement* in their author guidelines and if so, which open science practices. We will also code whether the journals specifically reference the TOP guidelines. All practices will be clearly defined in the codebook (see codebooks for definitions; Stegenga, 2023) All coders will be trained on inclusion and exclusion criteria for the articles as well as the codebook and definitions of the key open science practices. Before coding any of the articles, the research team members on the coding team will train by collectively coding five articles and then independently coding five articles to increase the reliability of coding and data extraction and ensure at least a Cohen's Kappa of .8 (strong agreement; McHugh, 2012) or higher for interrater reliability on all coding before moving on to full coding of all articles. If there are inconsistencies across raters during this initial training and reliability check, we will revise the codebook definitions for clarity (Belur et al., 2021; O'Connor & Joffe, 2020). Next, at least four coders, members of this research team and graduate students, will divide up and code the articles for the open science practices. All coders will independently answer questions via the data extraction instrument using an electronic spreadsheet (e.g., Google Form or similar) and providing specific text elements as evidence. Although dual coding is not required, except for the initial phases of systematic review (article screening, full article review, inclusion) per the Cochrane best practices in systematic reviews (Higgins et al., 2022) and PRISMA- ScR (Page et al., 2021; Tricco et al., 2018), we plan to do a final inter-coder reliability check in addition to the initial training check in an effort to increase coding transparency and the trustworthiness of the findings. Therefore, after coding the assigned articles independently, the research team members will randomly code 10% of the articles again, but with new coders to calculate agree and disagree statistics (e.g., Cohen's Kappa).

Since there is much discrepancy in the literature and little procedural guidance related to intercoder procedures for the data extraction phase of systematic reviews, we plan to use general guidance for best practices in qualitative analysis for similar data types (e.g. content analysis coding frames, strict criteria, predetermined codes). When calculating inter-coder reliability within these types of coding frames it is typically recommended that 10-25% of the articles be dual coded in order to balance time and feasibility (O'Connor & Joffee, 2020). Due to the size of the anticipated data set, we plan to dual code 10% of the articles in this phase and report final kappa statistics. Any discrepancies in this phase will be resolved through consensus discussion and if consensus is not reached a third researcher trained in the coding process will resolve the dispute. All data from the spreadsheet will be collected and analyzed in R or other statistical software (e.g., Rayyan.ai) for the kappa statistic.

Data Items

Using Cook and colleagues' (2023) codebook as a foundation, we will replicate all codes and add two additional codes related to (a) transparency, including positionality or reflexivity statements and (b) consent procedures that discuss the disclosure of future data re-use and storage. Please see our OSF repository for the proposed codebook and descriptions (https://osf.io/q2cfr/?view_only=8769eb6449e243a2a3561c2f9036a4aa).

Trustworthiness

Multiple measures will be taken to increase the trustworthiness of the findings. To ensure the rigor of the processes, all article screeners and content coders will be trained and intercoder reliability (Cohen's Kappa) will be calculated at training and during the coding of each article (Belur et al., 2021). To create transparency and improve the potential for replication, training protocols, code book definitions, and coding procedures will be available. The article search strategy, data extraction spreadsheet, codebook, and bibliography of the full corpus of articles will be publicly available on the OSF website following the publication of the paper. In addition, a private repository of the full corpus of articles will be maintained by the researchers due to copyright of the articles but will be available upon permission.

Researcher Description (Positionality)

We are a group of early career researchers and assistant professors from the United States. All of us use English at a professional level. We use mixed methods and qualitative methods to conduct research primarily within educational psychology, but also applied, community, and social psychology; occupational therapy; public policy; healthcare; early childhood special education, and other related fields. We have varied experience with open science practices. Some of us are newer to this space and consider ourselves learners, while others have been involved with the open science community for almost seven years and consider ourselves fairly knowledgeable about most mainstream open science practices (e.g., Chin et al., 2021; Lakens et al., 2018; Makel et al., 2022; Moshontz et al., 2018; Renbarger et al., 2021; Steltenpohl et al., 2021; Standiford Reyes et al., 2018; Terry et al., 2023). We also have varied experiences with qualitative and mixed methods research (e.g., Ezzani et al., 2021; Lustick, 2021; McAuliff et al., 2014; Meyer et al., 2023; Meyer & Rinn, 2022; Renbarger & Ridgley, 2021; Rosenberg et al., 2022; ; Stegenga et al., 2021; Steltenpohl et al., 2018; Steltenpohl et al., 2019). Some of us have been learning about qualitative research since our undergraduate or early graduate careers and others have made the move toward mixed methods research more recently.

A few of us grew up in lower income environments and/or have engaged with community-based work, which has influenced our perceptions around resource allocation within the open science community; namely, that we need to provide more support (e.g., time, money, etc.) for researchers and community members to learn about and engage with open science practices. People in positions of power can control narratives in policy, research, and practice. As such, we all agree it is important for a wider range of voices to be heard and integrated when it comes to setting community standards for transparency, rigor, and impact (Steltenpohl et al., 2023). To us, open science is a means to provide information to various audiences (researchers, funders, the general public, etc.) about our research practices to help readers make informed judgments about the trustworthiness, including transferability, credibility, confirmability, and dependability. Importantly, our conceptualization of open science also revolves around *who* participates in the research process. Ideally, open science should make the research process more understandable for the general public and allow people from a wide range of backgrounds, epistemologies, and experiences to meaningfully participate in the co-creation of knowledge. Open science also has the potential to provide researchers with opportunities to self-reflect on their role within the research process and think deeply and critically about how their perspectives, potential biases, and experiences may strengthen or weaken their research findings.

Our vision of open educational psychology is a community where researchers can engage in such self-reflection and not be intimidated by errors or gaps in knowledge. Researchers in this ideal world engage in open science practices (e.g., positionality; sharing materials, data, and code; open access publishing) that fit within their research paradigms and collaborate across disciplines and cultures when possible. Open science practitioners should be continually re-examining practices and recommendations for open practices to weigh any potential benefits and harms in a continually evolving world and strive for inclusivity around methodologies, cultures, and frames of reference.

These positionalities motivated each of us to conduct this research, formulate the research questions, and determine how we will code and analyze the results. Given our views on inclusion, this team provided multiple and broad conceptions of what counts as open science practices and will allow any mention of these practices to count. There will be no judgments in terms of good or bad practices to implement, but instead we acknowledge the need for nuanced decisions given the specifics of each study.

Researcher-Participant Relationship

We do not have a relationship with participants due to the nature of the study (i.e. systematic review), nor do we anticipate that we have a relationship with any of the participants of the studies we will review.

Syntheses of Results (Analyses and Interpretive Plan)

Following coding, we will examine the data for missing information and coding errors (e.g., impossible values), convert all yes/no responses to 1/0 responses, and run the analyses. Then we will address each research question through the following analytic procedures.

Objective #1 - Implementation Rates

Research Question #1. To address Research Question #1 on implementation rates, We will examine the percentage of early childhood special education articles reporting use of open science practices and identify the number of articles that report the open science practices divided by the total number of articles in the final data set.

Research Question #2. To address Research Question #2 focused on identifying the scope (i.e., total type and frequency) of key open science practices reported, we will run the frequencies of each of the reported open science practices to identify: (1) *which types* of practices are reported in the articles and (2) *how often* they are reported (total number and percent). Next, these numbers (type, total number) will be compared to the numbers within the Cook et al. (2023) article to determine whether there are differences between the use of the open science practices in early childhood special education compared to overall usage of open science practices identified in special education from the Cook et al. (2023) article. Last, we will graph the data using R statistical programming language (e.g., ggplot2) to examine trends including most and least common practices and any frequency trends over time. Specifically, we will examine the frequencies of open science practices reported by year (both percent of articles reporting open science practices and mean number of practices reported by year). These calculations will allow us to identify whether frequencies increase, decrease, or remain stable from 2015 through 2022. We will report these frequencies numerically and through data visualization to examine changes over time (increase, decrease, maintain).

Research Question #3. To address Research Question #3 focused on examining whether usage rates of particular open practices vary by field (ECSE research compared to special education research in Cook et al. [2023]), we will use descriptive statistics (e.g., frequency) to compare the percentages from questions #1 and #2 to the Cook et al. (2023) findings.

Objective #2 - Determinants Critical to Uptake Using the CFIR

Research Questions #4 (Individual Characteristics), #5 (Inner Setting), and #6 (Outer Setting). To address Research Questions #4, #5, and #6 we will replicate Cook et al. (2023) by running exploratory analyses using a generalized Poisson regression analysis. Specifically, we aim to examine whether differences in the rate of use of open science practices are a function of: (a) methodological design of the study (proxy for the researcher characteristic of methodological expertise), (b) journal impact factor, and (c) country of lead author. We ran an *a priori* power analysis and determined that we would need 139 articles for four variables (i.e., open science practice, methodological design of the study, journal impact factor, and the country of the lead author) to maintain .90 power at a .05 alpha level (see R Code for power analysis; (https://osf.io/q2cfr/?view_only=8769eb6449e243a2a3561c2f9036a4aa). If we do not have enough included articles to run all four variables within the same model, we will run each separately in individual regressions. Assumptions for Poisson regression will be assessed (i.e., equal mean and standard deviation of the dependent variable). If assumptions are violated, we will run another type of analysis that is more appropriate and update our registered protocol (e.g., negative binomial; Gardner et al., 1995).

Research Question #7 (Implementation Process). To address Research Question #7, which focuses on implementation rates of TOP Guidelines in the journals, we will identify the number of journals that name or describe key open science practices in their author submissions guidelines as being recommended. We will also break this down into categories of 0 practices (no usage), 1-3 practices (low usage), 4-6 (moderate usage), and 7-9 (high usage) practices discussed in the submission guidelines to identify whether only a few or many practices are recommended. The number identified for each category (i.e., 0, 1-3, 4-6, and 7-9) will then be divided by the total number of journals in the final data set to get percentages for each category. We will use the same process to identify percentages of key open science practices named or described as being required in the author submission guidelines.

Overall, the information garnered from these analyses will be valuable for helping to identify any gaps or disparities in the uptake of open science practices within early childhood special education research. Understanding these gaps in the use of open science practices may help to guide policy, training, outreach, doctoral training, and supports. As we know, with any new innovation or intervention, it often takes 17 years or more to achieve full implementation (Balas & Boren, 2000; Morris et al., 2011), so understanding where gaps in implementation are occurring, such as with open science practices, is critical to addressing issues of use and scale.

Timeline

If the registered report is accepted, the coding team will meet at least bi-weekly to make revisions, if any, to the protocols. Funding was awarded from the Society for Improvement of Psychological Science (SIPS) and will be distributed to a signed doctoral student to assist with coding. The research team will conduct the search and upload the data to OSF within a month of being approved for the registered report. Article screening will occur within two months of approval. The coding of an initial set of articles will also be conducted within two months of acceptance, with any necessary protocol revisions communicated to the *Collabra* team as needed. The full coding of the articles will take place in months two through six. The analysis and write-up of results will take place in months five through eight, pending the completion of coding. The team will complete the second stage manuscript and prepare it for submission in accordance with the journal requirements and deadlines, and revisions will be made according to journal deadlines. All OSF materials will be made publicly available prior to the submission of the second stage manuscript.

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