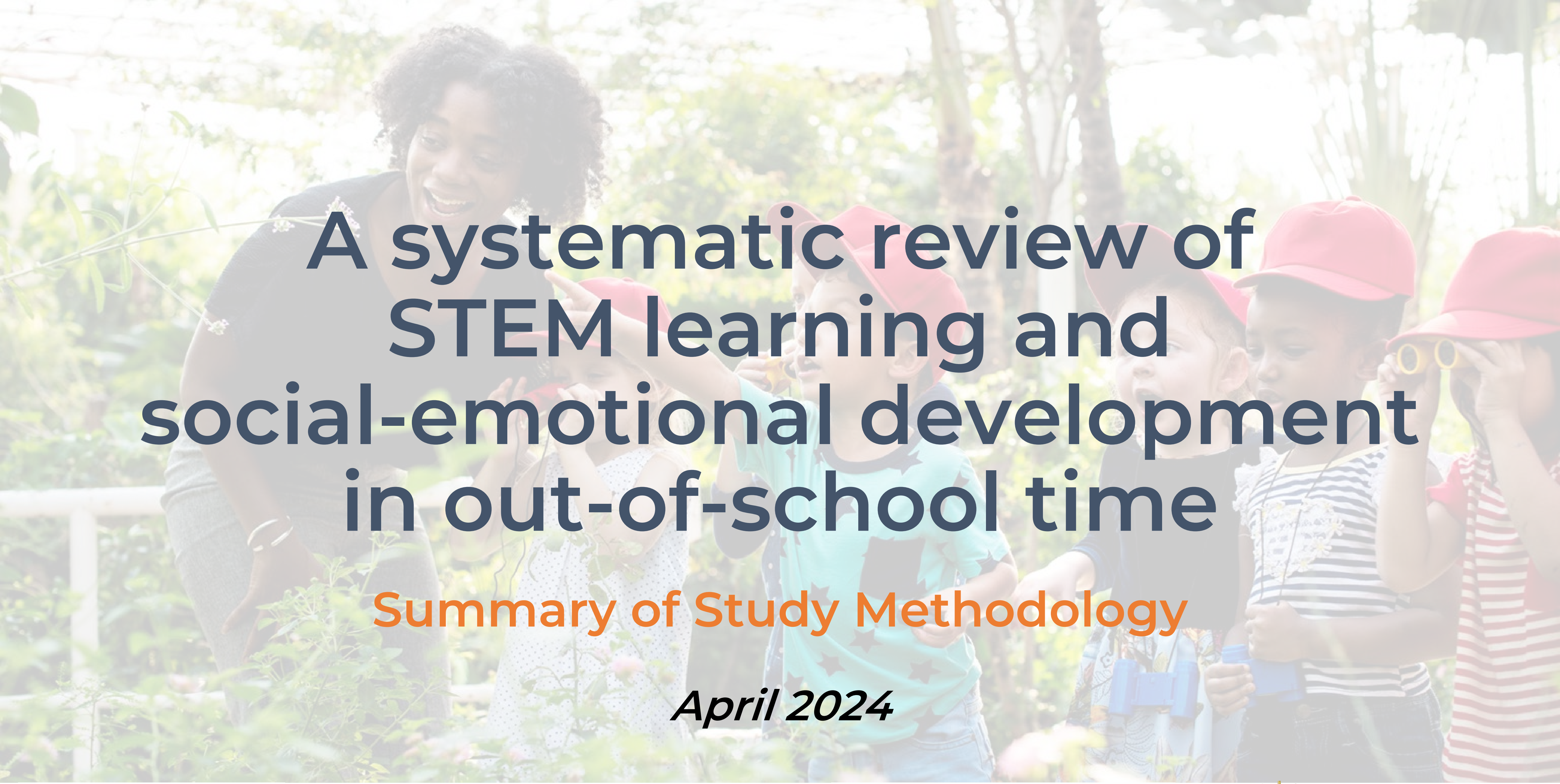


A systematic review of STEM learning and social-emotional development in out-of-school time

Summary of Study Methodology

April 2024

ISRY Institute for the Study of Resilience in Youth

Mass General Brigham McLean

HARVARD MEDICAL SCHOOL AFFILIATE

NSF Award #2115868

This **systematic review** examined **intersections** between the fields of **science, technology, engineering, and mathematics** (STEM) education and **social-emotional development** (SED) in **out-of-school-time** (OST) programs.

We wanted to learn…

Among K-12 youth in **OST STEM programs**,

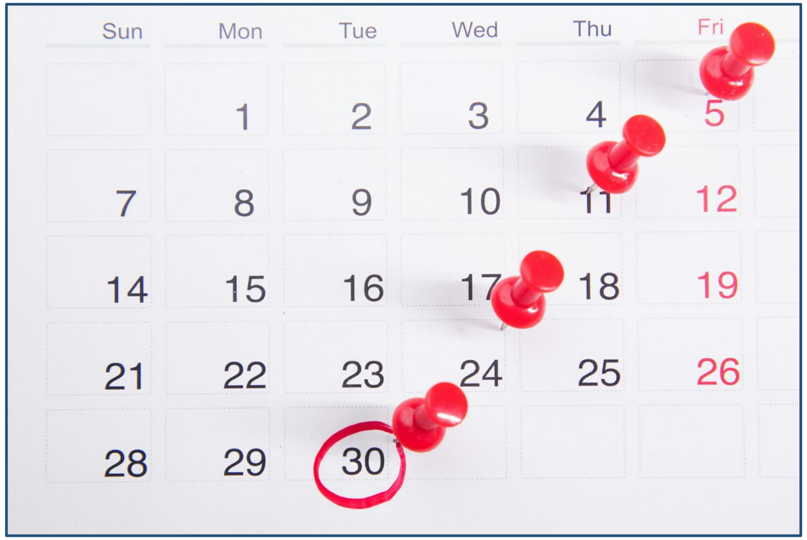
how are skills at the **overlap of STEM and SED**

conceptualized **implemented** **measured** ?

We wanted to learn…

Does the conceptualization, implementation, or measurement of STEM and SED vary

over time



by youth background

by formality of environment

?

Our systematic process

1. Developing a search strategy
2. Conducting a literature search
3. Screening available literature
4. Extracting information from sources
5. Assessing the weight of evidence
6. Synthesizing our findings

1. Developing our search strategy

First, **we made a list of rules*** to help us **find, assess, and synthesize articles** that:

- related to youth 5 to 18 years old
- conducted education in informal/OST STEM learning environments
- reported skills important to both the fields of STEM and SED

*These rules are called *inclusion* and *exclusion criteria.*

1. Developing our search strategy

Criteria	Literature included will involve…
Population	Children ages 5 to 18, or grades K-12, or international equivalent
Settings	All informal/OST STEM education settings: • Informal programming convened inside or outside of the school day, (e.g., gardening clubs, afterschool/summer programs), in settings like school gardens, community centers, science museums, and libraries. • Programming that was facilitated by an adult, centered on STEM activities/lessons, and attended by K-12 youth on a voluntary basis
Topic	STEM <u>and</u> SED discussed together in research, policy, and/or practice: • STEM: words and phrases* associated with one or more of the four disciplines (e.g. chemistry, computer and information sciences, mathematics, physics, engineering) • SED: words or phrases*+ associated with the field of SED (e.g. SEL, SEAD, 21st-century, life skills, employability skills, etc.) *Database thesauri and other relevant taxonomies identified in the course of this work were used to capture related terms +Harvard's Explore SEL thesaurus details 40+ evidence-based frameworks
Subtopics	One of three subtopics used in our synthesis model. Examples include: • Phenomenon, or what the field knows: theories, frameworks, models, classifications • Implementation, or how the field does: curricula/curricular materials, instructions • Assessment, or expectations for change and results: methods, measures, outcomes
Domains/Skills (Outcomes)	One or more concepts and synonyms. Examples include: • Agency : assertiveness, confidence, decision-making, risk-taking, negotiation, self-efficacy, self-empowerment, personal power, resistance • Belonging: caring, citizenship, collaboration, empathy, relationships with peers, sense of community • Engagement: achievement motivation, action orientation, self-management, self-regulation, motivation to mastery, willingness to learn • Reflection: critical thinking, curiosity, identity, optimism, problem-solving, responsibility, self-awareness
Recency	A date range of approximately twenty years (2000 to 2022) was used to represent research, practice, and policy in STEM and SED.
Geography	References from U.S. and international sources. Most international articles contain abstracts in English.
Databases	Empirical and gray literature collected using five databases: PsycINFO via Ovid, Web of Science, Academic Search Premier, Education Source, and ERIC.
Resource Type	Journal articles, books or chapters, technical reports (e.g. evaluation reports), conference papers, policy reports, and program descriptions.
Study Type	Theoretical or literature reviews, experiments (quasi-experimental, randomized controlled trials), observational research (cohort and case-control), cross-sectional studies, validation studies, longitudinal studies, were all covered, in addition to non-study sources.
Transparency	Explicit methodology used in research/evaluation studies (e.g., detailed information including sample sizes, measures, analysis/results).

2. Conducting our literature search

A health sciences **librarian searched 5 databases*** to find **articles – published** between January 1, 2000 through July 8, 2022 – that met our inclusion and exclusion criteria.

*PsycINFO via Ovid, Web of Science, Academic Search Premier, Education Source, and ERIC

2. Conducting our literature search

We found

31,085 articles

that met our inclusion criteria.

3. Screening available literature

We read the **title and abstract** of the **22,961 unique articles*** to determine if they still met our inclusion criteria.

The **title and abstract of 1,858 articles** DID follow our rules. So, we continued **reading the FULL text** of those articles.

* We used the online Covidence platform for screening and extraction. Two people read all abstracts and full-text articles.

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EMPOWERING GIRLS OF COLOR THROUGH AUTHENTIC SCIENCE INTERNSHIPS

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Abstract

The underrepresentation of girls and students of color in STEM fields, particularly in science, is an ongoing issue that is very well documented. There is a limited amount of research that provides insight on experiences of girls, especially girls of color, who have been exposed to authentic science experiences. This article interrogates the effects of experiential learning on students' science identity and interest in pursuing a career in STEM, specifically for girls of color. This study provides insight into girls of color experience of authentic science internships where they followed a traditional working scientist schedule, the use of, or referencing of specific science knowledge, and use of traditional science lab equipment. Through this study researchers found that after participating in the authentic science internship, students became more confident to pursue careers in STEM-related fields and envisioned the field of science and STEM-related fields as approachable and accessible.

Keywords: science internship, girls in science, science education, urban education

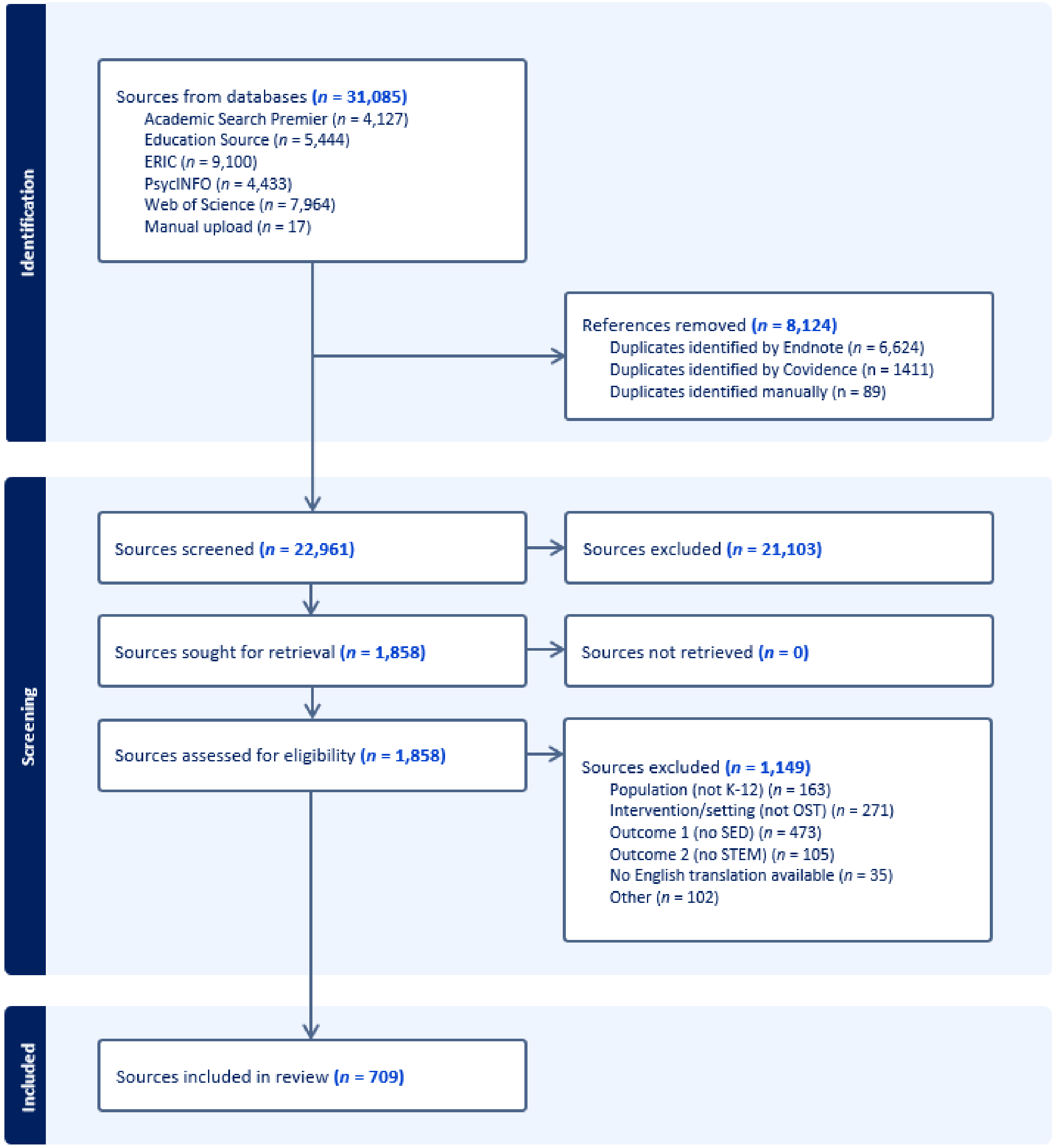
Introduction

Kolb (1984) defines experiential learning as "the process whereby knowledge is created through the transformation of experience." He further argues, "knowledge results from the combination of grasping and transforming experience" (p. 21). In response, this article interrogates the effects of experiential learning on students' science identity and interest in

3. Screening available literature

709 articles met all of our inclusion criteria.

Some reasons for removing articles were because they did not include the right ages of children, were not in OST settings, or didn't have SED or STEM outcomes.



4. Extracting key information

We extracted* evidence from the 709 articles to help us answer our 2 research questions.

*"Extracting" meant reading the articles and copying information about 43 pre-identified variables into an online form.

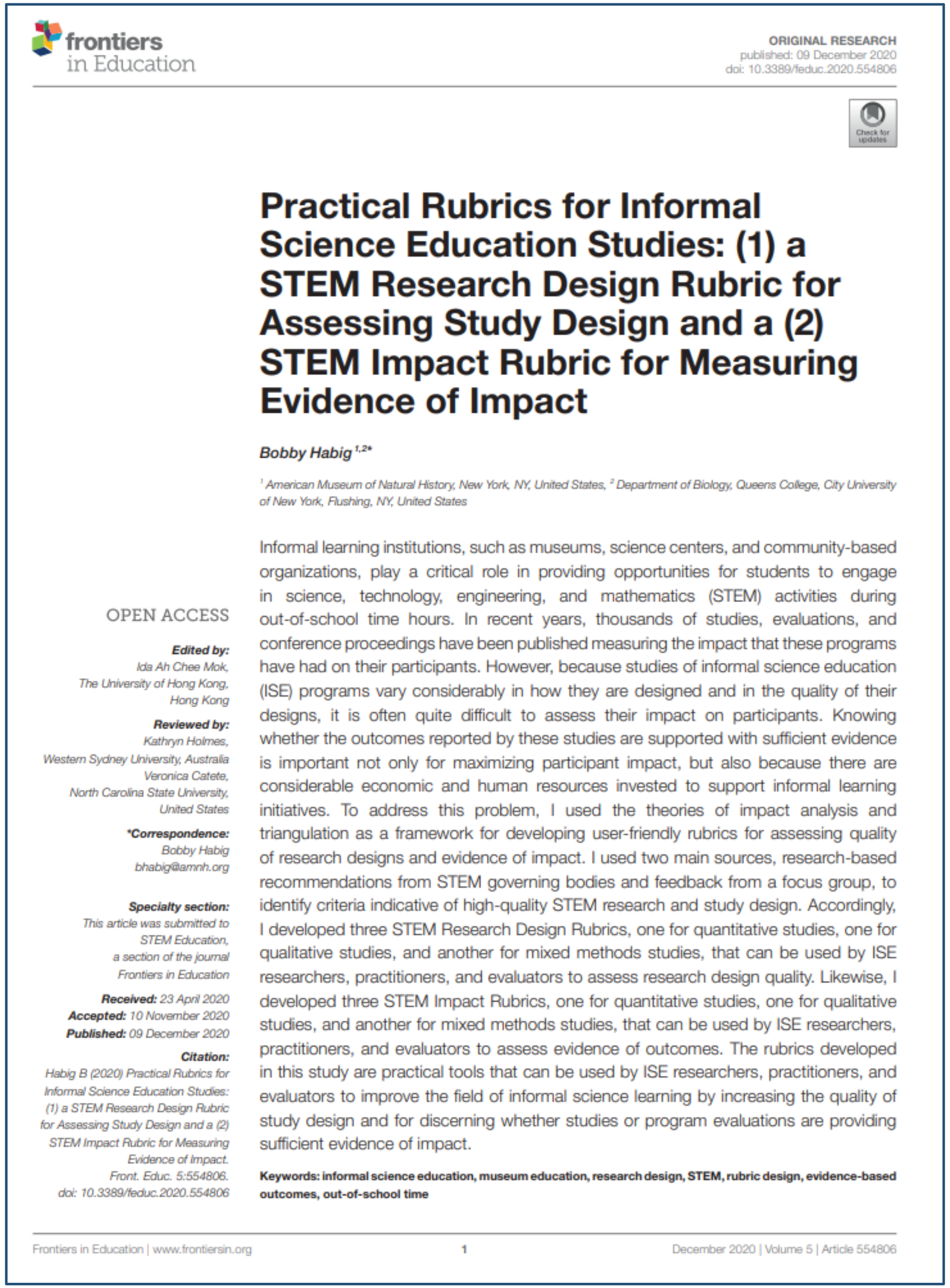
4. Extracting key information

	43 Variables of Interest
Source	Reference (e.g., Author, Title, Publication, Year); Abstract; Publication Type (e.g., book/book chapter, journal article); Source Purpose (e.g., curriculum/handbook, instruction/pedagogy, study); Primary Mission* (i.e., rationale for SED+STEM, thematically coded, e.g., career/workforce development, environmental awareness/protection, relevance/meaning-making); Source Purpose/Guiding Question,
Program & Participant Information	Program Type (e.g., afterschool, summer program, weekend program, etc.), Program Format (e.g., in-person, virtual, hybrid), Program Setting* (e.g., at a business, at a college/university, etc.), Locale* (e.g., rural, suburban, urban, et.), Country, Grade Level(s) Served
STEM Focus	Primary STEM discipline(s) (e.g., science, technology, engineering, mathematics, STEM, STEAM, etc.), STEM Definition (if available)
SED Focus	Primary SED domain(s)/skill(s) (e.g., agency, belonging, critical thinking, decision-making, etc.)
DEIA Focus	Program Representation (i.e., whether program or study intentionally includes youth underrepresented/underserved in STEM, and which groups); Diversity (whether program or study represents diverse groups, regardless of intentionality); Overall DEIA Focus (3-point rating scale, 1 – No acknowledgment of DEIA issues/value [admitted or ignored], 2 – Some acknowledgment of DEIA issues/value [no direct action taken], 3 – A key concern and primary focus [action taken])
Pillar 1: STEM+SED Phenomenon	Theory Supporting Study; Presence/Absence of: Definitions, Frameworks/Models, Logic Model, Summaries of Empirical Studies/Results, Theory or Summary of Theories, Visualizations, or Other (Noted when “knowledge” is directly connected to DEIA)
Pillar 2: STEM+SED Implementation	Practices that Support SED (e.g., family engagement, group or peer-to-peer activities, hands-on experiences, historical or cultural context that addresses DEIA, etc.); Training* (STEM, SED, STEM+SED training, or experienced staff); Note when “practices” are directly connected to DEIA
Pillar 3: STEM+SED Assessment	Type of Data (i.e. Quantitative, Qualitative, Mixed-Methods); Study Design (e.g., ethnographic study, grounded theory study, quasi-experimental study, etc.); Type of Data/Measures (e.g., content knowledge assessment, focus group interviews, student/youth self-report, etc.); Dosage/Duration of Programming/Study; Comparison between OST and School (yes/no); Dependent Variables; Number of Comparison/Control Groups (if applicable); Participant Grade Level (K to 12, may differ from program overall), Study Sample Size, Quantitative Result (i.e., if statistically significant effect within-groups/over time or between-groups/compared to control for any outcomes); Qualitative Result (i.e., key themes supported by evidence)

5. Assessing weight of evidence

We used a **four-point rubric to rate the quality*** (weight of evidence (WoE)) of each article that was considered a **research or evaluation "study"** (qualitative, quantitative or mixed-methods).

*Studies with higher WoE scores provide stronger evidence.


frontiers in Education

ORIGINAL RESEARCH
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Check for updates

Practical Rubrics for Informal Science Education Studies: (1) a STEM Research Design Rubric for Assessing Study Design and a (2) STEM Impact Rubric for Measuring Evidence of Impact

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Informal learning institutions, such as museums, science centers, and community-based organizations, play a critical role in providing opportunities for students to engage in science, technology, engineering, and mathematics (STEM) activities during out-of-school time hours. In recent years, thousands of studies, evaluations, and conference proceedings have been published measuring the impact that these programs have had on their participants. However, because studies of informal science education (ISE) programs vary considerably in how they are designed and in the quality of their designs, it is often quite difficult to assess their impact on participants. Knowing whether the outcomes reported by these studies are supported with sufficient evidence is important not only for maximizing participant impact, but also because there are considerable economic and human resources invested to support informal learning initiatives. To address this problem, I used the theories of impact analysis and triangulation as a framework for developing user-friendly rubrics for assessing quality of research designs and evidence of impact. I used two main sources, research-based recommendations from STEM governing bodies and feedback from a focus group, to identify criteria indicative of high-quality STEM research and study design. Accordingly, I developed three STEM Research Design Rubrics, one for quantitative studies, one for qualitative studies, and another for mixed methods studies, that can be used by ISE researchers, practitioners, and evaluators to assess research design quality. Likewise, I developed three STEM Impact Rubrics, one for quantitative studies, one for qualitative studies, and another for mixed methods studies, that can be used by ISE researchers, practitioners, and evaluators to assess evidence of outcomes. The rubrics developed in this study are practical tools that can be used by ISE researchers, practitioners, and evaluators to improve the field of informal science learning by increasing the quality of study design and for discerning whether studies or program evaluations are providing sufficient evidence of impact.

Keywords: informal science education, museum education, research design, STEM, rubric design, evidence-based outcomes, out-of-school time

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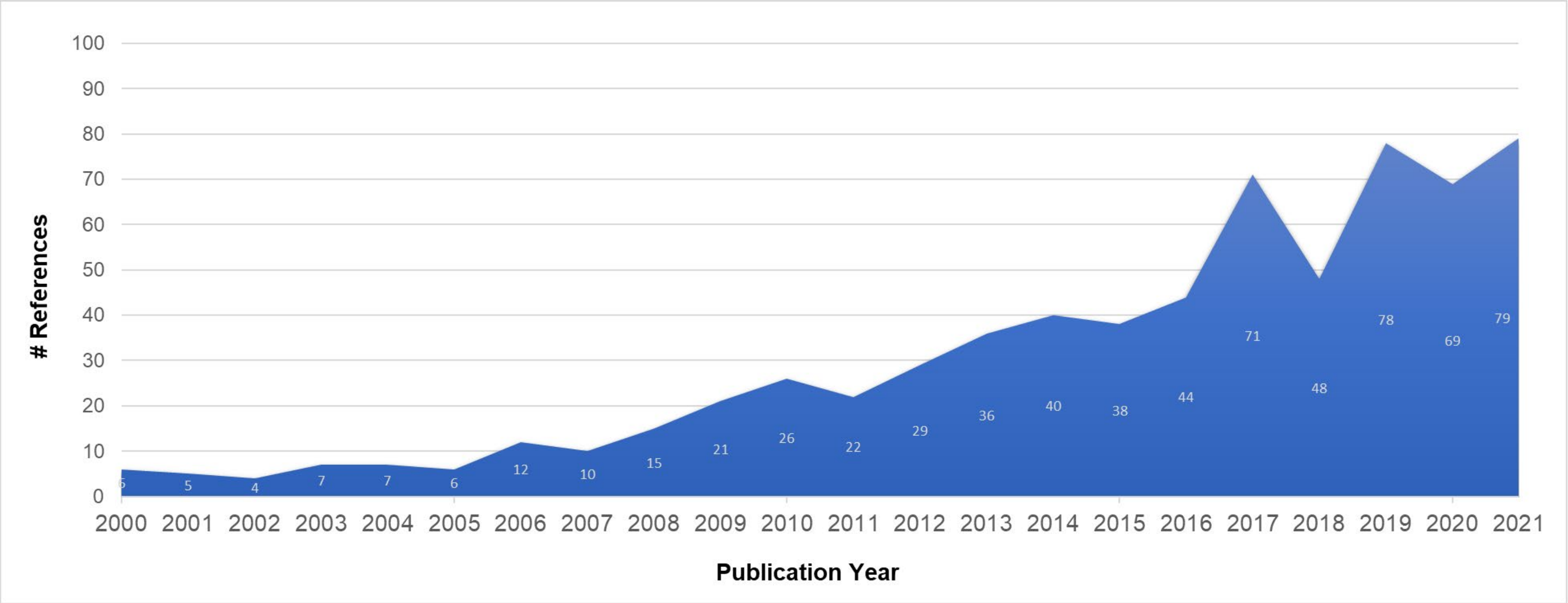
6. Synthesizing our findings

We **combined, integrated, and interpreted the results of multiple references** using the 43 variables extracted from each of the 709 eligible references.

This is an example of our **quantitative data.**

Figure 2. Increasing number of references focusing on STEM+SED in OST over time (2000-2021)



Note. Analysis of trends over time included all years with 12 months of evidence (Jan. 2000 to Dec. 2021).

We found increasing number of sources focusing on STEM+SED in OST over time (2000-2021). Since 2000, the number of sources grew by more than 1000%. Sources represented all grade levels of youth (K-12) and all disciplines within or related to STEM in over 50 countries.

6. Synthesizing our findings (continued)

We also **examined the qualitative data** we extracted.

Domain	Skills Youth Are Developing	Most Common Skills
Agency/Voice *(n = 795 mentions)*	Expressing & Empowering themselves, especially through self-directed (or agentic) actions and self-confidence in learning and achieving learning goals	1. Confidence (25.9%) 2. Self-efficacy (19.6%) 3. Agency (9.9 %)
Belonging/Collaboration *(n = 724 mentions)*	Connecting & Collaborating, especially through social interactions that create emotional bonds and attachments to learning spaces and others	1. Relationships (18.5%) 2. Communication (15.7%) 3. Teamwork (15.3%) 4. Collaboration (13.8%)
Creativity/Resilience *(n = 128 mentions)*	Creating & Adapting, especially through the creation of original ideas, evolution of ideas to fit new scenarios/situations, and the ability to be resourceful	1. Creativity (75.0%) 2. Innovation (8.6%) 3. Resilience/Resiliency (8.6%)
Engagement/Self-Regulation *(n = 383 mentions)*	Acting & Discovering, especially through active participation in learning and managing the drive to participate	1. Motivation (37.1%) 2. Active Engagement (12.3%) 3. Self-regulation/management (9.1%)
Reflection/Understanding *(n = 801 mentions)*	Understanding & Becoming, especially through thoughtful analysis, and an awareness of oneself, one's environment, and the world	1. Problem-solving (27.1%) 2. Identity (21.7%) 3. Critical thinking (12.9%)

We identified evidence for an emerging five-domain framework to help the field navigate the complex and expanding STEM+SED landscape, as well as guide the STEM field in the development of integrated STEM+SED measures, curricula, and activities.

For More Information

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