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Informal Learning in United States Libraries: A Systematic Review

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Abstract

Libraries may serve as a way to bridge educational equity gaps through informal learning programs. This is especially true in the United States where inequality is a growing concern at local, state, and federal levels. While the informal learning literature within the United States highlights innovative practitioner reflections and design cases, few articles have attempted to synthesize empirical trends that outline cognitive and affective learning outcomes. To address this gap, this systematic review explored empirical studies of K-12 informal learning programs within United States libraries. The findings suggest a focus on initiatives within public libraries and STEM learning, especially in urban settings. That said, many studies presented qualitative data and reported on affective learning outcomes, which leads to questions as to the extent of learning gains and replicability. Implications for practice are discussed.

Keywords Informal Learning · Equity · Libraries · Librarians · Systematic Review

Introduction

The field of education has seen an increased emphasis on performance and equity gaps within K-12 learning contexts. For example, the Program for International Student Assessment (PISA) shows that the United States dropped in key metrics relative to other higher-performance countries (Agasisti & Zoido, 2018; Rowley et al., 2019). This is coupled with the growing concern regarding the relationship between societal inequality and educational outcomes, especially in the STEM domain (Thorson & Gearhart, 2018). There have been a number of initiatives enacted to address

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these issues that call for a new emphasis on guiding students in active inquiry and the development of complex problem-solving (National Research Council, 2014; Pruitt, 2014). That said, decades of efforts to raise standards and equity in education have had only a modest impact in classrooms, which is exacerbated by the reduced time that elementary and middle school students spend studying some subjects (Darling-Hammond, 2014). Others highlight affective learning outcomes (e.g. self-efficacy, identity) as another growing concern in education, especially for minority populations (Fernandez et al., 2022; Simpson & Bouhafa, 2020). As such, educational institutions are exploring various standards and strategies to decrease these education gaps.

Along with the emphasis to improve school-based, K-12 instruction, policymakers are focusing on out-of-school contexts to overcome issues of equity (Barker et al., 2014; Roberson, 2015; Sahin et al., 2014). The National Research Council (NRC 2015) argues that after-school learning programs can facilitate inclusivity, create sustained interest for domain topics, and supplement formal educational institutions. Libraries are unique educational institutions because of the diverse roles they provide for their patrons. Academic libraries may serve a supportive role within K-12 formal structures (e.g., embedded librarian), while public libraries are public-facing to learners of all ages. Because libraries are often situated directly within communities, they are able to quickly adapt to the local needs and interests for its patrons

(Houghton et al., 2013; Lin et al., 2015). In doing so, they foster and maintain a sense of community by providing neutral locations that welcome everyone, are non-hierarchical, and focus on informal learning and communication with minimal participant obligation (Aldosemani et al., 2016; Oldenburg, 2001). This is instantiated within libraries via diverse programmatic offerings, including storytime (Cahill et al., 2020), book groups (Norcup, 2017), Makerspaces (Woods & Hsu, 2020), and coding groups (Prato, 2017). While each strategy may differ, many programs afford learners the opportunity to engage in iterative information-seeking, knowledge-building, and some form of active learning approach. The library thus migrates away from an information access portal and towards a setting where individuals can interact with information in meaningful ways. It follows that libraries can play a key role in informal learning and may address the aforementioned challenges of educational inequity.

Although there is considerable discourse as to the potential benefits of libraries, there is very little research that explores the role of libraries in supporting informal learning at the K-12 level within the United States. To date, much of the literature is primarily focused on practitioner voices, higher education, or empirical findings from outside the United States. While these certainly underscore the evolving role of the library and provide insight into specific strategies, it may be difficult to determine empirical trends of libraries as they move towards informal learning opportunities for school-aged children. Based on this gap, we address this issue through a systematic review of the informal learning literature within libraries that target K-12 learners within the United States. First, we present the theoretical basis for the evolving role of the library. Then we present related literature to informal learning approaches, namely around practitioner voices and international studies. Finally, we present the results of a systematic literature review and discuss implications for future research.

Literature Review

United States students' performance and readiness for careers is a perennial and growing concern, both domestically and internationally. For example, the National Assessment of Educational Progress (NAEP) rated only 38% of fourth-graders and 34% of eighth-graders as "proficient" or "advanced" in science. In mathematics, only 40% of fourth-graders and 33% of eighth-graders were rated at or above proficiency (Bandeira de Mello et al., 2015). To address the growing concerns for these learning outcomes, there has been an increased national focus on preparing learners to engage in inquiry-based and problem-solving activities, as evidenced in new national and local academic science standards (National Research Council, 2014). However, related research shows that the time learners spent on tasks has significantly declined

(Darling-Hammond, 2014) which coincides with performance on national tests. These aforementioned educational challenges impact all learners but they especially impact underrepresented learners within underserved communities who have less access to educational opportunities (Malm et al., 2017; P. S. Smith et al., 2016). Indeed, recent findings from PISA (2018) conclude that socioeconomic status was among the strongest predictors in proficiency in some disciplines. If equitable models of education are not addressed, this trend will lead to increased inequality in the United States and decreased global competitiveness.

One way to address these aforementioned challenges is through opportunities that extend beyond the traditional K-12 classroom. The National Research Council (2015) advocates for more holistic approaches, described as 'learning ecosystem', that consist of "*designed settings, such as schools, clubs, museums, and youth programs; naturalistic settings, such as city parks, waterways, and forests and deserts; people and networks of people, such as practicing STEM professionals, educators, enthusiasts, hobbyists, and business leaders who can serve as inspiration and role models; and everyday encounters with STEM, such as on the Internet, on television, on the playground*" (p. 5). This broader view affords a more community-driven approach to informal learning, whereby models such as family, friends, and local experts can be part of the learning experience. As opposed to more formal learning structures, this approach leads to a dynamic interplay of various stakeholders from the surrounding community.

Characteristics of Informal Learning

The formation of third places is one approach to facilitate these holistic educational experiences. Third places are informal, accessible, public locations that provide opportunities for sustained interaction and communication based on the shared interests of attendees (Houghton et al., 2013; Lin et al., 2015). Differentiated from the home and work (or school) environments where members are part of a hierarchical system with defined responsibilities and obligations, third places strive to form neutral environments where all are welcomed and treated equitably (Aldosemani et al., 2016; Oldenburg, 2001). Third places recognize that learning occurs holistically across multiple environments as individuals regularly interact in various settings (Gutiérrez, 2008). Thus, third places do not exclude employers, teachers, administrators, parents, siblings, coworkers, and classmates from participating (Aldosemani et al., 2016; Gutiérrez, 2008). Rather, they focus on leveling experiences where social status and hierarchy are less overt (Oldenburg, 2001). The focus of third places is jovial interaction and communication. Those with similar interests share ideas, interact, explore, and learn together in a non-threatening, physical, or online/virtual setting (Halvorson, 2010; Houghton et al., 2013; Steinkuehler & Williams, 2006).

Learning ecosystems contain various informal learning conditions that are engaging and responsive to the community. First, learning is different because of the educators who direct learning (Casla et al., 2008). As opposed to an in-service teacher, educators may include personnel from the organization (museum, librarians) or local experts. When compared with teachers, the learning component within informal education may be voluntary or a smaller subset of a professional's overall tasks. In addition, learning is non-compulsory, which impacts extrinsic learning factors such as high-stakes, mandatory testing. Hence, these programs "leverage common structural features of out-of-school settings (e.g., hands-on activities, ungraded or unassessed activities, multiage groupings, fluid uses of time) to spark, sustain, and extend young people's interest, developing understanding, and commitment" (National Research Council, 2015, p. 8). Finally, the timing of the learning is different when compared with formal learning systems. Whereas schools have a predetermined schedule that is often mandated by governing bodies, informal learning is designed to be complementary to formal programs and thus occurs during after-school hours or in other formats like summer camps, story times, and so forth (Casla et al., 2008; Russo et al., 2009). These programs often provide some active learning experience facilitated by a librarian or domain expert, typically focused on artifact creation, such as coding a robot or 3D printing (Moorefield-Lang, 2014). The goal is to provide situations that stimulate engagement, fostering individual interest and conceptual knowledge (Ghadiri Khanaposhtani et al., 2018). In doing so, these programs help support learning as they become part of the broader ecosystem that engenders cognitive and affective learning outcomes.

Beyond structure, instructional strategies within informal learning are often different when compared to formal approaches, especially in terms of access and free choice. Formal approaches to K-12 education are often dictated by necessary requirements, such as tuition costs, district goals, or state and federal guidelines. Therefore, they serve an important role that standardizes elements of education and allows the learners a clear pathway to progress. Informal education is often less restrictive in terms of participation, which allows for broader access and participation (Casla et al., 2008). The free-choice component further suggests that learners attend as desired, which relates to the motivational aspects of learning (Russo et al., 2009). Although this potentially introduces challenges in terms of curriculum delivery and iterative knowledge construction, the free-choice aspect of informal learning affords a learning experience whereby individuals can explore goals that are unique to them. As such, informal learning is engaging, responsive to individual needs, and makes connections with an array of different learning groups (National Research Council, 2015, p. 8).

Despite the potential benefits, informal learning is not without criticism. Russo et al. (2009) caution that voluntary, learner-centered, informal learning can introduce erroneous information, requiring additional literacies to navigate (e.g., media, digital, computer). Informal settings may also perpetuate established biases in the surrounding community (Woods, 2018). Related research shows that after-school learning gains have been difficult to maintain over time; therefore, theorists (Sahin et al., 2014; Young et al., 2017) discuss the need for after-school programs to move towards a more equitable design to foster and sustain skill growth and learning.

Why Libraries as Spaces for Informal Learning

Emerging literature describes informal learning programs as having the potential to foster various learning outcomes, thus enriching instruction, increasing understanding, and providing opportunities missed in formal education (such as job skills and use of scientific equipment; Barker et al., 2014). In terms of affective learning, studies show that informal learning programs increase self-concept and empowerment (Fadigan & Hammrich, 2005) and create environments where learners can engage in activities connected to their interests (Gonsalves, 2014). According to the Federal STEM Education Strategic Plan (2018), libraries are uniquely synergistic with after-school programs to build learning ecosystems, especially as libraries adapt their strategies toward the utilization of digital resources. Unlike schools, libraries provide longer hours of operation and welcome all members of the community throughout the day. Libraries also foster a neutral and welcoming environment because they are distanced from hierarchical school structures (Shtivelband et al., 2017). Tawfik et al. (2021) argue that libraries are distinctly suited to be part of the ecosystem for a community given their (a) collaborative learning spaces, (b) portals to open-educational resources and diverse digital materials, and (c) opportunity to develop inquiry skills. In addition to the role of after-school instruction and libraries, the placement strategically positions the library as a source of access within a community. Libraries thus exemplify key aspects of third places and act as 'connected learning hubs' for the community (Houghton et al., 2013; Lin et al., 2015).

Librarians play a critical role in these informal learning hubs given their expertise in information-seeking, especially for curricula that employ inquiry-based learning. Indeed, the library science field has undergone dramatic changes as technology catalyzed a transition towards more digital collection strategies (Glynn & Wu, 2003; Kennan et al., 2014). Beyond the reference desk, Cox and Corrall (2013) contend that the following specialties have emerged within the librarian domain: "systems librarian, electronic resource librarian, digital librarian, institutional repository manager, clinical librarian and informationist, digital curator/research data manager, teaching librarian/information literacy educator, and information and knowledge manager" (p. 1526). These subdomains materialized as educational needs and resource formats changed over

time, which underscores the evolving nature of librarian expertise. In terms of supporting inquiry-based learning in informal learning, library staff are skilled in information-seeking; familiar with the attainment, management, and circulation of various resources; and regularly host learning programs for all ages (Kvenild et al., 2017; Shepherd et al., 2017).

Whereas K-12 research is largely represented through publications from practitioners (e.g. - 'voices from the field', design cases), there is some empirical literature on the libraries role in informal learning within higher education library settings. The benefits of libraries as informal learning spaces include accessible learning spaces (Deng et al., 2019; Yip et al., 2019) and development of digital literacy skills (Miranda et al., 2018). That said, the implementations within higher education are often in the form of Makerspaces, with prominent examples including the Arizona State University Startup Lab, University of Texas - Austin Longhorn Maker Studio, and Carnegie Mellon University Morewood Makerspace. Within these library settings, research shows that Makerspaces have been used to support problem-solving, hands-on model construction, iterative knowledge building, and peer collaboration. In one study, Wong and Partridge (2016) explored the use of Makerspaces on university campuses and found that 12 of 43 Australian universities had Makerspaces. Further analysis from the survey outlined how these spaces helped learners to complete course and personal projects as they collaborated with their peers. Similar survey research by Hynes and Hynes (2018) found that students rated complexity, coherence, mystery, and legibility as important aspects of learning within this informal learning medium. Others describe how Makerspaces bridge the gap between the theory of academic teaching and the demand for practical and applied skills in industry, particularly around STEM skillsets (Pernía-Espinoza et al., 2017). Collectively, the research highlights ways in which libraries continue to evolve toward educational spaces that support informal learning.

Research Questions

The National Research Council (2015) suggests that libraries are ideal for informal learning because they are "institutions defined by their accessibility to knowledge, and as such, they reach a wide and varied public audience" (p. 18). However, the literature has identified various challenges, including administering after-school programming, developing strategic partnerships that support the learning ecosystem, and measuring the long-term impact of these programs (National Research Council, 2015; Tawfik et al., 2021). Others suggest that librarians struggle to administer education with fidelity, in part because of the employed curriculum and lack of infrastructure to support sustainability in informal settings (Bilandzic, 2016; Rhinesmith & Stanton, 2018). When discussing informal learning, Feder and Jolly (2017) noted that these informal programs "are an increasingly important component

of our educational system, but one that has been difficult to measure since it is so diverse" (p. 2). While there are a number of design cases and practitioner showcases, there is a considerable gap regarding the empirical literature and data driven trends around informal learning within library environments. Based on this gap, we propose the following questions:

1. What are the empirical trends identified in US K-12 informal library learning?

   a. *What library types* provide informal learning for K-12 learners in the United States?
   b. *For what populations do libraries* support informal learning for K-12 learners in the United States?
   c. *What informal learning domains and strategies* support K-12 learners in the United States?

Methodology

This systematic review follows the process outlined in the What Works Clearinghouse Procedures and Standards Handbook, Version 4.0 (U.S. Department of Education, 2017). First, researchers met to develop the review protocol. Second, team members independently identified pertinent literature that met the research goals. Next, the research team screened studies and reviewed articles. Finally, the researchers consolidated their findings around relevant themes.

Data Sources and Search Information

Given the intersection of learning and libraries, the following databases were searched using selected keywords ("library and informal learning"): Education Full Text, ERIC, Library Literature & Information Science Full Text (H.W. Wilson), Library Information Science and Technology, Social Sciences Full Text (H.W. Wilson), APA PsycArticles, and APA PsycInfo. The time frame from this search included academic articles from 2000-to 2021, which coincides with the rise of digital resource availability within schools and libraries (Li et al., 2019; Schwartz, 2000).

Inclusion/Exclusion Criteria

The preliminary query returned 342 articles for the timeframe and search term (see Fig. 1). To further narrow our search, academic articles had to include the following foci: K-12 education, empirical study (qualitative, quantitative, mixed methods), academic journal, identified library location in the United States, and described as informal learning. If an article did not meet all of these inclusion criteria, it was excluded from the review.

Selection of Articles

Research team members independently conducted the review process using the outlined databases and terms. After removing duplicate articles from the original 342, 203 articles remained. To further narrow the search, team members independently reviewed the abstracts of the remaining articles to see if they met the inclusion criteria. The abstract review narrowed the list to 31 articles, with many of the excluded articles focused on design cases, practitioner showcases, or editorials. The research team members then reviewed the remaining articles and resolved discrepancies in coding. The final review included 12 articles that met the inclusion criteria.

Review Protocol

The research team, which included two graduate research assistants and the primary investigator, developed the codebook using a shared spreadsheet. The codebook was created based on themes identified by the research team during their review of the 12 articles that met the inclusion criteria. The codebook included three research designs (qualitative, quantitative, and mixed methods), three types of studies (between, within, and correlation), three geographic locations (rural, urban, both), and four timeframes (after-school, during school, summer, and ongoing). Additionally, seven research themes emerged: Measure, Age Group, Research Participant Type (child/librarian), Technology, Educational Strategy, Library Type, and Topic.

Data Coding

The research articles selected for inclusion in the systemic review were independently coded by members of the research team (see Table 1). After the first round of coding, the two graduate research assistants met to discuss and resolve coding discrepancies as to inclusions or exclusion decisions. After this round of review, the research assistants consolidated their

coding with the primary investigator's coding and identified differences among ratings. The research assistants then met with the primary investigator to discuss the discrepancies in the criteria and resolve the differences. The final inter-rater reliability was 100%.

Using Martin et al. (2017) as a guide, the research team coded for specific details following the inclusion/exclusion round. To support interrater reliability, the research team met and discussed how to code the first 15-20 articles. This allowed the research team to better understand the elements, refine the codebooks, and review inclusion/exclusion criteria. After the finalization of the specific codes, each researcher independently analyzed each article. Similar to the inclusion/
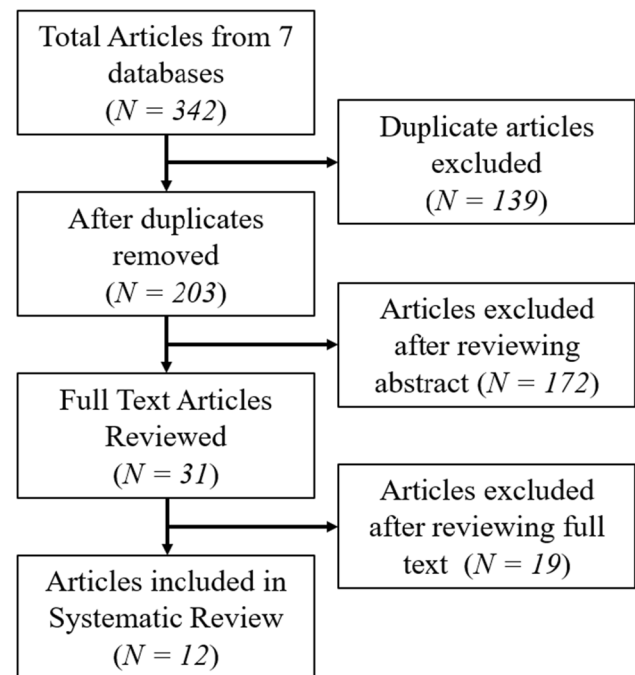

Fig. 1 Flowchart of research selection

Table 1 Inclusion/Exclusion criteria for Informal Learning in Libraries Systematic Review

Criteria	Inclusion	Exclusion
Focus of articles	K-12 informal learning in libraries	Articles that did not focus on K-12 informal learning in libraries
Databases Published	Seven identified databases	Journals that were not found within the seven identified journals
Publication date	2000 to 2021	Articles published before 2000 or after 2021
Publication type	Peer-reviewed scholarly articles	Articles that were not peer-reviewed, book chapters, dissertations
Research Method and Results	Articles identified as qualitative, quantitative, or mixed research	Theory articles, systematic reviews, articles that could not be identified as qualitative, quantitative, or mixed
Language	English	Languages other than English
Location	Within the United States	Outside the United States

exclusion round, the final negotiated agreement was 100% (Table 2).

Results

RQ1.A: What library types provide informal learning for K-12 learners in the United States?

The themes focused on library types were as follows: library type (public, academic) and location (urban, rural, both). In total, 12 empirical studies met the criteria. In terms of setting, 10 studies were focused within public libraries, while an additional 2 were within academic libraries. Within these types, the location primarily focused on urban settings (Hassinger-Das et al., 2020) when compared with rural (Brown & Kasper, 2013; D. L. Smith & TylerWood, 2020). Three studies looked across multiple locations (Layden & Anderson, 2021; Subramaniam et al., 2021; Weintrop et al., 2021). Various regions of the United States were represented, including the Northeast (Hassinger-Das et al., 2020; Yang et al., 2021), South (Hollett, 2016; Hollett & Ehret, 2017; Roberson, 2015), Midwest (Lakind, 2018), and Pacific-Northwest (Tzou et al., 2019) (Table 3).

RQ1.B: For what populations do libraries support informal learning for K-12 learners in the United States?

The systematic literature review explored two measures—stakeholder and age group. The former was skewed towards children (Hassinger-Das et al., 2020; Roberson, 2015; D. L. Smith & TylerWood, 2020; Yang et al., 2021) when compared with librarians (Lakind, 2018; Layden & Anderson, 2021; Subramaniam et al., 2021; Weintrop et al., 2021), with another exploring both (Brown & Kasper, 2013). For children, age groups included: elementary (Brown & Kasper, 2013; Hassinger-Das et al., 2020; Roberson, 2015; Smith & TylerWood, 2020), middle (Brown & Kasper, 2013; Hollett & Ehret, 2017; Weintrop et al., 2021; Yang et al., 2021), and high school (Hollett, 2016; Subramaniam et al., 2021; Tzou et al., 2019; Weintrop et al., 2021). Multiple studies detailed programs that crossed multiple age ranges (Table 4).

RQ1.C: What informal learning domains and strategies support K-12 learners in the United States?

Most learning outcomes focused on STEM (Roberson, 2015; Smith & TylerWood, 2020; Weintrop et al., 2021;

Table 2 Description of Coded Elements for Empirical Studies

Element	Description
Article Information	Full reference that included author information, publication date, article title
Research Design/Data Type	Quantitative, qualitative, and mixed methods
Participant Demographics	Age of participants. For children, this included ages and grade level, when possible
Library type	Academic (situated within a K-12 school) or public (focused on supporting the broader community)
Library setting	Setting consisted of the geographic region, including the Northeast, SouthEast, Pacific Northwest, Midwest. Within these regions, the study coded for urban/suburban and rural locations
Measurement	Codes focused on learning outcomes were subsumed under cognitive and affective learning outcomes. Additional codes included capacity building and participation (e.g.—attendance)
Domain/Topic	Domains and topics codes included the following: STEM, literacy/digital literacy, civic engagement, and art
Technology	Technology that supported learning included the following: Video games, coding, 3D printing, digital media, and assistive technology

Table 3 Frequency and Percentage of Locations of Informal Learning in Libraries

Theme Name	Description	Frequency	Percentage
Library Types			
Public Library	Libraries that are available to the general public	10	83%
Academic Library	Libraries that are situated within existing K-12 schools	2	17%
Location			
Urban/Suburban	Libraries that are situated within metropolitan areas	7	58%
Rural	Libraries that are situated within communities outside metropolitan areas and smaller populations	2	17%
Both	Studies that explore the intervention across multiple library locations	3	25%

Table 4 Frequency and Percentage of Individuals Studied for Informal Learning in Libraries

Theme Name	Description	Frequency	Percentage
Stakeholder			
Children	Intervention is focused on exploring learning outcomes for children ages PK-12	7	58%
Librarian	Intervention is focused on exploring learning outcomes for library staff	4	33%
Both	Intervention provides data related to both children and librarians	1	8%
Children Ages			
Elementary	Intervention is focused on grades PK-5	10	83%
Middle School	Intervention is focused on grades 6–8	9	75%
High School	Intervention is focused on grades 9–12	7	58%

Yang et al., 2021), digital literacy (Brown & Kasper, 2013; Hassinger-Das et al., 2020; Subramaniam et al., 2021), and civic engagement (Hollett, 2016; Hollett & Ehret, 2017). Described measures largely focused on affective learning outcomes (Hollett & Ehret, 2017; Weintrop et al., 2021) when compared with cognitive measures (Brown & Kasper, 2013; D. L. Smith & TylerWood, 2020; Yang et al., 2021). A subset also measured librarian's capacity building (Lakind, 2018; Layden & Anderson, 2021; Subramaniam et al., 2021) and participation metrics (e.g.—attendance) (Hassinger-Das et al., 2020; Roberson, 2015) (Table 5).

The review also examined learning strategies, with a majority of studies employing some form of project-based learning (Hollett, 2016; Roberson, 2015; Smith & TylerWood, 2020; Yang et al., 2021). To support learning, programs used the following technology: video games (Brown & Kasper, 2013; Hollett, 2016; Hollett & Ehret, 2017; Roberson, 2015), coding (Tzou et al., 2019; Weintrop et al., 2021; Yang et al., 2021), 3D printing (D. L. Smith & TylerWood, 2020), digital media (Lakind, 2018), and assistive technology (Layden & Anderson, 2021) (Table 6).

Discussion

Despite the potential of informal learning to address equity issues, the National Research Council (2015) cautions that "research and evaluation findings are not yet robust enough to determine which programs work best for whom and under what circumstances" (p. 9). A systematic approach to understanding the data helps to identify where libraries can best be leveraged, along with gaps that researchers and librarians should address. The results yielded unanticipated results in multiple respects as they relate to libraries. First, it was surprising to see how few empirical results actually met the criteria across the selected databases. A considerable number of library articles described innovative programs (e.g., design case; practitioner voices), but relatively few were data-driven studies that focused on K-12 informal learning outcomes within libraries. That is, few publications presented qualitative or quantitative data that outlined specific findings related to the efficacy of libraries in supporting learning within these contexts. In some respects, the seemingly low number of empirical articles is consistent with other systematic reviews that explore learning within libraries (Omar et al., 2022; Rouse & Rouse, 2022; Spante

Table 5 Focus of Studies for Informal Learning in Libraries

Theme Name	Description	Frequency	Percentage
Topic			
STEM	Intervention is focused on science, technology, engineering, and/or mathematics	5	42%
Literacy/Digital literacy	Intervention is designed to educate learners on ability to locate and evaluate information resources in a digital format	3	25%
Civic Engagement	Intervention is designed towards learners understanding of community building	2	17%
Art	Intervention is designed towards learners using art	1	8%
Assistive Technology	Intervention is designed towards learners and educators using assistive technology	1	8%
Learning Domain			
Cognitive	Learning outcomes are focused on advanced conceptual understanding of domain topic	4	33%
Affective	Learning outcome are focused on the socio-emotional component of learning	7	58%
Capacity building	Outcomes focused on librarians' ability to support library patrons	4	33%
Participation	Outcomes that focused on the degree to which individuals participated in the informal learning intervention	2	17%

Table 6 Technology Used to Support Informal Learning in Libraries

Theme Name	Description	Frequency	Percentage
Technology			
Video games	Intervention uses digital, interactive video games as a way to support the learning process	4	33%
Coding	Intervention uses coding software as the medium to complete the task, often in the STEM domain	3	25%
3D Printing	Technology that supports modeling and production of a physical, 3D artifact	1	8%
Digital media	Technology that allows learners to design and produce two dimensional images/videos	2	17%
Assistive technology	Technology that is designed to support functional capabilities of individuals with self-identified disabilities	1	8%
Not Reported	Technology type was not reported	1	8%

et al., 2018). When compared with academic libraries, data seemed to indicate studies are situated mostly within public library settings and focused on STEM. A more comprehensive understanding of these trends is important for the field to understand the unique role of libraries within the learning ecosystem.

In terms of where learning is happening (RQ1.A), results of the systematic review suggest that empirical studies for K-12 learners are largely focused within public library and urban settings—where density is the largest. This focus may speak to the ability of libraries to support access for a large number of K-12 informal learners within the United States. This finding also elucidates important aspects of the nuances of informal learning in libraries. Whereas K-12 academic libraries serve a supportive role within their school context, the initiatives may be focused on support of teacher-driven curriculum or overarching district initiatives (Cooper & Bray, 2011; Woods & Hsu, 2020). One might conclude the skewness towards public libraries allows for more flexibility in terms of programming options that can be offered and data that can be reported. The public-facing nature of these institutions also suggests it may serve a wider array of learners when compared with schools that have prerequisites on enrollment, which again may be reflected in the larger number of studies within public libraries.

RQ1.B sought to understand for whom learning is focused. The data suggests the focus is more on children than librarians, with many programs spanning multiple age ranges. Indeed, libraries have been discussed as an important aspect of the learning ecosystem because they are situated within the community and are less restrictive when compared with formal learning institutions (Shaby et al., 2021). The results suggest that public libraries meet the mission of supporting a range of learners and are accessible to multiple age groups. That said, it may lead to questions about the degree to which librarians as informal educators are able to meet the needs of learners across multiple stages of cognitive development, especially since the informal nature of learning is less compulsory. When compared with K-12 formal contexts that group learners by

age and allow for a consistent schedule, the informal nature of learning in libraries may make it difficult to engage in iterative knowledge building when attendance may not be consistent and age ranges require informal educators to support a large array of learners.

At the same time, these results might give the research community pause because of the lack of research directed towards librarians. The role of the librarian has changed considerably and now includes titles such as instructional repository manager, digital curator, teaching librarian, and others (Cox & Corrall, 2013). If they are to be key stakeholders of informal learning, the lack of studies focused on librarians suggests the field has a considerable gap in terms of redefining their role, providing professional development, capacity building, and meeting other educator tasks (Vassilakaki & Moniarou-Papaconstantinou, 2015). As discourse around librarian's evolving roles continues, future research should empirically document the supports needed to facilitate informal learning within these settings.

The final research question (RQ1.C) focused on the domains and learning strategies within K-12 informal library learning. The data seemed to be focused on STEM and digital literacy using some form of project-based learning, along with an array of different learning technologies (video games, coding platforms, etc.). It is noteworthy that a majority of studies were qualitative in nature when compared with a quantitative approach. While qualitative studies allow researchers to understand the nuanced approach to the learning phenomenon, they may lead to questions about replicability across contexts. The focus on affective learning outcomes is noteworthy because there have been efforts to not only increase conceptual understanding, but also support learners in terms of identity, self-efficacy, and others. When describing the benefits of informal learning within a library, this may speak to the degree to which this institution is beneficial for the broader profile of the learner. Despite its benefits, the review suggests caution when discussing the extent to which cognitive learning gains can be validated, as

evidenced by the lower number of empirical studies that measure this learning outcome.

Limitations and Future Studies

There may be multiple opportunities to build on the conclusions of this research. For example, a future study could expand the databases employed for this systematic review. Given the focus of libraries on informal learning, the search consisted largely within social science databases, including learning, psychology, and library databases. One might argue that expanding this to others may have yielded additional studies that explicate informal learning within US K-12 libraries. For example, there is considerable interest in alternative ways to support STEM, so it is possible that additional articles may be found in engineering journals or science-focused databases (e.g. - IEEE).

Another follow-up study could explore alternative search criteria. In the context of this systematic review, we were especially focused on studies that described the instructional component within libraries; therefore, the search criteria was somewhat strict to focus on studies that were distinctly described as 'informal learning' in the setting. Other library focused studies might arguably be categorized as supporting informal learning, such as "out-of-school time" or "community science." It is possible a broader search criteria may have found additional studies that highlight how libraries have evolved over the last two decades and empirical trends validating these as informal learning venues. Similarly, an additional follow-up study could also include criteria related to the location. The current study focused on the United States for various reasons, including federal initiatives that call on the broader learning ecosystem to address inequity gaps. However, the search yielded empirical studies from various locations outside the United States. While the community-focused nature of libraries may suggest it is best to limit the region, one might argue that a broader view might further identify library strategies as they support informal learning for diverse populations.

Appendix

Table 7 List of Returned Library as Informal Learning Articles

Authors	Title	Year
Brown, R. T., & Kasper, T	The fusion of literacy and games: A case study in assessing the goals of a library video game program	2013
Hassinger-Das, B., Zosh, J. M., Hansen, N., Talarowski, M., Zmich, K., Golinkoff, R. M., & Hirsh-Pasek, K	Play-and-learn spaces: Leveraging library spaces to promote caregiver and child interaction	2020
Hollett, T	Interests-in-motion in an informal, media-rich learning setting	2016
Hollett, T., & Ehret, C	Civic rhythms in an informal, media-rich learning program	2017
Lakind, A	Public libraries as sites of collision for arts education, the maker movement, and neoliberal agendas in education	2018
Layden, S. J., & Anderson, A	Expanding the educational network for students with autism: Partnering with school librarians	2021
Roberson, T. L	"STEM"-ulating young minds: Creating science-based programming @ your library	2015
Smith, D. L., & TylerWood, T. L	STEM academic achievement and perceptions of family support: a gender analysis	2020
Subramaniam, M., Hoffman, K. M., Davis, K., & Pitt, C	Designing a connected learning toolkit for public library staff serving youth through the design-based implementation research method	2021
Tzou, C., Meixi, Suárez, E., Bell, P., LaBonte, D., Starks, E., & Bang, M	Storywork in STEM-Art: Making, materiality, and robotics within everyday acts of indigenous presence and resurgence	2019
Weintrop, D., Morehouse, S., & Subramaniam, M	Assessing computational thinking in libraries	2021
Yang, H., Codding, D., Mouza, C., & Pollock, L	Broadening participation in computing: Promoting affective and cognitive learning in informal spaces	2021

Declarations

Conflict of Interest There are no potential conflicts of interests. Because no subjects were studies, Institutional Review Board was not necessary. All authors contributed to the study conception and design. All authors read and approved the final manuscript.

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