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**A Critical Perspective on Supporting Parents in Facilitating Informal STEAM Learning on  
Children's Early Literacy Development**

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of  
Philosophy at Virginia Commonwealth University

by

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## Abstract

### A CRITICAL PERSPECTIVE ON SUPPORTING PARENTS IN FACILITATING INFORMAL STEAM LEARNING ON CHILDREN'S EARLY LITERACY DEVELOPMENT

By Suzanne G. Alexandre, Ph.D.

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

Virginia Commonwealth University, 2024.

Major Director: Yaoying Xu, Ph.D., Professor and Program Coordinator, Counseling and Special Education

Considering that parents/caregivers and home environment play an influential role in a child's school readiness and future academic success, this study sought to support parents in using facilitation strategies to engage their child in informal learning at home. In order to examine if access to support for parents of preschoolers influenced parents' confidence in their ability to facilitate informal learning at home, the project used informal STEAM learning, for context. The study also examines the potential impact of informal STEAM learning on children's school readiness and early literacy skills and the intersections of parent involvement, STEAM, and school readiness through the lens of Critical Race Theory. This dissertation uses a three-paper format and includes a systematic literature review, a qualitative study using focus groups, and a mixed methods study using data from focus groups, pre- and post- surveys, and early literacy screenings.

## Vita

Suzanne Gaillard Alexandre was born on May 14, 1974, in Calgary, Alberta, Canada, and is an American citizen. She graduated from Brentwood High School, Brentwood, Tennessee in 1992. She received her Bachelor of Science in Elementary Education from Brigham Young University, Provo, Utah in 1997 and subsequently taught in a public school in Utah for 2 years. She received a Master of Education in Literacy from Virginia Commonwealth University in 2002 and worked as a reading specialist for Roanoke City Schools for 10 years. She received her Doctor of Philosophy in Education in the Curriculum, Culture and Change concentration from Virginia Commonwealth University in 2024.



## **A Critical Perspective on Supporting Parents in Facilitating Informal STEAM Learning on Children's Early Literacy Development**

Children entering kindergarten in the United States public schools are expected to be equipped with a specific set of skills to ensure they are ready for school (Ackerman & Barnett, 2005; Williams et al., 2019). These expectations are not always met considering that preschool in the U. S. is not compulsory and children's early childhood educational experiences are varied and disparate. The expectations for school readiness stress the critical role of parent/caregiver involvement in children's development and learning. This role is important regardless of socioeconomic status (SES) or cultural differences, especially in authentic informal learning environments and in addition to formal schooling. Researchers suggest that parent involvement in learning, both informal and formal, can have a multitude of benefits for children including character building, social emotional development, increased attention span, motivation for learning, and attention to difficult tasks (Thomas et al., 2020; Tippet & Milford, 2017).

### **Research Problem**

There is a significant relationship between parent involvement and school readiness outcomes (Ma et al., 2016; Tazouti & Jarlégan, 2019; Wilder, 2014). It is important to consider that the positive role parents play in their children's learning may not be equitably recognized, especially if parents are from low-income families or families whom our systems marginalize (Moll et al., 1992; Tan et al., 2020; Yosso, 2005; Yosso & Burciaga, 2006). This inequitable gap in recognition should be noted, especially when considering the substantial disparity that exists in school readiness outcomes in the U.S. This dissertation addresses the lack of support and resources for informal learning that parents may face in light of the disparity in school readiness outcomes in children from low socioeconomic families, minoritized groups and/or dual language learners (DLL) as compared to their more affluent, white, English-speaking peers (Hayakawa et

al., 2013; Ladson-Billings, 2022; Nasir & Hand, 2006). Systemic racism and the hidden curriculum of white dominant culture is not often mentioned as a factor of these disparities by educational researchers, and it is imperative that it is called out, as placing the onus for achievement outcomes on families may cause further harm and marginalization (Dumas, 2021; Ladson-Billings, 2021; Milner et al., 2021; Soloranzo, 2021).

Considering that parents/caregivers and home environment play an influential role in a child's future academic success (Gross et al., 2020; Hayakawa et al, 2013; Wilder, 2014; Williams et al., 2019), this project sought to understand if access to support for parents of preschoolers influenced parents' confidence and ability to facilitate informal learning at home. The project used informal STEAM learning, for context, to examine if parent facilitation of informal STEAM learning in the home environment might influence and improve school readiness outcomes, especially as it pertains to early literacy skills.

The foundation for this project is a research study that explored preschool parents' attitudes about STEAM and how parent-supported facilitation in engaging their children in STEAM activities at home might influence the parents' confidence for engaging their children in informal learning. This dissertation adds another layer to the existing educational research by examining the potential impact on children's school readiness and literacy skills and the intersections of parent involvement, STEAM, and school readiness through the lens of Critical Race Theory (CRT).

## **Definitions**

The term *informal learning* in this study refers to opportunities for learning and discovery, both cognitively and socially-emotionally, that occur outside of formal educational practices (Callanan et al., 2011). *School readiness* in this study refers to a set of skills that are

related to a child's ability to meet classroom and school expectations both academically, socially and emotionally (Ackerman & Barnett, 2023). *Early literacy development* includes six skills that a child needs in order to be able to learn to read. These skills include vocabulary, print motivation, print awareness, letter knowledge, phonological awareness and narrative skills (Lonigan and Shanahan, 2009; Snow et al., 1998; Snow 2017). This study focuses primarily on two early literacy skills, vocabulary development and narrative skills. The terms *parent involvement* and *parent engagement* are used interchangeably throughout these papers and, for the purpose of this project, can be defined as how a parent invests resources, such as time and energy, on their child/ren (Grolnick et al., 1997; Gross et al., 2019). *STEAM* is an acronym, more commonly seen as STEM. The STEAM acronym includes science, technology, engineering, and mathematics, with the additions of the arts. *Socioeconomic status* can be thought of as the class or social standing of an individual or of a group of people, and for the purpose of this project refers to a combination of education, occupation and income (American Psychological Association). *Hidden curriculum* refers to the implicit cultural and social norms, messages, rules, expectations, et cetera, of the dominant (in this case, white) culture in which teaching and learning are situated (Giroux & Penna, 1979). These rules and assumptions, although not formally conveyed, pose a "right" way of being in school and may limit academic success for students who do not possess the cultural wealth of the dominant group.

### **Conceptual Framework**

This study is framed through the lens of Critical Race Theory. CRT can be used as a theoretical lens to examine achievement outcomes that are often presented as deficits of marginalized groups in public education (Ladson-Billings & Tate, 1995; Ladson-Billings 2022; Nasir & Hand, 2006; Vossoughi & Gutiérrez, 2016). Two learning theories, sociocultural theory

(SCT) and funds of knowledge theory (FoK), drive this research in fueling the belief that home and family systems can be powerful tools for social and cognitive growth even before a child begins formal schooling. However, when approaching educational outcomes through a critical lens, the existing power structures of white dominance and white cultural norms are centered as foundational for the disparities in educational outcomes.

The expected outcomes of this project are, in the short term, to build self-efficacy for parents facilitating informal learning at home, intermediately, to address gaps in literature connecting informal STEAM, early literacy, and parent involvement, and for the long-term, to create awareness of social structures of oppression and improve school readiness and school success for students whom our systems marginalize.

### **Researcher Positionality**

The researcher is a Canadian-born, American, English-speaking, white, cis-gender woman who recognizes that her social identities impact her cultural awareness and implicit biases. This project is influenced by the researcher's positionality as a reading specialist and her continual efforts to be an anti-racist educator and critical researcher. Her professional experiences in under-resourced public schools have guided her to seek ways to bridge gaps for all children to have access to the essentials that are optimal for academic achievement: family/school partnerships that recognize and honor cultural differences, access to informal learning outside of classroom walls, and plentiful opportunities for early literacy development.

### **Description of the STEAM Experience**

Researchers suggest that STEAM experiences early in life can support executive functioning and cognitive development, both of which are crucial to the development of school readiness skills (Chesloff, 2013; McClure et al., 2017). More specifically, participating in

STEAM can build children's social emotional skills, early literacy, science inquiry and positive attitudes about STEAM (Aldemir & Kermani, 2017; Duncan et al., 2007; Goldstein et al., 2019; McClure et al., 2017; Saçkes et al., 2011). For this study, parents and their preschool children participated in an at-home STEAM experience in which they engaged in STEAM activities over a period of five months. At the commencement of the study, the parent participants were given access to a website which consisted of six modules. The purpose of the first module was to teach the parents four strategies for facilitating informal learning with their child: providing feedback, modeling, asking for explanations, and encouraging problem solving. The remaining five modules were various STEAM activities for them to engage in with their child at home, with the intention that they would use the facilitation strategies they learned in the first module.

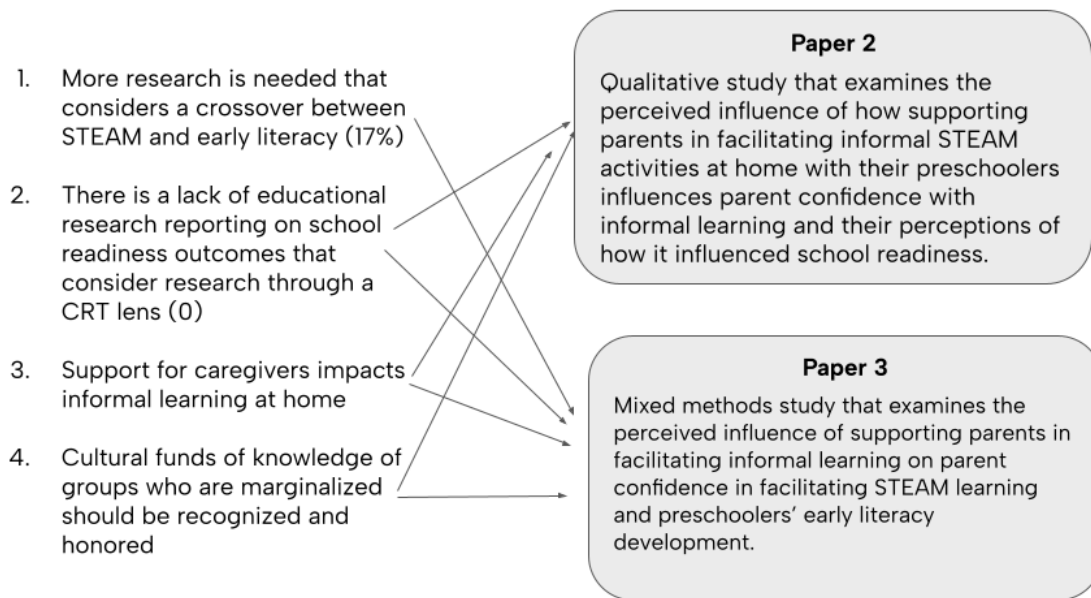
### **How the Three Papers are Connected**

This dissertation project follows the three-paper format. Paper one is a systematic literature review that sought to discover what literature already existed about the relationship between early informal learning experiences, early STEAM and early literacy skills. An examination of the collected literature suggested that more research is needed that considers the crossover between STEAM and early literacy, as only 17% of the studies in the review suggested this connection. There were several other pertinent themes that arose from this review that informed paper two and paper three, one being that there is a lack of educational research reporting on school readiness outcomes that considers research through a CRT lens. None of the studies examined in the systematic review used the lens of CRT when reporting demographics and/or academic outcomes. Another finding was that support for caregivers may impact informal learning at home, and finally, cultural funds of knowledge should be recognized and honored,

especially in families from groups who are marginalized. See Figure 1 for a diagram of how the findings from the systematic review guided papers two and three.

### Figure 1

#### *How the Findings of Paper 1 Guided Papers 2 and 3*



As a result of the findings from the systematic review, paper two of the dissertation is a qualitative study using focus groups to examine and understand parents' perceptions about whether and how receiving facilitation support influenced their confidence in engaging their child in informal learning. Paper two also examines the parents' perceptions of whether participating in the STEAM experience influenced their child's school readiness. Paper three is a mixed methods study using focus groups, pre- and post-surveys, and early literacy screening scores to examine how the parents perceived the influence of receiving facilitation support on

their confidence in engaging in STEAM projects with their child, and how participating in STEAM activities might influence early literacy development.

**STEAM and Informal Learning Influences on Early Literacy: A Systematic Literature Review**

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School of Education, Virginia Commonwealth University



## **STEAM and Informal Learning Influences on Early Literacy: A Systematic Literature Review**

More than 80% of a child's waking hours are spent outside of school settings, and in these cultural and social spaces, much informal learning takes place (Falk & Dierking, 2010; Neuman & Knapczyk, 2022; Osborne & Dillon, 2007). Despite the distinction between the amount of time spent in school versus time spent in informal settings, the quantity and quality of research on knowledge gained outside of formal schooling pales in comparison to the vast research conducted in formal learning environments (Osborne & Dillon, 2007). It is important to note these gaps in educational research when considering what is known and not known about school readiness, especially due to the disparities that exist among children's school readiness across race, ethnicity, socioeconomic status (SES), and culture, specifically language. Research suggests that children who are exposed to and who practice academic skills before entering formal schooling have an advantage for school readiness that is apparent when they enter kindergarten (Lee & Burkham, 2002; Susperreguy, M.I. et al., 2020). Data across the U.S. also suggest that many preschool children are not meeting school readiness milestones at kindergarten entry. For example, the results of the Virginia Kindergarten Readiness Program (2023) suggest that 40% of children in Virginia arrive at kindergarten without necessary preparation to be successful in one or more critical learning domains (literacy, math, self-regulation, and social skills). School readiness is the foundation for this research project and it is influenced by the researcher's positionality as a reading specialist and antiracist educator. The current study is also based on the funds of knowledge that are known to be essential for optimal academic achievement: family/school partnerships, learning enrichment outside of classroom walls, access to informal learning and early literacy development.

## **Background**

It is known that exposure to stories and rhymes and being read to positively impact early literacy and school readiness (Evans et al., 2016; Massaro, 2017; Snow et al., 1998; Trelease, 2019). Additionally, everyday events such as chores, errands, and simple home routines can serve as literacy-enhancing activities that supplement children's early literacy learning (Evans et al., 2016; Neuman & Knapczyk, 2022; Roskos et al., 2003). The purpose of this systematic review is to examine the hypothesis that early engagement in informal STEAM (science, technology, engineering, the arts, mathematics) and other authentic learning activities at home or in communities may have a positive impact on early literacy skills leading to school readiness. In addition, the hypothesis that access to early informal STEAM engagement and the parent facilitation of such may be influenced by the demographics of race, ethnicity, socio-economic status and language. This review was conducted to determine if there is literature to support these hypotheses or if any gaps exist in the research that need to be addressed.

Considering the literature and theory surrounding informal learning, STEAM, and early literacy, this systematic review seeks to answer the following questions; (RQ1) What is the relationship between early informal learning experiences and early literacy skills? (RQ2) What types of informal learning experiences have been found to most positively impact the acquisition of early literacy skills and school readiness in general? (RQ3) What does the literature say about the relationship between early STEM/STEAM experiences and early literacy/school readiness skills/outcomes? All three of these research questions will be examined through a critical race theory (CRT) lens at the nexus of education using five basic tenets of CRT to frame the research: (1) Belief that racism is normal or ordinary in US society, (2) Interest convergence or

material determinism is present, (3) Race is a social construct, (4) Intersectionality and essentialism contribute to inequity, and (5) Voice and counter-narrative are necessary (Bell, 1995; Crenshaw, 1990; Delgado, 1989; Solorzano & Yosso, 2001; Ladson-Billings, 2022). This theory is used as a framework to guide the study because informal learning involves children's home and neighborhood environments and is shaped by cultural and language differences. Due to the hidden curriculum in the U.S. public schools that is enmeshed with white culture (Ladson-Billings & Tate, 1995; Ladson-Billings, 2022; Nasir & Hand, 2006), the assets that children gain from their home environment may not be recognized (Esteban-Guitart et al., 2019; Gonzolaz et al., 2011; Moll et al., 1992; Moll, 2019).

### **Methodology**

PRISMA (Prisma, 2023) procedures were used to identify studies about informal learning, STEAM and early literacy. The PRISMA process consists of a checklist of items and a flow diagram which outlines the four phases of the systematic review process. The rationale in using this process is to ensure consistency and transparency which result in good reporting. In addition, Boolean logic was used to define the search in order to broaden it to ensure that it was as inclusive as possible.

The databases that were used in the search include Education Resources Information Center (ERIC), Education Research Complete and American Psychological Association (PsycInfo). These databases were designated for this review to make certain that literature in both the fields of education and psychology were included. In order to ascertain the strongest query terms, an initial search was undertaken to determine the strongest search terms that would produce the richest results. As a result of the synonym and keyword searches, the final search string included the following terms: informal learning, informal education, experiential learning,

situated learning, prior learning, early literacy and school readiness. STEAM was not included in the final search string as the researcher wanted to capture all of the literature on early informal learning and early literacy generally to then see how often STEAM studies were included in this broader search. The following search strand was used in all three of the aforementioned databases: ("informal learn\*" OR "informal education" OR "experiential learn\*" OR "situated learn\*" OR "prior learn\*") AND ("early literacy" OR "school readiness").

### **Inclusion and Exclusion Criteria**

The time frame from 1980 through the present was used as a field quantifier in each database while running the above search string. Seminal work on the socio-cultural concept of literacy acquisition issued forth from the 1980s, so this timeframe was used in order to encompass the theories and research in early literacy from that period and forward. Three inclusion criteria were developed. One, they investigated or reported on informal learning in any setting. Two, they included preschool children and/or children in the range of 3-11 years old. Three, they were published in English. Most of the sources included in this review are empirical studies from peer-reviewed journal articles, however, one non-empirical book chapter, two literature reviews, one dissertation, two concept papers and one book were also included in this review so as not to bias results nor leave out pertinent information (University of Cambridge, n.d.).

### **Screening and Coding Procedures**

During the initial search process, ( $n = 92$ ) articles were uploaded to Zotero, an online tool for collecting, organizing and annotating research. At this point, ( $n = 36$ ) duplicates were identified and eliminated. Additionally, the reference lists of articles that seemed especially

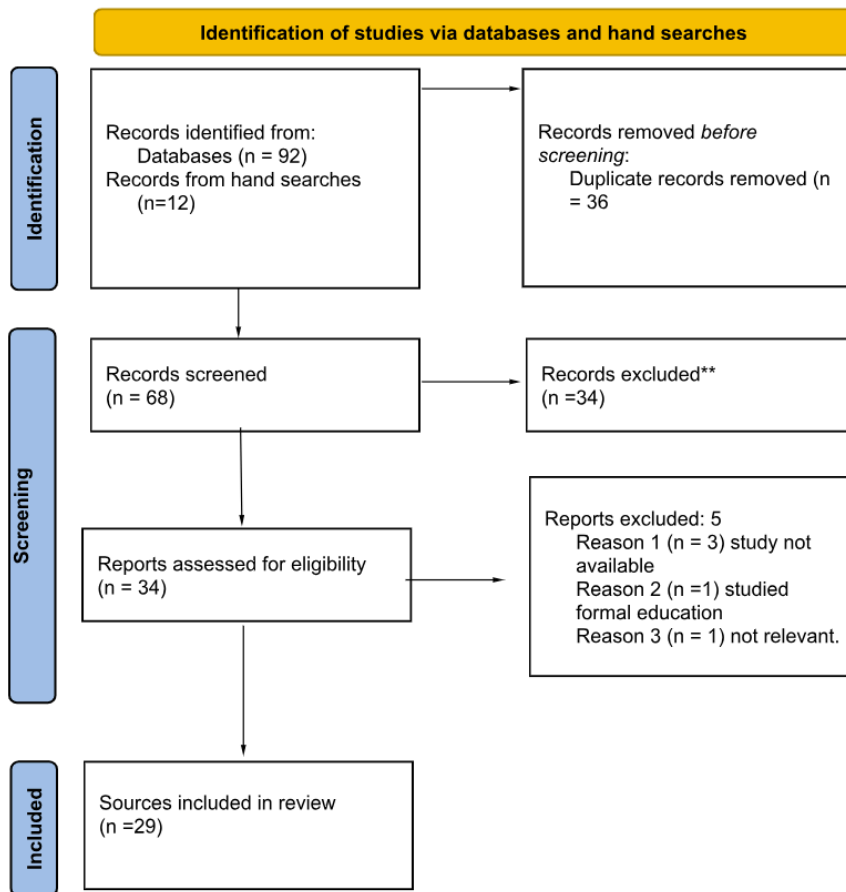
relevant were hand scanned to ensure that no pertinent information was overlooked. The hand searching resulted in adding ( $n = 12$ ) more articles. The remaining studies were screened by title and abstract to determine that they met the inclusion criteria. The title and abstract screening eliminated ( $n = 34$ ) studies. The final number of studies included in this review for full text screening was ( $n = 34$ ).

For the coding process, a detailed coding sheet was created to organize the final scanning process. The following categories were included in the coding sheet: title, year of publication, abstract, research design, sample size, participant demographics, CRT perspective (i.e., was racial disparity and/or systemic racism addressed?), type of informal learning site (i.e., at-home, after-school program, child care program, other location), STEAM component/s studied, whether or not the article discussed literacy and/or general school readiness, notes on how the study answered any of the three research questions, and a category for other pertinent findings. Themes that emerged were coded in accordance with how they answered the research questions.

The full text screening process excluded ( $n = 5$ ) studies. The reasons for the exclusions after the full text screening were: studies ( $n = 3$ ) were unavailable, one study was about formal rather than informal education, and one study was determined as not relevant. See Figure 1 for the PRISMA flow diagram of the search process.

## **Figure 1**

*PRISMA Flow Diagram*



## Results

This section presents the results of the systematic review and is organized as follows.

First, the characteristics of the research, including the research design of the studies, sample size, demographics of participants and types of informal learning environments are presented. Then, the findings are organized by how they answer each of the three research questions. The section ends with an explanation of how the studies were examined through the lens of CRT.

### Characteristics of the Research

The sample size and demographics of the studies included in this review can be found in Table 1. It should be noted here that seven of the 29 sources included in this review did not have

empirical evidence, therefore their characteristics are not relevant to this section and are marked as “not applicable” in Table 1. The non-empirical sources include a book chapter reporting on a related concept (Callanan & Jipson, 2001), three concept papers (Hoff, 2006; Klebanoff, 2009; Zimmerman et al., 2008), and one book (Singer et al., 2006). Also not included in this section are the two literature reviews (Alexandre et al., 2022, Callanan et al., 2011). Of the 22 articles included in this review that are empirical research articles, five used quantitative research methods, 14 used qualitative methods, and three studies used mixed methods design. Sample sizes for all of the included studies ranged from 1-709 participants. The range of sample sizes for the quantitative studies was 20-426 participants with a mean of ( $M = 310$ ). The qualitative studies sample sizes ranged from 1-2,096 participants, with the average being ( $M = 259$ ). The range of sample sizes for the mixed methods studies was 81-709 with a mean of ( $M = 900$ ).

Eleven of the 22 empirical studies, or 50%, reported on SES. Two reported that their sample consisted of middle to upper class families (Borriello & Liben, 2018; Kleemans et al., 2012). Eight of the 22 empirical studies consisted of participants that were a majority of low-income families (Fabiano et al., 2016; Greene & Sawilowsky, 2018; Hassinger-Das et al., 2020; Li, 2001; Neuman & Knapczyk, 2022; Shivaram et al., 2021; Son & Hur, 2020; Tenenbaum & Callanan, 2008). Two of the eleven studies that reported SES reported a mix of low and moderate-to-high SES (Gold et al., 2021; Jorgensen, 2016). One study classified all of the families in the sample as “urban”, but didn’t clarify SES (Goldstein et al., 2019).

Nine, or 41%, of the empirical studies reported the racial demographics of their participants. Of these nine, three of the studies reported a majority of white participants (Borriello & Liben, 2011; Gold et al., 2021; Son & Hur, 2020). Just one study reported that all of the participants were white (Rodriguez-Meehan et al., 2022). Another study reported that the

participants lived in predominantly Black neighborhoods (Hassinger-Das et al., 2020). And four of the studies reported a majority of Latinx participants (Huerta & Riojas-Cortez, 2011; Neuman & Knapczyk, 2022; Shivaram et al., 2021; Tenenbaum & Callanan, 2008).

**Table 1**

*Research Design, Sample Sizes and Demographics of the Research*

Author/s	Research Design	Sample Size	Participant Demographics
Adams (n.d.)	Quantitative - action research pre-experimental design	20 kindergarteners	Not given
Alexandre et al. (2022)	Systematic literature review	N/A	N/A
Borriello & Liben (2018)	Qualitative - video recordings of play sessions	46 mothers and their preschool aged children	85% white, 7% Asian, 5% Hispanic, 3% African American; 83% college-educated
Callanan & Jipson (2001)	Book chapter, "diary methodology" for studying explanatory conversations	N/A	N/A
Callanan & Oakes, (1992)	Qualitative-speech coding	30 preschool age children	Not given
Callanan et al. (2011)	Literature review	N/A	N/A
Cook (2001)	Qualitative - observation	4	Not given
Crowley et al. (2001)	Qualitative - video taping	91 families with children 4-8yo	Not given
Ezati et al. (2018)	Mixed methods; longitudinal over 3 years	709 children	Not given
Fabiano et al. (2016)	Quantitative - survey	426 parents of young children	Low SES
Gold et al. (2021)	Mixed methods; observation and formal assessment	110 preschoolers	Mixed SES; 77% white, other races not identified
Goldstein et al., (2019)	Mixed methods - surveys, interviews, logs, observation	81 6-9 year olds and their families	Urban population
Greene & Sawilowsky (2018)	Quantitative	837 Head Start students	Low SES
Hassinger-Das et al. (2020)	Qualitative, observation of how caregivers and children interacted	165 caregiver-child groups in control group and 115 groups who visited the playground	Low SES; predominantly Black neighborhoods
Hoff (2006)	Concept paper; discussion of environmental impacts on language development	N/A	N/A
Huerta & Riojas-Cortez (2011)	Qualitative - field notes and audio recordings	64 parents	Mexican-American parents
Jorgensen (Zevenbergen) (2016)	Quantitative, test scores from partial Woodcock-Johnson and Peabody Development motor scales	177 3-5 yo	Mix of high and low-income families, no racial demographics given
Kennedy et al. (2006)	Qualitative, photo-diaries, observations, transcribed conversations	65 children and families	Not given
Klebanoff (2009)	Concept paper	N/A	75% boys
Kleemans et al. (2012)	Quantitative, parent survey and child cognitive/linguistic test	89 5-7yo	All middle class, two parent families
Li (2001)	Qualitative, ethnography	1 3yo girl	Low SES
MacDonald et al. (2018)	Qualitative - video and audio recording	6 families, children 12mos-10yo	Not given



Author/s	Research Design	Sample Size	Participant Demographics
Neuman & Knapczyk (2022)	Qualitative, observation	20 laundromats, 2096 children	Low SES, primarily Latinx/African American communities
Rodriguez-Meehan et al. (2022)	Qualitative, Case Study	4 5-7yo	All white
Shivaram et al. (2021)	Qualitative - observation	212 families; children 2-10yo	All low SES (at a food pantry); 6% Asian, 9% Black, 68% Latinx, 12% white, 1% mixed race
Singer et al. (2006)	research based book	N/A	N/A
Son & Hur, 2020)	Qualitative- observation	46 Head Start students	Low SES; 50% white, 18% Black, 10% Hispanic, 10% multi-racial, 2% other
Tenenbaum & Callanan (2008)	Qualitative- speech coding	40 children, 2-8yo	Mexican descent families, low SES, 20 basic schooling, 20 higher schooling
Zimmerman et al. (2018)	Concept paper	N/A	N/A

Another pertinent characteristic included in this review is the environment in which informal learning was studied. The types of sites that were used in each study can be found in Table 2. For the purposes of this review, informal learning sites were categorized by four types: (1) at home, (2) after-school program, (3) child care program, and (4) other location. Some of the studies included more than one type of site in their study (Alexandre et al., 2022; Callanan et al., 2011; Crowley et al., 2001; Huerta & Riojas-Cortez, 2011; Tenenbaum & Callanan, 2008).

Twelve of the studies used the home environment to examine informal learning (Alexandre et al., 2022; Borriello & Liben, 2018; Callanan & Oakes, 1992; Callanan et al., 2011; Crowley et al., 2001; Ezati et al., 2018; Fabiano et al., 2016; Huerta & Riojas-Cortez, 2011; Kennedy et al., 2006; Kleemans et al., 2012; Son & Hur, 2020; Tenenbaum & Callanan, 2008). Two of the research articles studied informal learning in afterschool programs (Alexandre et al., 2022; Callanan et al., 2011). Child care programs were the location examined in four of the studies (Alexandre et al., 2022; Cook, 2021; Gold et al., 2021; Greene & Sawilowsky, 2018). Sixteen of the reviews used other locations to study informal learning. Five of these studies that took place in “other locations” were situated in museums (Alexandre et al., 2022; Callanan et al., 2011;

Crowley et al., 2001; Tenenbaum & Callanan, 2008). The other locations that are individually unique are as follows, a kindergarten classroom (Adams, n.d.), outdoor spaces such as parks, nature centers (Goldstein et al., 2019), bus stops (Hassinger-Das et al., 2020), a cultural folk-medicine event (Huerta & Riojas-Cortez, 2011), swim schools (Jorgensen, 2016), a library (Klebanoff, 2009), a family-owned restaurant (Li, 2001), a shopping center (MacDonald et al., 2018), laundromats in high-poverty neighborhoods (Neuman & Knapczyk, 2022), an animal shelter (Rodriguez et al., 2022), and a food pantry (Shivaram et al., 2021).

**Table 2**

*Types of Environments for Informal Learning*

Author/s	At Home	After-School Program	Child Care Program	Other Location
Adams (n.d.)				kindergarten classroom
Alexandre et al. (2022)	X	X	X	museums
Borriello & Liben (2018)	X			
Callanan & Jipson (2001)				museum with caregiver
Callanan & Oakes (1992)	X			
Callanan et al. (2011)	X	X		museums
Cook (2001)			play area, pretend birthday party	
Crowley et al. (2001)	X			museum
Ezati et al. (2018)	X			
Fabiano et al. (2016)	X			
Gold et al. (2021)			preschool class, during playtime	
Goldstein et al., 2019)				outdoor spaces- parks, nature centers, after-school centers with green space
Greene & Sawilowsky (2018)			X	
Hassinger-Das et al. (2020)				bus stop
Hoff (2006)			N/A	
Huerta & Riojas-Cortez (2011)	X			cultural folk-medicine event

Author/s	At Home	After-School Program	Child Care Program	Other Location
Adams (n.d.)				kindergarten classroom
Jorgensen (Zevenbergen) (2016)				swim schools
Kennedy et al. (2006)	X			
Klebanoff (2009)				library
Kleemans et al. (2012)	X			
Li (2001)				family restaurant
MacDonald et al. (2018)				shopping center
Neuman & Knapczyk (2022)				laundromats in high-poverty neighborhoods
Rodriguez-Meehan et al. (2022)				animal shelter
Shivaram et al. (2021)				food pantry
Singer et al. (2006)			N/A	
Son & Hur, 2020)	X			
Tenenbaum & Callanan (2008)	X			science museum
Zimmerman et al. (2018)			N/A	

## Findings by Research Question

### ***RQ1 What is the Relationship Between Early Informal Learning Experiences and Early Literacy Skills?***

The relationship between informal learning experiences and early literacy skills was addressed by 14 of the sources in this review (Adams, n.d.; Cook, 2001; Ezati et al., 2018; Greene & Sawilowsky, 2018; Hassinger-Das et al., 2020; Hoff, 2006; Huerta & Riojas-Cortez, 2011; Jorgensen, 2016; Kennedy et al., 2006; Klebanoff, 2009; Kleemans et al., 2012; Li, 2001; Neuman & Knapczyk, 2022; Rodriguez-Meehan et al., 2022). Four common themes emerged from the research around the relationship between informal learning experiences and the acquisition of early literacy skills: (1) play as a source of literacy learning, (2) caregiver-child conversations as important for developing language skills and early academic understandings, (3)

early literacy development is impacted by social processes, and (4) the importance of socio-cultural and socio-economic factors being understood by educators. Each theme is explained with the supporting research in the following section.

**Play as a Source of Literacy Learning.** Research suggests that play can be a source of literacy learning (Adams, n.d.; Cook, 2001; Greene & Sawilowsky, 2018; Hassinger-Das et al., 2020; Jorgensen, 2016; Kennedy et al., 2006; Klebanoff, 2009; Singer et al., 2020). For example, in Klebanoff's (2009) weekly Lego block party at the local library, books were paired with Lego play according to the themed build each week. Research also suggests that participation in structured play through physical activity like swim lessons might increase children's literacy scores by building their linguistic capital and overall cognitive development (Jorgensen, 2016). In addition, Green and Sawilowsky (2018) suggested that participating in music, dance, and art through play might increase speaking, listening and comprehension, phonological awareness, alphabetic knowledge, and writing skills. By observing children in a birthday party-themed play area in a childcare center, Cook (2001) found that allowing children the opportunity to practice writing, or "mark making" in authentic play settings may deepen their early literacy skills. Adams (n.d.) created a playful rhyming unit for their research and found that the children who received the treatment fared better in verbal post-test scores than the students in the control group who did not have access to the rhyming play materials.

**Caregiver-child Conversations.** Several of the studies mentioned caregiver conversations with preschoolers positively impacting their school readiness skills, and furthermore, supporting caregivers in having educational conversations with their children can also prove beneficial (Callanan & Oakes, 1992; Ezati et al., 2018; Hassinger-Das et al., 2020; Hoff, 2006; Huerta & Riojas-Cortez, 2011; Kennedy et al., 2006; Kleemans et al., 2012; Li,

2001; Neuman & Knapczyk, 2022; Shivaram et al., 2021). Research suggests that children's questions and the answers that caregivers provide can offer a rich and valuable transfer of information to springboard early literacy learning (Callanan & Oakes, 1992). When a child's social experience offers more opportunities for rich communication with adults, their vocabulary increases at a faster rate than for a child who may not have those same communicative opportunities (Hart & Risley, 2003; Hoff, 2006). Huerta and Riojas-Cortez (2011) suggested that adults may provide linguistic scaffolding through cultural experiences which helps build vocabulary and other literacy skills. The installation of literacy centers in laundromats were found to increase caregiver/child conversations (Neuman & Knapczyk, 2022).

Similarly, Hassinger-Das et al. (2020) embedded playful literacy learning activities into urban bus stops and their findings emphasize that implementing informal learning activities into architectural design encourages caregiver/child conversations which assist with early childhood language development. Ezati et al. (2018) reported that offering guided learning modules for parents to use at home with their preschool age children significantly improved early literacy development, particularly in their language development and exposure to print. The study of family interactions at a food pantry suggests that parent-support interventions, such as signs around the food pantry to encourage academic discussions, can impact the quantity and quality of parent/child interactions (Shivaram et al., 2021).

***RQ2 What Types of Informal Learning Experiences Have Been Found to Most Positively Impact the Acquisition of Early Literacy Skills and School Readiness?***

The second research question for this study examined the types of informal learning experiences found in the literature that most positively impact early literacy and general school readiness. Although this systematic review does not provide a way to rate the types of

experiences from most beneficial to least beneficial, it does allow us to quantify the findings based on the frequency of mentions of each type of learning experience found in the included literature. See Figure 2 for a graphic representation of these findings.

**Physical Activity.** Physical activity as being beneficial for building school readiness was found in three of the studies (Ezati et al., 2018; Greene et al., 2019; Jorgensen, 2016). The specific types of physical activities were, playing with playground equipment, participating in music and dance and swimming, respectively. Both Ezati et al. (2018) and Goldstein et al. (2019) present research that supports outdoor play for building school readiness and academic success.

**Art.** One study in this review mentioned creating art as a pathway for building the cognitive development and fine motor skills necessary for school success (Greene et al., 2019).

**Books.** Reading books and/or being read to was mentioned in the work of three of the studies (Kennedy et al., 2006; Klebanoff, 2009; Rodriguez-Meehan et al., 2022).

**Blocks and Game Play.** Engineering play, in the form of building with blocks, was examined by two of the studies (Gold et al, 2021; Klebanoff, 2009). Game play with adults and other children were pertinent to the findings of five studies (Alexandre et al., 2022; Cook, 2001; Kleemans at al., 2021; Li, 2001; Zimmerman et al., 2018).

**Cultural Events.** Participation in cultural events as a way to build literacy and school readiness skills was presented in another study (Huerta & Riojas-Cortez, 2011).

**Museums.** Museum visits and learning installations in public places surfaced in the literature six times (Alexandre et al., 2022; Callanan & Jipson, 2001; Crowley et al., 2001; 2001; Hassinger-Das et al., 2020; Neuman & Knapczyk, 2022; Tenenbaum & Callanan, 2008).

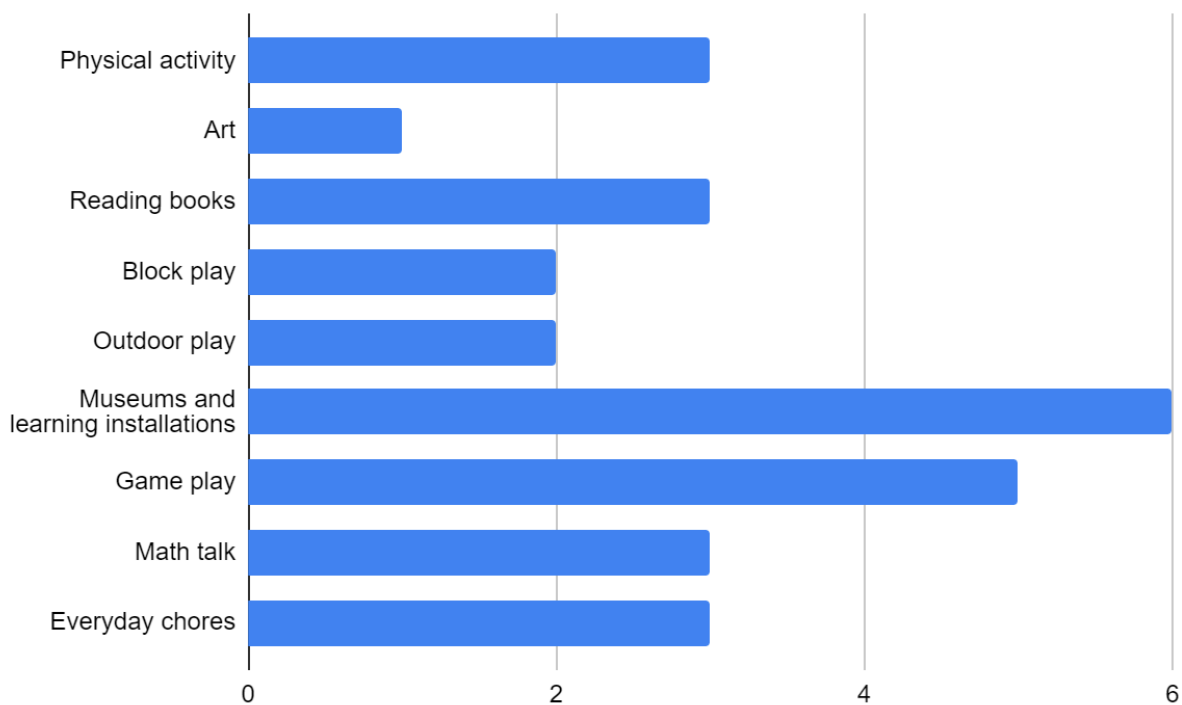
**Math.** Home math talk and math activities, for example, counting, playing counting games, practicing numerical conceptual knowledge, rehearsing counting rhymes and

measurement games, were examined in three of the articles (Alexandre et al., 2022; Kleemans et al., 2021; Son & Hur, 2020).

**Everyday Chores.** And finally, three other studies found that everyday family chores, such as shopping and doing laundry, were types of experiences that could be positively related to school readiness (MacDonald et al., 2018; Neuman & Knapczyk, 2022; Shivaram et al., 2021).

## Figure 2

*Frequency of Reference to Types of Informal Learning Experiences*



### ***RQ3 What Does the Literature Say about the Relationship Between Early Informal STEAM Experiences and Early Literacy/School Readiness Skills/Outcomes?***

Twelve of the 29 articles reviewed indicate that integrating investigative play, explanatory conversations, and family involvement into informal STEAM activities mirrors themes observed in the relationship between informal learning and early literacy, thereby

influencing school readiness (Alexandre et al., 2022; Boriello & Liben, 2018; Callanan & Jipson, 2001; Callanan et al., 2011; Crowley et al., 2001; Gold et al., 2021; Goldstein et al., 2019; Gold et al., 2019; Hassinger-Das., 2020; Huerta & Riojas-Cortez, 2011; MacDonald et al., 2018; Son & Hur, 2020; Tenenbaum & Callanan, 2008; Zimmerman et al., 2018).

**Explanatory Conversations.** Crowley et al. (2001) examined the types of conversations happening among families at a science museum and suggest that explanatory conversations, specifically, can be tied to children's gains in scientific literacy.

**Engineering Play.** Research suggests that investigative engineering play is highly correlated with executive functioning, mathematics and spatial reasoning (Gold et al., 2021). Goldstein et al. (2019) found value in combining outdoor play and science.

**Outdoor Learning.** Their findings suggest that incorporating science content into outdoor learning can increase children's interest in science because the children perceive the activities as fun and are motivated to engage. Similarly, *Thinkscape*, the learning installations at bus stops created and studied by Hassinger-Das et al. (2020) engaged children in scientific, mathematical and spatial conversations with adults while they played outdoors.

**Cultural Practices.** Huertas and Riojas-Cortez's (2011) research suggests that exposing children to cultural practices, in this case the cultural practice of studying medicinal herbs, can enhance scientific vocabulary learning. Their research also suggests that interactive writing, which the children participated in with their caregivers during the event, strengthened both scientific knowledge and writing skills. Additionally, participating in this cultural event offered authentic experiences for the families which may have increased engagement and learning.

**Math Talk.** Another study sheds light on how mathematical activities and interactions in everyday contexts such as family shopping may contribute to children's ongoing mathematical



learning and development outside of homes and schools (MacDonald et al., 2018). Son and Hur (2020) found that specific and intentional math talk at home was significantly associated with children's early math skills.

**Support for Caregivers.** Researchers report that when caregivers are supported and offered guidance in informal STEAM learning at home, children are more likely to make gains in school readiness (Alexandre et al., 2022; Boriello & Liben, 2018; Ezati et al., 2018; Fabiano et al., 2016; Kleemans et al., 2012; Shivaram et al., 2021). Some examples of caregiver support are instructions and specific language to use in spatial learning activities (Boriello & Liben, 2018). The systematic review of informal STEM learning by Alexandre et al. (2022) posits that structured questioning provided for caregivers to use during STEM activities can positively impact child learning outcomes. Son and Hur's (2020) research of math conversations at home suggest that interventions for parents might improve the quality and frequency of mathematical interactions at home and that when the interventions incorporate scaffolding, higher gains in children's early math skills may be achieved. The results of another study propose that giving guidance to caregivers to help them incorporate both literacy and math in informal activities at home would boost the caregivers' knowledge and motivate them to use more intention toward informal learning activities (Kleemans et al., 2012).

### **Discussion**

The results of this review suggest three pertinent themes for discussion. The first theme is that early literacy is impacted by social practices. The second theme is that sociocultural and socioeconomic factors need to be identified and understood. Another theme is the consideration of the connections made in the literature between informal STEAM and early literacy. The final point of discussion is the explanation of how CRT was used to guide this review and a discussion

of if and how it surfaced in the literature. The research and practical implications are also presented in the following section.

### **Early Literacy as Impacted by Social Processes**

Literacy acquisition is a profoundly social process embedded in children's everyday lives, and supporting literacy learning across boundaries (i.e. between home, school and community) can help build bridges for community learning opportunities (Hassinger-Das, 2020; Hoff, 2006; Huertas & Riojas-Cortez, 2011; Kennedy et al., 2006; Li, 2001; Neuman & Knapczyk, 2022; Rodriguez-Meehan et al., 2022). Research suggests that access to literacy-building activities in local, public places, such as laundromats and bus stops can make a difference in children's access to resources which can support the development of early literacy (Hassinger-Das, 2020; Neuman & Knapczyk, 2022). Another study found that crossing the school/community boundary in the way of reading to shelter dogs was found to positively affect children's motivation for and confidence in reading (Rodriguez-Meehan et al., 2022). Likewise, children who participated in a folk medicine event where parents were invited to be the "teachers" witnessed a variety of literate behavior while making cultural, real-world connections to learning (Huertas & Riojas-Cortez, 2011). Kennedy et al. (2006) suggests that when caregivers are made aware of informal learning practices that are happening in their home, the pathways between home and school are strengthened and the caregivers become more intentional about creating these types of opportunities for their children.

### **Socio-cultural and Socio-economic Factors Need to Be Understood**

Furthermore, the literature highlighted that socio-cultural and socio-economic circumstances need to be identified and thoroughly understood by educators and stakeholders to mediate early literacy learning. In this way, culture should be seen as funds of knowledge for

young children rather than a deficit (Ezati et al., 2018; Fabiano et al., 2016; Huertas & Riojas-Cortez, 2011; Kennedy et al., 2006; Li, 2001). The findings of Huertas and Riojas-Cortez (2011) suggest that comparing home literacy practices of middle-class whites and lower income Latinos can and often does lead to a deficit model. Rather, educators and researchers should be looking at the wealth of home literacy practices that are influenced by culture. Li's (2001) study of informal literacy events happening in the context of the family's restaurant provided a wealth of learning opportunities for the family's children. Another study also capitalized on the cultural wealth by implementing informal home-based learning centers, and found that by focusing on the family in this way, children's school readiness and literacy improved (Ezati et al., 2018). Fabiano et al. (2016) propose that caregivers are more likely to engage in school activities and learn about informal interventions that they can provide for their young children at home when their own socio-cultural beliefs and practices are considered and celebrated, and this parent motivation toward informal learning at home impacts opportunities for children to make gains in literacy.

### **Connections between STEAM and Early Literacy**

It should be noted that of the 29 articles included in this review, only 5 of the articles explicitly connected STEAM to early literacy. One such study suggests that there may be a connection between early mark making/writing and early development of mathematical representations (Cook, 2001). Greene and Sawilowsky's (2018) work that developed a program to incorporate music, dance and art into a childcare setting that serves children from predominantly low SES backgrounds suggests that "arts integration provides important opportunities for child pre-academic skill development including approaches to learning; social-emotional development; language, literacy, and communication; science and technology;

and social studies and saw specific gains in emergent literacy and emotion regulation” (p. 222). The *Thinkscape* project, which created a playful learning space at a bus stop, showed that a playful space may be a way to bring people together in new ways while at the same time influencing curiosity and offering a springboard for caregivers and children to have meaningful conversations. Simultaneously, the participants were intermingling and participating in activities that promote language, mathematics and spatial awareness (Hassinger-Das et al., 2020). One study considered the way that families that incorporated both math and literacy play learning at home (Kennedy et al. (2006), and another study combined the practice of block play and themed books to incorporate both STEAM and literacy into the informal learning environment (Klebanoff, 2009). Kleemans et al. (2012) suggest that linguistic skills are highly related to numeracy skills and that the two should be incorporated into informal learning scenarios. For example, when doing a counting-related activity with the child, caregivers could also use the knowledge of the counting words while reading a storybook to the child. Although there were several solid studies that crossed over between the ideas of STEAM and early literacy, this line of inquiry warrants further investigation.

### **Gazing Through the Lens of CRT**

The findings of this systematic review can be examined through a CRT lens using the five tenets of CRT to frame the research. In general, the studies in this review failed to make any mention of racism as being normal in United States society and as a result, racism being a causal or even a correlative reason for disparity in school readiness and the acquisition of literacy skills. A few of the studies did mention the caregiver’s level of education and/or SES as a factor for limiting informal learning experiences at home (Crowley et al., 2001; Hoff, 2006; Jorgensen, 2016; Kleemans et al., 2012; Shivaram et al., 2021; Son & Hur, 2020). However, even when

presenting such data, the researchers fail to name systemic racism and its overshadowing effects and implications as a contributing factor on the academic achievement of our nation's children. For example, in the introduction to their study, Neuman and Knapczyk (2022) cite research suggesting that it is not parental income that impacts informal learning at home, but rather the "knowledge, preferences and values that parents hold about education" (p. 1170) that influence time spent on informal learning activities at home. Similarly, the discussion section of Son & Hur's (2020) research states, "Overall, findings indicated that caregivers with low-income backgrounds did not provide much math talk to their young children during a home cooking activity. The results are not surprising, given the previous literature reporting lower levels of parent-child involvement in home math interactions" (p. 420). And Kleemans et al., (2012) even went so far as to say, "Moreover, because parents of children with a lower SES possibly spend less time with their child in numeracy-related activities, this may have repercussions for the child's early numeracy skills" (p. 476).

Presenting research in this way, without giving credit to the overreaching effects of systemic racism, can have a detrimental impact on the communities being represented. This type of reporting can lead to a merit-based way of thinking, as if certain groups are less capable of achieving optimal social and academic outcomes. Rather, it may be the cultural capital of middle- and upper-class families that give them an upper hand in academic achievement, and conversely, the lack of cultural capital related to our public school systems that may lead to a reproduction of inequality in minoritized families (Bourdieu, 2011; Levinson, 2015).

Two studies did diverge slightly from the majority which ignored the impacts of systemic racism on educational outcomes in this literature review. Fabiano et al. (2016) mention in their study how values and cultural beliefs from different ethnic/minority backgrounds may influence

a caregiver's interest in participating in school-based activities. They suggest that identifying caregivers' preference can help educators and stakeholders understand how certain components of early childhood programs may influence racial/ethnic minority groups' participation. Huertas and Riojas-Cortez (2011) do this in a similar manner but in terms of language minority groups rather than racial/ethnic minority groups. The introduction of their study discusses how researchers often tend to report findings emphasizing deficit views of the literacy practices of language minority groups. Their research emphasizes how schools and educational settings can be intimidating places for many Mexican-American caregivers to interact with when they feel they have been assigned a status that depicts them as lacking in some way. This deficit way of thinking goes beyond literacy practices and beyond Mexican-American caregivers. It is a part of the hidden curriculum and white dominant culture that infiltrates the public school systems in every way. Researchers, educators and stakeholders need to question who determines the content of the curriculum and what are considered the "standards" which impact policy and practice. The voices of those who have been marginalized must be included in these determinations and in every decision making process.

### **Research Implications**

This systematic review suggests that there may be considerable gaps connecting informal STEAM learning and early literacy outcomes. Considering the amount of time that young children spend in informal learning environments, and the research implications of the positive impacts of both informal STEAM activities and early literacy on cognitive development and school readiness overall, research that permits a crossover of both might prove beneficial. Also, the dearth of quantitative data in this area could be addressed with a focus toward measuring early literacy outcomes with quantitative assessments in relation to early STEAM interventions.

Another critical point to consider is the lack of educational studies in general that consider research through the lens of CRT. This review is an example of a case in point, where not a single article of the 29 included here gives mention to systemic racism and its impact on opportunities for minoritized families nor its impact on education in the United States. As Dumas (2022) vehemently argues, and Gomez & Cammarota (2022) echo, white supremacy is a web that infiltrates all of our public and private arenas to keep the status quo in effect, and in this way, it is totalizing. For this reason, what if more educational studies were framed through the lens of CRT? Can stakeholders even begin to address the “achievement gap” without stopping to consider the deep and pervasive roots of systemic oppression? It needs to be considered that even when studies present racial/ethnic/language demographics and point to academic disparities between minoritized children and white children, systemic racism is not called out in the sense that public schools were created with white children in mind (Dumas, 2022; Gomez & Cammarota, 2022; Ladson-Billings, 2022; Milner et al., 2022). According to CRT educational scholars, in today’s political and educational climate, CRT is needed now more than ever (Lynn & Dixson, 2022). Research that uses counter-narrative can give powerful voice to the underlying web of how systemic racism impacts Black and brown families and communities because it captures the “ethnocentric and hegemonic way stories can and do operate” (Ladson-Billings, 2022, p. 38-39). Gallaway & Baber (2022) emphasize why storytelling matters using Du Bois’ (2007) work as a seminal exemplar and exhort that as a methodological tool, counternarratives “connect to analysis and actions that disrupt endemic forms of white supremacy in education” (p. 221).

### **Practical Implications**

This systematic review also serves as a source of practical implications for scholars, policymakers and educators to consider. Caregivers need to be supported in offering informal educational opportunities to children across authentic settings beyond formal schooling. Schools and communities should make every attempt to build bridges that support and encourage caregivers, especially those from racial and ethnic groups for whom our systems were not built. This can be accomplished with educational installations in public places and with outreach opportunities within communities for caregivers to become informed about the impact that informal learning at home can have on school readiness. Moreover, early childhood educators must recognize the value of children's everyday life experiences and use them as the rich resources that they are to support academic success.

Cultural funds of knowledge should be recognized and honored and our communal and educational programs can build off of these funds of knowledge (Vélez-Ibáñez & Greenberg, 1992). As research suggests, schools that promote social capital theory can better perceive the interdependence between academic and social learning, and this idea can be applied to our communities as well (Ada & Zabizarreta, 2001). Similarly, all stakeholders need to understand the impact of SES and the bigger picture of how those deficits came about in order to address the disparities head-on and effect positive change for those who are most vulnerable, our young children.

### **Conclusion**

The intended contribution of this study is to iterate the criticality of the early childhood period for promoting literacy and preparing children to be able to achieve their potential. The results of this systematic review suggest that informal learning for young children can and should be considered a top priority for researchers, educators, policymakers and stakeholders. Informal



STEAM activities can serve as a powerful and motivating academic tool and should also be implemented into the research to serve this purpose. The study also confirms the importance of family/caregiver involvement and the need for supportive opportunities to aid caregivers in offering learning opportunities outside of the formal classroom. Moreover, demographics of race, socio-economic status and language highly impact access to these opportunities and, to this end, should not be excluded from the research.

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**Supporting Parents of Preschoolers in Informal STEAM Learning at Home**

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## **Supporting Parents of Preschoolers in Informal STEAM Learning at Home**

Parents and home environment play an important and influential role in a child's early years for brain development and future academic success (Gross et al., 2020; Hayakawa et al., 2013; Wilder, 2014; Williams et al., 2019). Research on child development suggests nutritional and physical well-being, motivation toward learning, intellectual skills, social-emotional capacity, and social-emotional supports as necessary qualities that contribute to the learning trajectory of young children. It is important to note the modifiable nature of these qualities in that they can be heavily influenced by the child's environment including the home and neighborhood (Williams et al., 2019). The intention of this study is to explore parent involvement in informal learning at home, which may contribute to children's school readiness. Informal learning can happen in a myriad of ways and circumstances. Researchers have suggested informal engagement with science, technology, engineering, the arts, and mathematics (STEAM) have the potential to increase school readiness in young children (Alexandre et al., 2022; Andrews & Wang, 2017; Zhang et al., 2020). For the purpose of this study, STEAM activities were offered to parents to give them structure and context for engaging with their child in informal learning at home.

### **Parent Involvement**

Parent involvement, for the purpose of this study, and also referred to in the literature as parent engagement, can be defined as how a parent invests resources, such as time and energy, on their children (Grolnick et al., 1997; Gross et al., 2019). There are many factors that contribute to parent involvement such as cultural characteristics, household income, parents' education level, and access to resources (Banerjee et al., 2011; Calzada et al., 2015; Tan et al., 2020; Wilder, 2014). Additionally, data suggest that a parent's beliefs about their ability to influence their

child's education may predict a parent's involvement in academic activities (Hoover-Dempsey et al., 2005; Ma et al., 2016; Sheldon, 2002; Tazouti & Jarlégan, 2019). Given the strong relationship between parents/families and pre-academic engagement, it is important to consider that parents' values, attitudes and self-efficacy can affect if and how they engage their children in informal learning (Archer et al., 2012; Raynal et al., 2022).

### **Informal Learning at Home**

There is a large distinction between the amount of time children spend in school (formal learning) versus time spent in informal settings (more than 80%) (Bell et al., 2009; Osborne & Dillon, 2007). Due to the amount of time that children spend outside of school, it is important to consider the opportunities for informal learning in the home environment. The term informal learning in this study refers to opportunities for learning and discovery both cognitively and socially-emotionally that occur outside of formal educational practices (Callanan et al., 2011). Home-based parent engagement in informal learning may consist of activities such as reading aloud to children, talking about academic concepts, and taking them to museums and libraries (Gross et al., 2020; Ocular et al., 2022; Riojas-Cortez et al., 2008).

### **Importance of Home Environment and Parent Involvement on School Readiness**

Educational researchers suggest a significant relationship between home environment, parent involvement, and school readiness (Ma et al., 2016; Tazouti & Jarlégan, 2019; Wilder, 2014). Definitions of school readiness can vary from state to state, district to district and even teacher to teacher (Ackerman & Barnett, 2023). For the purpose of this study, school readiness refers to a set of skills that are related to a child's ability to meet classroom and school expectations both academically, socially and emotionally (Ackerman & Barnett, 2023). Data across the U.S. suggest that many preschool children are not meeting school readiness milestones

at kindergarten entry. For example, the results of the Virginia Kindergarten Readiness Project (2021) suggest that 42% of children in Virginia arrive at kindergarten without necessary preparation to be successful in one or more critical learning domains (literacy, math, self-regulation, and social skills). Poverty is one of the most broadly known risk factors for school readiness (Isaacs, 2012). Statistics suggest that disadvantages are exaggerated for children in racial minority groups, more specifically for Black and Latinx families (Nolan et al., 2016). A suggested effect of these disparities can be seen in the academic performance of Black and brown youth as compared to white children (National Center for Education Statistics, n.d.).

### **The Current Study**

Despite the positive influence of informal learning at home on a child's school readiness, disparities exist in school readiness outcomes and limited research was conducted in informal settings (Osborne & Dillon, 2007). The present study focuses on parent's beliefs about their ability to influence their child's education through informal STEAM learning (Abdul-Adil & Farmer, 2006; Hoover-Dempsey et al., 2005; Sheldon, 2002). This study embarked on an exploration to better understand if access to facilitation support of informal learning experiences at home for parents of preschoolers, specifically STEAM learning, influenced parents' attitudes about informal learning in order to improve school readiness outcomes for young children. Parents and their preschool children participated in an at-home STEAM experience in which they engaged in STEAM activities over a period of five months. The research attempts to determine parents' perceptions related to how the resources provided to them and how participating in STEAM activities with their child improved their facilitation skills for informal learning.

### **Researcher Positionality**

The primary researcher on this project is a cis-gender white woman who has worked as a classroom teacher, reading specialist, and literacy coach in under-resourced schools that serve predominantly Black students. The theoretical framework of this study is a result of the researcher's experiences and in public schools while being ignorant of the reasons for the disparity in achievement gaps. She began her journey of reading and learning about systemic racism and its pervasiveness. Her perceptions and understandings went from finding fault in individuals, behavior causality, and meritocracy, to realizing that the institution of education as a whole in the United States is deeply flawed and stems from a racist system in general (Dumas, 2022; Levinson, 2015). With this new understanding as to why there is such disparity among schools and achievement outcomes, she is deeply dedicated to finding solutions.

### **Theoretical Framework**

The overarching lens that frames this study is Critical Race Theory (CRT), while also considering the learning paradigm Funds of Knowledge (FoK). CRT emerged from legal theory, with the same name and introduced by Derek Bell (1980) as a way to examine the racist power structures that exist in legal institutions in the U.S. (Brown & Jackson, 2022). Two specific tenets of CRT are used in the framework, (1) the belief that racism is normal or ordinary in US society, and (2) intersectionality and essentialism contribute to inequity (Ladson-Billings, 2022). It is the assumption of the researcher that the disparity in school readiness outcomes is heavily influenced by the pervasive nature of racism in U.S. society. With this in mind, the study is grounded in Funds of Knowledge (FoK) learning theory. FoK theory emerged in Tucson, Arizona in the early 1990s as a direct challenge to deficit thinking in education, in which skills and knowledge gained in the home and community have been historically undervalued by formal public school systems, and the onus for unsatisfactory achievement is placed on the students and

families from marginalized groups (Moll et al., 1992). This theory proposes a repulsion of deficit thinking in education and instead, a thinking toward the value of the accumulated knowledge, skills, and cultural resources that students from historically marginalized groups have and acquire from their families and social groups (Basu & Barton, 2007; Esteban-Guitart et al., 2019; Gonzalez, 2006, Moll et al., 1992; Riojas-Cortez et al., 2008). It is the intention of this study to grow parents' understanding of and the ability to use facilitation strategies and weave them together with the cultural wealth and resources the family already possesses (Ocular et al., 2022; Yosso, 2005; Yosso & Burciaga, 2016).

### **In Consideration of Marginalized Groups**

Whenever reporting on academic outcomes and achievement in general, it is important to consider the impact of systemic racism in U.S. public schools and its impact on the families and students whom it marginalizes. Not doing so can cause further harm to these groups (Bourdieu, 2011; Levinson, 2015). Educational researchers often report results without acknowledging that white cultural norms are dominant and pervasive in U.S public schools. This is significant considering that the underachievement of minoritized and lower income students is often seen as the problem rather than a product of an educational system that was designed for the dominant group (Gomez et al., 2023; Ladson-Billings, 2020; Levinson 2015; Nasir & Hand, 2006).

### **Literature Review**

#### ***School Readiness***

Even though a child's social, emotional, and cognitive development is varied and individual, there are certain skills and knowledge that are regarded as important for entering kindergarten which contribute to long term academic success (Ackerman & Barnett, 2023; Bettencourt et al., 2018). Development of language, cognition, social skills and physical health

are considered to be important factors in pre-determining whether a child will be successful in the kindergarten classroom (Ackerman & Barnett, 2023). The key domains of school readiness include language, literacy, background knowledge, physical health and social and emotional development (Bettencourt et al., 2018; Child Trends, 2018; The Virginia Kindergarten Readiness Program, 2023).

Due to the fact that children's pre-kindergarten experiences vary from child to child and family to family, children enter kindergarten with varying levels of readiness. Readiness can be highly influenced by environmental factors and also by participation in preschool (Ackerman & Barnett, 2023). This is significant because evidence suggests that early learning resolutely impacts a person across their lifespan, not only in academic achievement but also quality of life (Barnett & Yarosz, 2007).

Data collected around SES and young children suggest that there is already a significant gap in achievement upon entry to kindergarten between children who come from higher and middle-income homes and those who come from homes classified as low-income (Ackerman & Barnett, 2023; Brooks-Gunn & Duncan, 1997; Daily et al., 2010; Denton & West, 2002). For example, the state of Virginia reported that in 2023, 40% of kindergarten age students were deficient in one or more key school readiness categories. The percentage of children from marginalized backgrounds is higher (e.g. Black children 47%, Hispanic/Latinx children 55%, children from low-income backgrounds 51%, English learners 66%, and children identified as having a disability 62%) (The Virginia Kindergarten Readiness Program, 2023). This data is significant considering the long-term consequences for children who are behind at kindergarten entry. Findings from Ricciardi et al. (2021) suggest that a child's school readiness skills at age four may predict not only academic achievement through fifth grade, but also the likelihood for



elementary students being retained and suspended from school throughout their academic career. Additionally, the data from a longitudinal study over 8 years suggests that school readiness can contribute to middle school outcomes for children (Józsa et al., 2022).

### ***Informal Learning***

Informal learning can happen in many spaces including home, museums, parks, and during family/caregiver conversations (Callanan et al., 2011). Researchers have sought to understand what types of informal learning environments and activities promote the most growth, especially considering the criticality of the early years for brain development (Williams et al., 2019). Alexandre et al. (2022) conducted a systematic review on informal STEM learning and found several home factors to be influential to informal learning: (1) opportunities for investigative play, (2) the quality of the caregiver's STEM talk and questioning, (3) facilitation guidance for caregivers, and (4) a child's interest. Researchers suggest that a family's everyday routines such as shopping, cleaning, conversations, playing with toys, caring for pets, and giving medication served as opportunities for informal learning in literacy, science and mathematics (Gold et al., 2021; Kennedy et al., 2016).

### ***Parent Involvement***

Researchers have extensively examined the influence of parent/caregiver involvement on academic outcomes (Calzada et al., 2015; Gross et al., 2019; Hayakawa et al., 2013; Lee & Bowen, 2006; Peña, 2000; Sheldon, 2002; Wilder, 2014). Factors such as cultural characteristics, home language, household income, parents' education level, and access to resources, may impact parent involvement (Banerjee et al., 2011; Calzada et al., 2015; Tan et al., 2020; Wilder, 2014). Because prior research reports that parent involvement positively benefits children's academic

achievement (Barnard, 2004; Fan & Chen, 2001; Hayakawa et al., 2013), empowering parents with tools and resources to encourage involvement in their child's education is suggested as a way to improve academic outcomes for students whose families have been historically marginalized in our educational system (Abdul-Adil & Farmer, 2006; Hayakawa et al., 2013; Lee & Bowen, 2006; Wilder, 2014).

It is important to consider parental understandings and beliefs and about involvement in their child's education in both informal and formal settings. Of particular importance in the literature is a parent's beliefs that they can affect their child's learning (Hoover-Dempsey et al., 2005; Sheldon, 2002). Prior research suggests that a person is more likely to engage in behavior in which they believe they will be successful (self-efficacy) (Bandura & Walters, 1977; Fang et al., 2021). The results of studies of parent involvement suggest that parental beliefs predict involvement (Calzada et al., 2015; Gross et al., 2020; Hoover-Dempsey et al., 2005; Sheldon, 2002). The findings of Gross et al. (2020) suggest a consensus among the kindergarten parent participants they surveyed that home-based activities are an essential component of parent involvement. Prior research also suggests that a parent's social network may predict a parent's involvement in their child's education both at home and at school (Peña, 2000; Sheldon, 2002). They suggest that encouraging interactions among parents may positively impact their engagement in their child's learning.

### **Research Questions**

Little has been studied on parents' facilitations of informal STEAM learning at home. This study, guided by the following research questions, attempted to address this gap in the literature. Note: the term, "parents" as used in the research questions refers specifically to the parents who participated in the informal STEAM experience.

RQ1. What are parents' perceptions of participating in the informal STEAM experience?

RQ1a. What are parents' understanding of informal learning?

RQ1b. What are parents' perceived changes in their understanding of informal STEAM learning?

RQ1c. What strategies do parents use to facilitate informal learning at home?

RQ2. How do parents perceive the relationships between informal learning and school readiness?

RQ3. What attitudes do parents have about engaging their children in informal STEAM activities?

Within the context of informal STEAM learning, the researcher is interested in understanding the FoK that the families and the children brought to the STEAM experience that may be captured in the dialogical evidence that emerges. Considering the wealth of knowledge and cultural resources they already possess, how does this contribute to the outcomes of the STEAM experience?

### **Methodology**

This section describes the research design, sampling technique, the participants, data collection and researcher positionality for the current study. A discussion of data analysis and trustworthiness is also explained here.

### **Design**

The current study was part of a larger study that included an intervention program with multiple components. The focus of the current study is on the qualitative inquiry stemming from the first iteration of the tool that was created for the purpose of the research. A qualitative inquiry focus group approach was used for this study to explore the lived experience of parents of preschoolers within the framework of the STEAM project. The researcher investigated the

experiences and perceptions of the parent participants who were offered strategies and support to facilitate informal learning at home. Qualitative research can be used to attempt to explain how situations and events influence others (Maxwell, 2013). Rather than seeking for rigor, and within the broad methodological framework of qualitative inquiry, this study aspired to use “artful science” to help both the researchers and the participants to understand the influence of informal learning at home through the context of the informal STEAM experience (Bochner, 2018, p.366).”

### **Project Components and Procedure**

The participants who were recruited for the study were given access to a website composed of six learning modules. The first module was intended for parents only, and introduced them to four facilitation strategies that they could use to support their children in informal learning, (1) providing feedback, (2) modeling, (3) asking for explanations, and (4) encouraging problem solving (Hsin & Wu, 2011). The succeeding five modules consisted of different STEAM activities for the parents to engage in with their preschool child. The parents had a period of 5 months to complete the modules.

During this period of time, parents were also invited to participate in parent support groups that were held virtually each month. A morning and evening session were offered monthly to accommodate all of the participants' schedules as far as possible. During each parent support session, one of the four facilitation strategies was discussed and parents were encouraged to share how they had experienced using that particular strategy. At these sessions, parents were also given the opportunity to talk about the learning modules and their challenges and successes with the STEAM activities.

Families were assigned the task of coming up with completing a final project that was based on one or more components of STEAM and was inspired by their child's interests as they worked through the modules. The culminating event of the program was a family night held at the local science museum where the children showcased their projects.

Accommodations were made at every step of the process with the intention of accessibility and inclusion of Spanish speaking families. All written materials were translated into Spanish, including the recruitment materials, surveys, email correspondence, and slides for our virtual sessions. A private translation company was hired to attend each of our virtual sessions to write live Spanish subtitles.

### **Sampling and Participants**

Criterion sampling, a purposive sampling technique (Palys, 2008) was used to recruit participants. The criteria for joining the study were (1) parent of a preschool child, (2) low-income, (3) local to the metropolitan area where the study was conducted, (3) English or Spanish speaking. Parents who met the criteria were recruited by way of fliers that were sent to the local Head Start preschool and the local community center for Spanish-speaking families. The flier was also advertised on the university's School of Education Facebook page. Parents who filled out the interest form were invited to a virtual information session so that they could decide whether or not they wanted to participate in the study. As a result of these recruiting methods, 43 families initially signed up to participate. The families who were recruited were parents of preschoolers in the local community with diverse backgrounds. The intended participants were families of lower SES, however, we did not turn away any families who wanted to participate based on their income. Families for whom Spanish was their first language were also targeted to participate.

Following the virtual information session, potential participants were asked to complete a short questionnaire, and upon return of the questionnaire, they were sent an information sheet. The information sheet was used in lieu of a consent form due to the exempt Institutional Review Board designation of the study. The total number of parents who joined the study initially by completing the questionnaire was 43. Thirty-nine of the pre-surveys were completed in English, and four were completed in Spanish.

### **Data Collection Methods**

At the end of the five-month period, focus groups using a semi-structured interview protocol were used as the data source for this study as a way to understand experiences from the participants and garner shared understandings about the project (Mills & Gay, 2019). Participants of the STEAM study were invited to participate in a focus group for the purpose of gaining information about their perceptions on the experiences and their attitudes about facilitating informal learning at home. See Table 1 for how the interview questions relate to the research questions.

**Table 1**

*Research Questions and Focus Group Questions*

<b>Research Question</b>	<b>Focus Group Questions</b>
RQ1. What are the parents' perceptions on participating in the informal STEAM experience? RQ1a. What are parents' understanding of informal learning? RQ1b. What are parents' perceived changes in their understanding of informal STEAM learning? RQ1c. What strategies do parents use to facilitate informal learning at home?	<ul style="list-style-type: none"> <li>● How would you define informal learning?</li> <li>● How would you describe your understanding of early STEAM learning?</li> <li>● Has that understanding changed since participating in the STEAM experience? If so, how?</li> <li>● Describe what strategies you would use to encourage your child to engage in STEAM activities?</li> <li>● What role do you usually play in your child's projects?</li> <li>● Tell me about a time you worked with your child on a STEAM related project. How did the experience make you feel?</li> </ul>

	<ul style="list-style-type: none"> <li>• Did your child's interest and motivation with STEAM change from the beginning to the end of the modules? How so?</li> <li>• What types of ongoing support can be offered to ensure the sustainability of this project?</li> </ul>
RQ2. How do parents perceive the relationships between informal learning and school readiness?	<ul style="list-style-type: none"> <li>• How often do you participate in your child's education related projects?</li> <li>• Do you think participating in your child's project activities helped/would help prepare your child for school/kindergarten? If so, In what ways?</li> </ul>
RQ3. What attitudes do parents have about engaging their children in informal STEAM activities?	<ul style="list-style-type: none"> <li>• How would you describe your understanding of early STEAM learning?</li> <li>• Has that understanding of STEAM changed since participating in the study? If so, how?</li> </ul>

Maxwell (2013) suggests that qualitative research is an interactive research design that is valuable in education research in that it allows for “interconnection and interaction among the different design components” (p. 3). This interaction is especially evident in the coding of the focus group transcripts. Fourteen of our parent participants volunteered to participate in the focus groups and they were divided into three groups. One couple who wanted to participate was not available at the times the focus groups were offered, so they were interviewed using the same focus group questions.

### **Ethics and Ethical Considerations**

The families who participated were offered a free computer tablet and a free year-long membership to the science museum were not mentioned in the recruitment materials. The potential participants did not learn about the free materials until they received the information sheet when they signed up to participate so as not to use coercion to influence them to join.

### **Trustworthiness and Validity**

Trustworthiness was addressed in this study by having 3 coders coding the transcriptions. The process for how this was done is explained in detail in the next section. Trustworthiness was

also established by memoing throughout the process on a shared document between the three coders (Maxwell, 2013; Shufutinisky, 2020). Validity was established by the participant-oriented program including long-term ongoing involvement, and the collection of rich data by way of focus groups and final projects (Maxwell, 2013). Over the course of the project, the researcher developed professional relationships with the parent participants through email communication and virtual face-to-face time during the parent sessions. These relationships could impact researcher bias and may have influenced the participants' responses in the focus groups.

### **Analytic approach**

The audio from the focus groups was recorded on personal handheld devices and those files were uploaded to Otter.ai transcription. One researcher cleaned the transcripts by removing the participants names and assigning each participant an identifying number. The researcher also edited the transcripts for clarity by listening to the audio recordings and correcting words/phrases that Otter.ai transcribed incorrectly. The cleaned transcripts were then uploaded to Atlas.ti for coding and analysis.

The transcript data were analyzed in a three-stage process, (1) the chunking of data into units and assigning codes to the chunks, (2) grouping the codes into categories, and (3) searching for patterns among the chunks and assigning themes to the patterns (Onwuegbuzie et al., 2009). In stage one, an inductive process was used for coding the transcripts and a structured process was used to ensure reliability. One researcher coded the first transcript and developed the codebook. Then, all three researchers met to look over the coded transcript and make any necessary additions and adjustments to the codebook and to clarify the codes and the definitions. Next, all three researchers separately coded the second transcript. Another meeting was held to go over this transcript and make sure the coders were all in agreement about the codebook and



how the codes were being used. At this meeting, nine new codes were added to the codebook, three different sets of codes were merged, and one code was removed. Code definitions were clarified once again, as needed. Once this reliability was established, each researcher was assigned to individually code a transcript. The first researcher, who had coded transcript one and developed the codebook, was assigned to code transcript three. A different researcher re-coded transcript one and the third researcher coded the interview, with all three researchers using the same codebook. Once all of the transcripts were coded, the researchers met to look for themes and analyze the data in order to answer the research questions (Bhattacharya, 2017). A categorical matrix was created, structured by research question, to aid in organizing the analytic process (Maxwell, 2013). Themes were determined based on dialogic patterns that emerged from the transcripts in relation to the research questions (Onwuegbuzie et al., 2009). The results from this process are described in the next section.

## **Results**

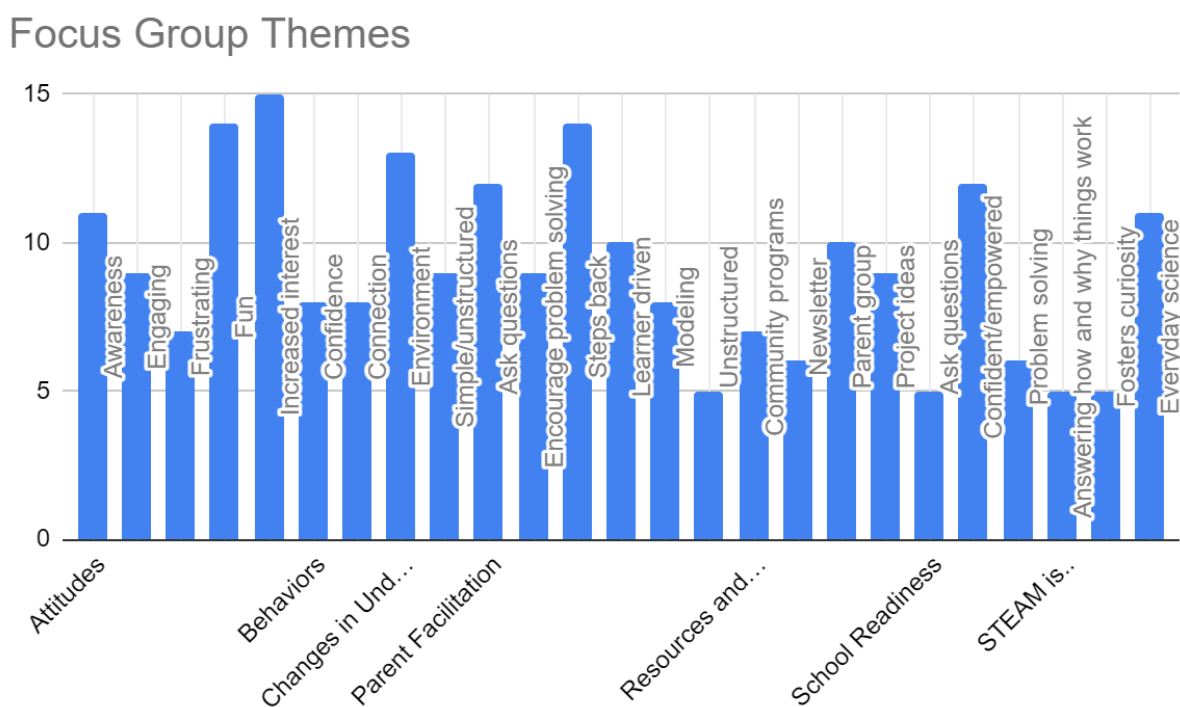
This section presents results from the focus groups and individual interview and the results of the project showcase event. The findings of this study suggest a positive influence on parent facilitation and attitudes. Specifically, access to facilitation support of informal learning experiences at home for parents of preschoolers (in this case, STEAM learning) does influence parent's attitudes about providing informal learning opportunities for their children. The results are also first shared as quantified codes. An explanation of the findings and the themes that emerged in relation to the research questions are presented next, and finally, the results of the project showcase event are given.

### **Overall Themes**

The coding process showed quantifiable themes. The codes were determined to be themes if they were mentioned five or more times by at least three different participants. These numbers were chosen as they show consistency of patterns across the discussions (Maxwell, 2013; Onwuegbuzie et al., 2009). The groups were organized by the major and minor themes within the major theme groups. The major themes are categorized as follows: attitudes about STEAM, behaviors learned from engaging in informal STEAM activities, changes in understanding about STEAM, parent facilitation of informal learning, resources and support, school readiness. See Figure 1 for a visual representation of the themes by the frequency in which they appeared in the coding.

**Figure 1**

*Themes from Focus Groups*



## Results by Research Question

Results and themes as they relate to the research questions are presented in this section. Each research question is addressed by the data collected through focus groups and individual interviews.

***RQ1 What are the parents' perceptions on participating in the informal STEAM experience?***

**Confident and Empowered.** The participants in this study expressed that since participating in the STEAM experience, they feel more confident in providing learning opportunities for their children at home and they feel empowered with better understanding about STEAM and informal learning in order to do so. One parent excitedly stated,

It's very empowering. I think all these things are super hard. I see them being done [by other people] and I think, wow, I could never be that person. And then I just try it. And first of all, now I am like a magician to my child, because these projects are like science magic. So, then I feel wonderful as a parent, because I'm teaching her, but she is also showing me all of the things that she knows and that she is grasping.

Another parent said, "This [STEAM experience] has been helpful for us. I now feel confident and feel that I can be competent in teaching [my child at home]."

**Better Connected to their Child.** Participating in the STEAM project helped the parent participants understand and better connect with their children. "The biggest takeaway for me wasn't exactly STEAM related, but the power of the caregiver-child relationship, especially in early education settings, just how meaningful and powerful building that relationship can be toward the development and educational growth of the child." For one parent, the nighttime bathtime routine became a time when they could connect.

I think the biggest feeling, I guess, is connected. Like with the float and sink module. We did that in the bath. And so we went around the whole house and collected all these things and you know, bath time at bedtime can get very boring every single day. And it was really nice to have a different experience at night and feel very connected during a time where I'm usually very, very tired and kind of done and ready for bed.

Several parents felt the same way, one said, "Yes, connect is a great word. Yes, I wholeheartedly agree with that." And one parent expressed how they would like to continue to have a way to connect with their child moving forward, "If I had a newsletter that came to me like once a month with ideas of how I can incorporate STEAM, we could have a special date that we always do, from that newsletter."

**More Intentional about Informal Learning.** The parents who participated in the STEAM experience said that now they realize that learning experiences can stem from everywhere, they are more intentional about engaging in informal learning with their children. One parent expressed their new intentionality toward informal learning in this way, "I think this project was wonderful at opening my eyes about how much we can be engaged [in informal learning] in everyday life, and there were some awesome ideas that were presented to us and that we got to try." In another instance, a participant expressed,

I would say that it's made me kind of slow down a little bit more, even though the days are still long and busy, but just thinking about how I can integrate my son into everyday things that are happening around us and to just explain it and see what questions he has, what kind of curiosity comes up, even with the most simple, mundane routine things.

Another parent explained, “But this [STEAM experience] had me being more intentional about putting time on the schedule to do something that is more structured, or do an activity that's more tailored to meeting an end, like flexible natural learning.”

**Resources Needed.** The participants were clearly excited to continue engaging with their child in informal learning activities at home. They suggested different types of resources and support that could be beneficial to continuing with STEAM learning at home.

**Knowledge of Community Programs.** One type of support suggested often by parents was that it would be helpful to have knowledge about community programs for engaging children in STEAM activities. One parent said, “I also like just talking to you guys tonight, about things like the library, like [STEAM project] bags, knowing where I could go in my own city and find different ways to help do projects and stuff.” Another parent chimed in about what they had found at their local library and a suggestion for making it even better,

At our library, they're set up in a very similar way where we can go and check out STEAM kits. And they always come with a book and a planned activity that you can do with your child. I think they could improve on theirs by adding an extension of how we can use that outside of the library and outside of using those things instead of coming up with our own plan.

**STEAM Newsletter.** Parents stated that a monthly or quarterly newsletter about STEAM would be beneficial in reminding them and motivating them to continue with STEAM activities at home. For example, “If I had a newsletter that came to me like once a month with ideas of how I can incorporate STEAM, and maybe even the tablet, into an activity with her, that would be awesome.” And in a second example from another parent,

I think a great way to make [the STEAM experience] sustainable is maybe once a month, once a quarter, something, give us a pop-up with, you know, here's two new ideas you might want to try, and just things to encourage us to keep reaching for it in a way that's easily manageable.

***Parent Support Group and/or Social Media Group.*** The participants explained that the monthly parent sessions that were part of the informal STEAM experience where they could talk to other parents about STEAM were extremely helpful in giving them ideas for strategies and activities that they could also try with their own child. The idea of a parent meet-up group, social media group, or support group was mentioned several times as something that could be a useful resource for sustaining informal STEAM learning at home.

I just think that overall, this project really has opened my eyes and has made me appreciate fellow moms. I love that we all could bounce ideas off each other [in the parent support meetings]. We got to hear each other's perspective. By bringing together all the people under the same project umbrella, I think it's just really helpful.

Another parent reflected about the value that the support groups offered,

I'm definitely going to miss the groups and hearing from other parents and the ideas that they came up with doing the same activity. Sometimes I'd go back and try to do that module again. Like, take it in the new direction, wondering if maybe I was too limiting in that module. So I can redo the module. I'm definitely going to miss the monthly groups where I heard what other parents were able to do with the same materials and same concepts that I was presented with too.

Another parent suggested the idea of starting a social media group that parents and researchers on the project could join to continue to share ideas with each other,

I am a big fan of Facebook groups. And that can be something that's parent-led, like if everybody that's involved in this wants to join this group. That's a way where the parents can put out ideas, the professors could put out ideas, and it could kind of keep everybody somewhat involved. You know, you might see things pop up, somebody did this, somebody did that.

***Project Ideas.*** Participants also said that ideas for future STEAM projects would be helpful in continuing to engage their children in STEAM learning at home. One such comment was, “I would love to receive different activity ideas to continue to incorporate [STEAM]. Because I was able to jot down just so many great ideas with the parent meetings, I would love to continue to receive different activities.” Another participant suggested,

I'd like to see resources out there to show parents how learning can happen everyday. And just giving them examples of how you can easily work the concepts into your everyday life without having to gather a ton of supplies, or buy a bunch of things, or even add extra time to the day. You can work it into little minutes. And you can use things that are already in your home. And just, again, the conversation piece of it, I think is huge, especially with the young kiddos. I would like to see resources that help encourage families to have those conversations and give ideas of simple things you can do at home.

***RQ1a What are parents' understanding of informal learning?***

The dialogue from the transcripts revealed that the participants have a solid understanding of what informal learning is. Several descriptors came up in the transcripts when

participants were asked to explain their understanding of informal learning. Some of the words and phrases the parents used about informal learning were, structured play, going with the flow, answering their children's questions, explaining how things work, giving feedback, being responsive, unplanned activities, and learner-driven. For example, one parent explained their understanding in this way, “I would say that [informal learning] is more unstructured play and just kind of going with the flow everyday, observing what's around you and explaining how everything works.” Another example is, “I think it can just look like play. So many times the kids are learning while they're playing. And it can also look like child-led exploration. If you're outside and they find something interesting and they just follow their curiosities.” One parent described informal learning this way,

I think that informal learning is any type of learning that isn't directly taught. So, it's like play, you know, something that they can just learn without having to sit and read or write and stuff like that. So, through play, just anything that they learned that can help them grow without having to sit them down and teach them.

And another parent suggested, “I would say it's like, unstructured, mostly learner driven versus instructor driven.”

***RQ1b What are parents’ perceived changes in their understanding of informal STEAM learning?***

The findings suggest that participants gained new understandings about STEAM after participating in the intervention. There were three sub themes that arose in this category.

**STEAM is Everywhere.** One new understanding that was prevalent was the realization that STEAM is everywhere and that materials and experiences from one's own environment can be used for STEAM learning. One parent realized, “I don’t have to have these materials. And,



you know, just using what's already in our environment, like more of a natural learning environment.” Similarly, another participant stated, “We can be in scenarios that have nothing to do with science, but using scientist skills like your senses and observation can turn it into science.”

**STEAM Learning can be Simple and Unstructured.** The other new understanding was the recognition that STEAM learning can be both simple and/or unstructured. A parent stated, “[My understanding] has definitely changed, like, okay, I don't have to be so structured. Another parent explained it this way, “But I agree with them, feeling like I don't need to set it [all up], like it doesn't need to be this big production. It just kind of happens.” One parent gave an example of how to turn a simple, everyday occurrence into informal learning, “[I learned] how to better engage my child, and, you know, something as simple as ‘Put your shoes on’, could turn into, ‘How do you put your shoes on?’ And then, having them figure it out!”

**STEAM is Understanding How and Why Things Work.** The participants’ understanding of STEAM grew in that STEAM can go beyond science, technology, engineering, the arts, and mathematics. STEAM is also about answering how and why things work and it fosters curiosity and creativity.. For example, participant one stated, “STEAM is just taking everyday occurrences and relating that to science and other elements and letting kids know this is how the world works and why these things happen.” Another parent explained their new understanding of STEAM in this way, “It's sort of observing things, putting things together. It just seems like it's starting to put pieces together of why things happen, and how.” Another theme that emerged in new understandings was that STEAM is something that fosters curiosity. Parents stated that with STEAM, even mundane and/or everyday tasks and occurrences can cause their

child to be curious and ask questions to broaden their understanding of the world around them.

Along these lines, a parent stated,

I would say [STEAM] is fostering creativity and curiosity. In everyday language with our kid, we use scientist skills, using senses and observation. And so we'll be in scenarios that have nothing to do with science. I will use the scientists' skills and try to make some of that language accessible for them, and build their toolbox in that way.

***RQ1c What strategies do parents use to facilitate informal learning at home?***

The results identified the parents' mastery of several strategies they use to facilitate STEAM and informal learning at home.

**Asking Leading Questions.** One strategy the parents use to facilitate learning with their children is asking leading questions. One parent stated, "As my kids are doing something, I might ask leading questions to encourage them to try something new." Another parent explained it in this way,

I discovered that asking open questions whenever she discovers a problem, instead of telling her the solution [is effective]. I sat back and I asked her a question that's more open, that makes her think, 'What, what would be the best way to solve this problem?'

Another parent explained that her role is to keep her child engaged and she uses this strategy to help, "I ask questions that I know the answer to, but to see what she thinks may solve the problem, or that may be important for us to remember."

**Modeling.** The parents rely on modeling to help their children understand how to do something. One participant stated,, "Sometimes I spend a good portion of the time modeling the

activity first.” A second parent stated, “When I see that he gets frustrated, I model some calm and then ask him how he thinks he could solve the problem and then just wait for his answers.” A parent explained how they model activities and create interest for their child in this way, “Sometimes I do the activity, and I’m sitting in her space. So, she’s being nosy and watching what I’m doing, and she asks, ‘What’s that, what are you doing?’ And then she wants to do it because she sees it.”

**Step Back and Allow the Child to Lead.** Since participating in the STEAM experience, parents state that they are more likely to step back and act as a facilitator rather than driving the direction of the activity. They allow informal learning activities to be learner-driven, letting the child’s interest drive the learning and allowing the child to make decisions on their own. One parent explained,

My take on [facilitating] is letting my child approach me with things that they want to learn about, or things that they have questions about and taking those interests or inquiries and then facilitating how we can explore them or answer them. Just, you know, allowing her to go through that and having a conversation with her, but also providing the materials for her to then explore encountering them on her own. And just sort of letting it go where it may go versus like, ‘Oh, let’s sit down and let’s talk about this.’

Another parent explained being allowing informal learning to be learner-driven in this way,

We don’t do a ton of projects, I’m not very crafty. So getting into this program helped me get a little bit more creative with ideas and things. And kind of, just like going based on his interest level. He’s more interested in learning and showing me what he’s retaining from school. So as interested as he is, I am. And

now that he's showing some interest, and he's excited about learning, I kind of just move at his pace.

**Encourage Problem Solving.** The participants also explained how they encourage their children to come up with their own solutions when they encounter projects. One example of this from a parent was,

I use modeling and positive responses. They definitely keep her motivated, and I also use problem solving. I try being intentional around those things. I think I've really seen the benefits of it. We'll be in the moment where we lose her attention and I say, you know, 'This is really hard and you really pushed through!' or 'You really kept going, you thought it through!' So, in the end it makes her so proud.

And it may give us a couple more minutes for her to engage.

Another parent explained that learning the strategy of encouraging problem solving has been helpful for her daughter,

I appreciated [learning the strategies] asking for explanations and problem solving. I think the two questions that I use as a parent are, 'Why do you think that?' and 'How do you know?' And I think just having those at all times has helped my daughter just sit in [the problem] for a little bit.

***RQ2 How do parents perceive the relationships between informal learning and school readiness?***

The parents who participated in the STEAM experience perceive that informal learning at home may have had a positive influence on their child's school readiness. Several substantive categories arose in support of this research question.

**Solving Problems.** In relation to the participating in the STEAM experience aiding in school readiness, one parent stated, “It’s going to be a long day without parents at school and I’m sure that, not just with STEAM related things, but just being able to solve those problems that pop up throughout the day.” Another parent stated, “I think it really helped her open up and explore her reasoning and her why for things that she was doing and learning.” One parent explained their child’s newly developed problem solving skills in this way,

I think overall, the guidance that I had from these modules is taking a step back and giving her the tools for her to succeed and for her to problem solve. And giving her the ability to think things out and plan things. Like, ‘How is this done scientifically?’ ‘What is the mathematics behind this?’ Like, really breaking it down for her and watching her take root in all of it, and just really start to grow.

**Asking Questions.** Participants also explained in relation to school readiness that their children are better now at speaking up when they need help or do not understand something. A participant explained it this way. “[My child] is learning to ask questions, clarify directions, and ask for help.” Another parent made this observation about their child, “She feels more comfortable asking questions instead of staying quiet in the background. She was shy when she was younger and wouldn’t really ask questions.”

**Following Directions.** The parents also perceive that STEAM experience has influenced their child’s school readiness in that they seem to be better at listening to and following directions. For example, a parent said,

[At school], you’re taking instruction from an adult and you have to follow directions. You have to be able to listen. And so it’s teaching those basic skills

that you need in a classroom. [Engaging in these informal learning activities at home] helps them transition into the classroom setting.

Another parent explained it this way,

I think the piece that is important is the idea to attend to a task you don't want to do. And so, her being willing to kind of sit with it, even if she wasn't thrilled, I think helps her to be able to be set up for times that she has to listen. She prefers to lead things versus having someone else do it. And so that I think is a really good way to help prepare her.

**Social-Emotional Skills.** The parents who participated reported that their children were growing their social-emotional skills. One example is how a parent noticed that their child seems better able to cope with making mistakes. “In a way I feel like it emotionally helped her. She didn't feel like she had to be perfect and she was okay getting things wrong. She was not like that before.” Another parent explained the growth in their child’s self regulation, “I would say that my child isn’t feeling pressure. She feels empowered to do the activities and feels confident and comfortable while she’s getting it done.”

**Confidence.** Another theme in the school readiness category is that the parents feel their children have grown in confidence. “My child is having that confidence to ask questions, and more comfortable not knowing the answers to things and realizes he can learn along the way.” Another parent explained their child’s growing confidence in this way,

I think now, engaging in this [STEAM experience] with me, asking him more of how he feels and his opinion about things. He's more confident. And I haven't heard that feedback at the current school, that he wasn't speaking up. He's really

engaged and he thinks he's everybody's ball. So maybe that comes with age or just doing this, but I've noticed that too.

Another parent said, "I think [my child has grown] in curiosity and growth mindset. They have confidence to make the mistake and know they're learning through it."

***RQ3. What attitudes do parents have about engaging their children in informal STEAM activities?***

**Fun and Engaging.** The participants realized that STEAM can be both fun and engaging for themselves and their children. As one parent expressed, "I didn't know if this [the STEAM experience] would be a task that I'd enjoy. But I have to say that I truly enjoyed it. I am truly grateful for the experience." A third parent stated, "But really, with science and engineering, it was fun to watch our kid turn on to those kinds of things." One parent laughed about how since participating in the STEAM experience and having so much fun with it, her daughter sees opportunities for projects everywhere, almost to the point of exhaustion,

I believe at the very beginning [of the STEAM experience] we kind of did these things low-key, but I never explained anything or dug deep into them. So, ever since I've been making her aware of things like, this is STEAM, she comes to love them and expect them and she's always kind of looking at things. And if we go through a cookbook or something she was always like, 'We can make this into a STEAM night project!' And now she's just always about STEAM. When we go out on hikes, she'll say, 'How can we turn this into a STEAM activity?' So, I'm kind of having to be like, 'Hey, we don't have to make it a big project.' So, she definitely thinks it's so much fun.

**Increased Interest.** Several participants mentioned their surprise at how engaged their child was when engaging in STEAM activities. “[The nature walk] was kind of fun and opened up my head a little bit to realize that [STEAM] was engaging for both of us.” Parents reported an increased interest in engaging with activities involving STEAM concepts. The excitement of the participants to continue engaging their children in informal learning at home was evident, and they feel like they have grown the skills needed to do so. This parent response explains this new attitude well,

My daughter's interest changed from the beginning to the end. Like I said, she really likes the art and the music. But I did see her become more interested in the science and the engineering. So now she talks about experiments and making up experiments and trying different things. And she likes to build more things now. So just seeing her grow within the science and the engineering part.

**Frustration and Increased Patience.** The participants also reported that engaging in STEAM activities with their children can be frustrating and felt like their ability to be more patient with their child through the learning process increased. Participants mentioned this both in terms of their child expressing frustration at times when engaging in STEAM and that they experienced frustration at times when encouraging their child to engage in STEAM learning.

[The STEAM experience] made me feel like I have to be patient, and made me feel that I have to create more space for her to lead, as to her interest areas, as opposed to telling her what we need to do. It really made me become more self-aware as a parent.



Another parent expressed a change in patience in both herself and her child, “I think she changed and we changed. She became more curious and easier to engage. I noticed the difference in her attention span. When we first started, she would lose interest and we were fighting to keep her motivated, but that has become easier for us.” Another example of working through frustration was explained by a parent in this way,

A lot of people had expressed the different aspects of frustration and we definitely had moments of frustration, but my overall feeling from the project was encouraging. I just loved how when doing the activities I was able to watch my child's thinking progress, and able to see those moments of enlightenment, and see the furrowed brows of frustration as they worked through those problems, and get to experience just watching them take an idea and then make it their own and take ownership of the things that they were doing. And I found that really encouraging.

### **Project Showcase**

The excitement among everyone involved was palpable at the project showcase event as families and community members engaged in STEAM activities together in a setting where FoK were honored and supported (Basu & Barton, 2007; Esteban-Guitart et al., 2019; Gonzalez, 2006, Moll et al., 1992). One participant said of the experience, “My boys were so impressed by the projects - they wanted to try everything! Since the STEAM night, each of my children have shown more interest in ‘making something’. On the weekends and during down time, they will often ask what kind of project we can do or create.” Another participant stated:

The Family Night was great for this because he got to see people outside of our family take a real interest in his work, hear their questions and their different

reactions. I think having that experience of presenting and seeing how your work is perceived and valued by others is really valuable, and although [name redacted] is not very eager to verbalize his feelings, I do think he felt accomplishment when new adults sincerely complimented our project. We also left with several ideas for new activities to try at home (the balloon racing, slime making and ladybug projects were of particular interest) and a lot of admiration for others' ideas and work.

### **Discussion**

The findings are promising overall and suggest that both parents and children may benefit when parents are supported in facilitating informal learning at home. The findings also suggest that informal learning through the context of STEAM activities may positively influence school readiness skills. Following is a discussion of the findings in relation to the implications for practice, implications for future research, and contributions to the theoretical foundations.

#### **Implications for Practice**

The results of this study are promising in terms of how offering support to parents in guiding their children in informal learning opportunities builds positive attitudes towards engaging in informal learning (Fang et al., 2021). When parents are offered strategies for engaging in informal learning, they are likely to continue to use the strategies in everyday life (Calzada et al., 2015; Gross et al., 2020; Hoover-Dempsey et al., 2005). This finding is meaningful because young children tend to spend most of their waking time in informal authentic settings beyond formal schooling. The findings suggest that parents are willing to step back and allow informal learning to be child-driven. They understand how to ask questions to improve their children's critical thinking skills and they know how to encourage their children to

solve problems (Hsin & Wu, 2011). They also use the strategy of modeling to show their children how to acquire new skills.

Participants in the informal STEAM experience realized that STEAM can be found everywhere, and therefore they see informal learning opportunities as readily accessible to their children (Tal & Dierking, 2014). The realization that everyday experiences and their own home and neighborhood environments can be used as tools for informal learning, and informal learning can be simple and unstructured. This implication is especially important when considering families who have been marginalized by our system (Nolan et al., 2016) and may have limited resources due to poverty, cultural barriers and/or language barriers in that science learning opportunities can happen without access to expensive or elaborate materials (Penuel, 2017; Philip & Azevedo, 2017; Riojas-Cortez et al., 2008). The results suggest that parents can benefit from receiving information about STEAM related programs within their communities. The findings also indicate parents can be empowered with knowledge and skills to influence their children's academic success and social emotional development through daily life routines.

The implications of this study for preschool educators suggest that facilitation skill-building in parents may impact a child's school readiness and for that reason, outreach and support for families is imperative (Banerjee et al., 2011; Peña, 2000). The participants reported that participation in the STEAM activities encouraged their children to problem solve, an important development in cognition, and participants also reported excitement about learning which is also a factor of school readiness (Ackerman & Barnett, 2023; Bettencourt et al., 2018; Child Trends, 2018; The Virginia Kindergarten Readiness Project, 2021). Participants reported that children are more comfortable making mistakes and don't get as frustrated as easily when

working on difficult tasks which implies emotion regulation, an important component of school readiness (Ackerman & Barnett, 2023; Bettencourt et al., 2018; Williams et al., 2019).

Findings suggest that participation in informal STEAM activities at home may have had positive influences in their children's learning, which can lead to school readiness. They report that their children are more confident to engage in learning activities and feel more empowered to take learning opportunities in directions according to their interests. This finding further confirms parents' positive influence on children's school readiness and long-term outcomes. The children who participated reportedly seem more comfortable making mistakes and using mistakes as opportunities for problem solving.

### **Implications for Research**

Further research could follow these parents to determine if they are still using the learned strategies as their children progress through elementary school. It would also be beneficial to further research to target larger samples of families whose first language is not English to see if participation in this type of project helps empower them toward more parental involvement in both at-home and in-school settings (Banerjee et al., 2011; Hayakawa et al., 2013). Focus groups and individual interviews through the current study provided rich data on parents' perceptions and attitudes. Findings from this qualitative study can help inform future research in identifying content areas upon which to develop intervention studies. The current study focused on parents' perceptions without direct observations of parent-child interactions or direct assessment of child outcomes. Future research could further examine the impact of parent-child interactions on children's school success.

### **Theoretical Implications**

Parents can be empowered by realizing the value in their own accumulated knowledge, skills, and cultural resources (Basu & Barton, 2007; Esteban-Guitart et al., 2019; Gonzalez, 2006, Moll et al., 1992; Riojas-Cortez et al., 2008). With the application of the four facilitation strategies the parents learned in the project modules (providing feedback, modeling, asking for explanations, encouraging problem solving) (Hsin & Wu, 2007), parents can weave together their FoK with the facilitation strategies they learned to continue to increase their child's interest in STEAM learning. Families can support one another when common bonds are established through the sharing of experiences with informal learning as was evident in the Project Showcase event (Abdul-Adil & Farmer, 2006; Peña, 2000; Sheldon, 2002). The results of this study are encouraging in that they suggest overall that when supported with facilitation strategies for guiding their children in informal learning, parents' perceptions of their ability to do so increases which seems to increase the likelihood that they will use these strategies with their children moving forward. However, the power structure that exists in the public school system cannot be minimized, even when individual students and families show promising results. School readiness and academic outcomes are consistently impacted by white dominant culture. Using the CRT paradigm allows for an analysis of power with respect to how the cultural practices of non-dominant racial and ethnic groups are overshadowed and marginalized by the dominant group. The current study contributes to this theoretical foundation by refusing to report the data of imbalanced school readiness outcomes without naming the power structures that contribute to these cycles of disparity.

### **Limitations**

The focus groups may have limiting factors such as the sample who volunteered for the focus groups ( $n = 15$ ) not being representative of the entire sample ( $n = 43$ ) who signed up to

participate in the study. Focus groups can also be limiting in the tendency for participants to give answers they deem socially acceptable. Because the researchers did not collect focus group data before the parents participated in the STEAM experience, this study is also limited in terms of understanding the FoK that the families and children possessed upon embarking on the STEAM experience and how this wealth of knowledge and cultural experience both grew through the study and at the same time supported the outcomes of the research. The findings of this study may be limited due to the small number of low-income families who volunteered to participate. Similarly, the low number of Spanish speaking parents who participated may be a limitation.

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**The Influence of Supporting Parents in Facilitating Informal STEAM Activities on Early  
Literacy Development**

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## **The Influence of Supporting Parents in Facilitating Informal STEAM Activities on Early Literacy Development**

There exists a set of intangible resources that are widely believed to be essential for optimal academic achievement in United States public schools such as family/school partnerships, learning enrichment outside of classroom walls, and access to informal learning at home. Before children in the U.S. even begin formal schooling, they are expected to possess a specific set of skills and knowledge in order to be deemed “ready” upon entering kindergarten (Ackerman & Barnett, 2005; Williams et al., 2019). Considering that public schools in the U.S. are culturally euro-centric, designed for the white middle and upper class with a power structure of white dominance (Dumas, 2021; Ladson-Billings, 2021; Milner et al., 2021; Soloranzo, 2021), it is not surprising that disparities exist among children’s school readiness outcomes across race, socioeconomic status (SES), language, ability/disability, and culture (Hayakawa et al., 2013; Ladson-Billings, 2022; Nasir & Hand, 2006). For example, the results of the Virginia Kindergarten Readiness Program (VKRP) (2023) suggest that 40% of children in Virginia arrive at kindergarten without necessary preparation to be successful in one or more of the critical learning domains including literacy, math, self-regulation, and social skills. Comparisons of VKRP data show that students who are historically marginalized were more likely to score below the benchmark overall. The 2023 data show 47% of Black children, 55% Latino/x children, 51% children from low-income backgrounds, 66% of English learners (EL), and 62% of children identified as having disabilities did not meet the benchmark for students entering kindergarten.

There is an immense amount of research supporting the importance of informal learning outside of school and the impact of parent involvement on school readiness outcomes (Ma et al., 2016; Tazouti & Jarlégan, 2019; Wilder, 2014). It is important to consider that the positive role

parents play in their children's learning may not be equitably recognized across culture, primary language and socioeconomic status, especially if parents are from low-income families or families whom our systems marginalize (Moll et al., 1992; Tan et al., 2020; Yosso, 2005; Yosso & Burciaga, 2006). Due to the hidden curriculum dominated by white culture, not all caregivers and parents have access, opportunity and/or the knowledge and skill base to adequately support their children's early informal learning experiences to prepare them for what is expected as "proper" school readiness (Giroux & Penna, 1979). There is a substantial body of literature that examines larger institutional spaces such as museums and after-school programs as sources for informal learning, but the home environment has been studied less often. Additionally, there is limited research on parent involvement in informal STEM (science, technology, engineering, and mathematics) learning (Thomas et al., 2020).

Considering the research that suggests early STEM opportunities may positively influence young children's school readiness outcomes (Duncan et al., 2007; Kilbanoff et al., 2006; McClure et al., 2017; Son & Hur, 2020), this study seeks to address the gaps in informal STEAM (science, technology, engineering, the arts, and mathematics) research (Penuel, 2017; Philip & Azevedo, 2017; Tal & Dierking, 2014). This research also seeks to broaden the discussion from STEM to STEAM (to include the arts) and to deepen understanding of ways to build parents' confidence and skills in facilitating informal learning at home regardless of cultural and social identity and SES. This study also attempts to examine intersections of STEAM, early literacy, and parent involvement.

## **Literature Review**

The following section summarizes the literature that supports the need for this study. The review of literature is divided into four sections, (1) early impacts of STEAM, (2) relationship of

STEAM with parent engagement, and (3) relationship of parent engagement with child outcomes, and (4) risk factors. The literature is also examined through the lens of Critical Race Theory (CRT) to support the theoretical framework of this research.

### ***Early Impacts of STEAM***

Analogous to how necessary it was (and of course, still is) for children to learn to read during the industrial revolution, it is now equally as necessary for children to understand and have skills in STEAM in our current technological revolution (Aldemir & Kermani, 2017; Dou et al., 2019; Hurst et al., 2019; McClure et al., 2017). Aside from the need for technologically advanced students at a national level, at the individual level, STEAM experiences early in life can support children's brain development across the spectrum, from cognitive and executive function to literacy development (McClure et al., 2017). Chesloff (2013) builds a case for early STEAM through research that suggests the brain's receptivity for math and logic is high in the early childhood years. For example, math has been shown to be integral for teaching reasoning skills beyond number identification and counting. Allowing children to talk about their mathematical thinking can lead to cognitive development across subject domains (Kilbanoff et al., 2006; Son & Hur, 2020). Furthermore, preschool mathematics skills may predict future academic success even more so than early literacy outcomes or social-emotional developmental skills such as paying attention (Duncan et al., 2007).

Similar to the positive outcomes reported from early mathematical reasoning, early science experience and investigation is shown to improve science inquiry skills and foster positive attitudes which correlate with science achievement (Aldemir & Kermani, 2017; Goldstein et al., 2019; McClure et al., 2017; Saçkes et al., 2011). One study examined parents' science talk in an outdoor play space and the findings suggest that both parents and children

crave and benefit from spaces that promote science talk in active, informal settings (Goldstein et al., 2019). Shared scientific thinking between parent and child has been suggested as a way to promote scientific growth, maybe even more so than when talking with peers or by themselves (Crowley et al., 2001).

Dou et al. (2019) studied how early interest and identity in STEAM may impact students' future career choices. The researchers asked participants to take a retrospective look at early STEM experiences, the results suggest specific childhood experiences that may have contributed to later STEM identity, (1) talking with friends and family about science, and (2) watching science media, both fiction and nonfiction, as a child. These findings indicate the importance of the parent-child connection and conversations around science and other STEAM related topics for children's interest and engagement (Dou et al., 2019). Furthermore, children benefit within the context of social learning, and conversations around STEAM encourage children to explain their thinking which may result in deeper understanding and enhanced learning (Hassinger-Das et al., 2020; Hurst et al., 2019).

These types of conversations also shape a child's language development, which is a key component of early literacy skills (Hoff, 2006; Lonigan & Shanahan, 2009). Kennedy et al. (2006) examined the boundary crossing that exists between early mathematical and literacy development and the findings suggest that learning through play can support both sets of skill domains. Another study infused literacy into STEM activities and found that children were simultaneously developing oral language skills and academic vocabulary while also practicing problem solving, collaboration, critical thinking and creativity (Rivera & Molina, 2017).

### ***Relationship of STEAM with Parent Engagement***

Parents can be a powerful and pivotal resource to a child's early brain development and school readiness considering the continual presence they have in their children's lives, even when children start formal schooling. Only 10% of their time is spent in school (Bell et al., 2009; Hull & Newport, 2011; Osborne & Dillon, 2007). Considering the positive impact of early STEAM experiences as suggested above, family engagement in STEAM can serve as an impactful resource (Caldeza et al., 2015; Gross et al., 2020; National Science Teachers Association, 2009; Van Voorhis et al., 2013). Research suggests that parents need support and guidance in STEAM in order to strengthen their confidence and efficacy in engaging their children in this type of informal learning (Philip & Azevedo, 2017; Tazouti & Jarlégan, 2019). Many parents report anxiety and lower levels of self-confidence around STEAM topics, and these attitudes can unwittingly be transferred to their children (McClure et al., 2017; Thomas et al., 2020).

### ***Relationship of Parent Engagement with Child Outcomes***

Bronfenbrennar (1977) suggested that children develop within "nested systems of influence" (as quoted in McClure et al., 2017, p. 13) in which the child resides in the center of concentric circles and is most closely influenced by their home environment, including parents, caregivers and siblings, and by their neighborhoods, teachers and peers. The National Association for the Education of Young Children (NAEYC) (2013) suggests that everyday life experiences can contribute to science learning when an adult provides a way for exploration and encourages conversation about what was done and what observations were made. These types of hands-on interactions with an adult guide can be related to later academic success (Tippett & Milford, 2017). Thomas et al. (2020) posit that parent involvement can benefit children both socially and academically. The socialization aspects that may be affected by a parent's

involvement are character and social emotional development as well as increased attention span for learning. Academically, a child can benefit from parent involvement with an improved attitude toward school, motivation, and attention to difficult tasks. Specific to school readiness and parent involvement with STEAM, research suggests that children grow their quantitative reasoning skills and problem solving (Hurst et al., 2019; McClure et al., 2017; Tal & Dierking, 2014).

Early literacy is considered as an important subset of school readiness which can be highly influenced by parent engagement. Early literacy development includes six skills that a child needs in order to be able to learn to read. These skills include vocabulary, print motivation, print awareness, letter knowledge, phonological awareness and narrative skills (Lonigan & Shanahan, 2009; Snow et al., 1998; Snow 2017). The development of oral language and literacy acquisition are inextricably and bidirectionally linked; the ability to learn to read depends on vocabulary skills, and reading provides an opportunity for vocabulary development. Children from lower socioeconomic groups are shown to be at a disadvantage in terms of exposure to vocabulary (Evans et al., 2016; Lonigan & Shanahan, 2009). Research suggests that this is due to parents from differing SES groups providing their children with disparate exposure to vocabulary (Stoiber & Gettinger, 2021; Vasilyeva & Waterfall, 2010). A rich home literacy environment in general contributes generously to the literacy acquisition of young children and the effects are long lasting, impacting the overall academic trajectory of the child (Lonigan & Shanahan, 2009; Sylva et al., 2010). Literacy researchers have determined that access to resources and opportunities are more influential than an individual child's skill attributes and deficits when it comes to early literacy development (Kennedy et al., 2006).

### ***Risk Factors***

The early literacy research noted above is important to address when considering school readiness outcomes. Research on early brain development suggests that early experience matters in terms of cognitive and social-emotional outcomes for school readiness. Multiple environmental factors in early childhood can cause toxic stress which leads to changes in brain circuitry and therefore can have negative effects on mental and physical health. Risk factors include lack of access to adequate healthcare, chronic neglect, emotional and/or physical abuse and exposure to violence (Williams et al., 2019).

Poverty is one of the most broadly known risk factors for school readiness. Isaacs (2012) reports that less than half (48%) of children at age five who live in impoverished circumstances are ready for school compared with 75% of children from middle- or upper-class homes. Statistics suggest that disadvantages are exaggerated for children in racial minority groups, more specifically for Black and Latino/x families. Nolan et al. (2016) used several sources of data to determine that in 2014, poverty was substantially higher for these groups, with the poverty rate of non-Hispanic Black and for Latino/x youth both at 28.2%, compared to the poverty rate for non-Hispanic white youth at 9.6%. Furthermore, in the 2020-2021 school year, more than half of the students in the United States qualified for free or reduced-price lunch (FRPL) (52.1%) (*Digest of Education Statistics, 2021*). Since the COVID-19 pandemic, the child poverty rate in the United States has more than doubled. According to the US Census Bureau, the rate increased from 5.2% in 2021 to 12.4% in 2022, which is estimated to be over 9 million children living in impoverished circumstances (United Way of the National Capital Area, 2022).

These economic disparities should be examined through the lens of CRT in order to ensure that the blame for such does not rest on the shoulders of the communities who already bear the brunt of marginalization. Racial discrimination has historically impacted housing,



employment, and educational opportunities for BIPOC communities and this discrimination works to keep the status quo in place (Dumas, 2021; Ladson-Billings, 1995; Milner 2021). Poverty, therefore, is not a result of merit, but rather of the long-term influence of systemic racism. Even if bridging the cultural gap between non-white families and schools was not already a barrier, families living in poverty often do not have the means to be involved with their child's education (Abdul-Adil & Farmer, 2006; Lee & Bowen, 2006). When families in poverty are trying to survive, there exists little space, time, and access to the resources that are necessary for creating a rich literacy environment.

In addition to barriers to rich literacy environments in the home setting, CRT analyses suggest that STEM has the characteristic of being the least inclusive discipline in both academia and U.S. Society at large (Philip & Azevedo, 2017; Vakil & Ayers, 2019). As a result, Black students often learn to internalize the dogma that their identities do not belong in STEM (Milner et al., 2021). Milner et al., (2021) suggests that transformation of the STEM discipline to be more inclusive, "...involves exploring the social, material, and health costs of academic achievement and problematizing STEM education, with an unapologetic focus on Black students in these places and spaces" (p. 365). Furthermore, positive racial identity in general is critically important to addressing the achievement gap (Banerjee et al., 2011; Ladson-Billings, 1994; Horsford et al., 2021).

### **Theoretical Framework**

This research is theoretically framed in Critical Race Theory (CRT) while also considering two learning paradigms: sociocultural theory (SCT) and funds of knowledge theory (FOK). According to SCT, learning has its basis in socializing and interacting with other people, and then is integrated by the learner at the individual level (Vygotsky 1978). Culture, within this

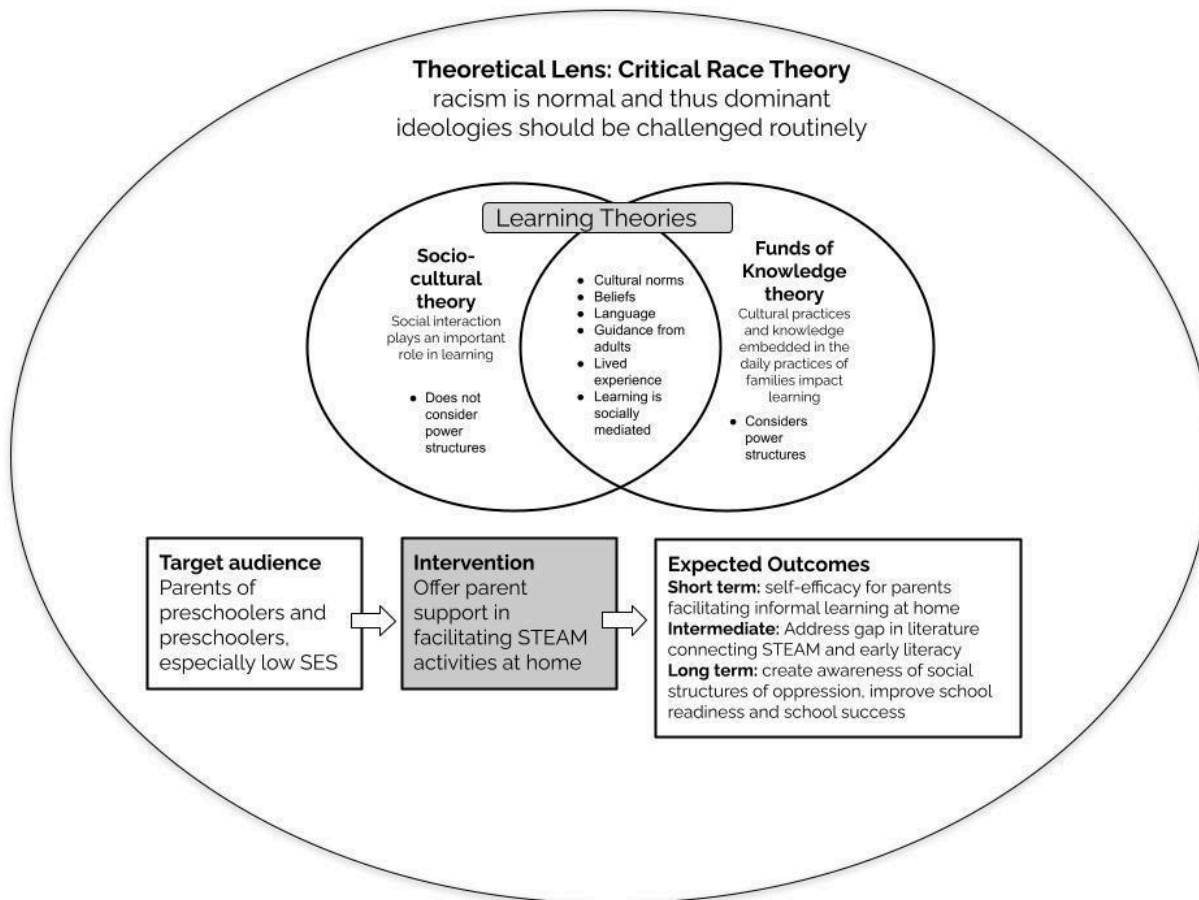
paradigm, is passed on through generations and is also constantly being created and recreated by the individual within local contexts (Nasir & Hand, 2006). This learning theory focuses on the interplay between people and culture and how they influence the way that we live and especially the way that we learn.

Similarly, FoK recognizes the importance of social groups and culture in the learning process, but arose as a direct challenge to deficit thinking in education, in which the onus for unsatisfactory achievement is placed on the students and families from marginalized groups (Esteban-Guitart et al., 2019; Gonzolaz et al, 2011; Moll et al., 1992; Moll, 2019). This theory proposes a repulsion of deficit thinking in education and instead, a thinking toward the value of the accumulated knowledge, skills, and cultural resources that students from historically marginalized groups have and acquire from their families and social groups (Esteban-Guitart et al., 2019).

CRT posits that the dominant (white) group still controls the rules and culture of our public schools and society at large (Ladson-Billings & Tate, 1995; Ladson-Billings 2022; Nasir & Hand, 2006). Therefore, this study uses FoK as a way to mediate the tensions between the SCT and CRT by recognizing the importance of culture while acknowledging the power structures that exist (Esteban-Guitart et al., 2019; Vossoughi & Gutiérrez, 2016). See Figure 1 for a graphic representation of the conceptual framework for this study.

## **Figure 1**

### *Conceptual Framework*



This concept map depicts how critical race theory can be used as a theoretical lens to examine achievement outcomes that are often presented as deficits of marginalized groups in public education. Two theories, sociocultural theory and funds of knowledge theory, drive this research in fueling the belief that home and family systems can be powerful tools for social and cognitive growth even before a child begins formal schooling. However, when approaching educational outcomes through a critical lens, the existing power structures of white dominance and white cultural norms are centered as foundational for the disparities in educational outcomes.

### Researcher Positionality

This project is influenced by the researcher's positionality as an elementary school reading specialist and anti-racist educator. She recognizes her implicit bias as a white woman and the privilege that hinders her experience to speak for marginalized groups. The professional understanding she brings to this research comes from 10 years of experience working in

under-resourced public schools and seeing how systemic racism and dominant white culture impacts opportunities for students whom our society, politics and education systems marginalize.

### **Research Questions**

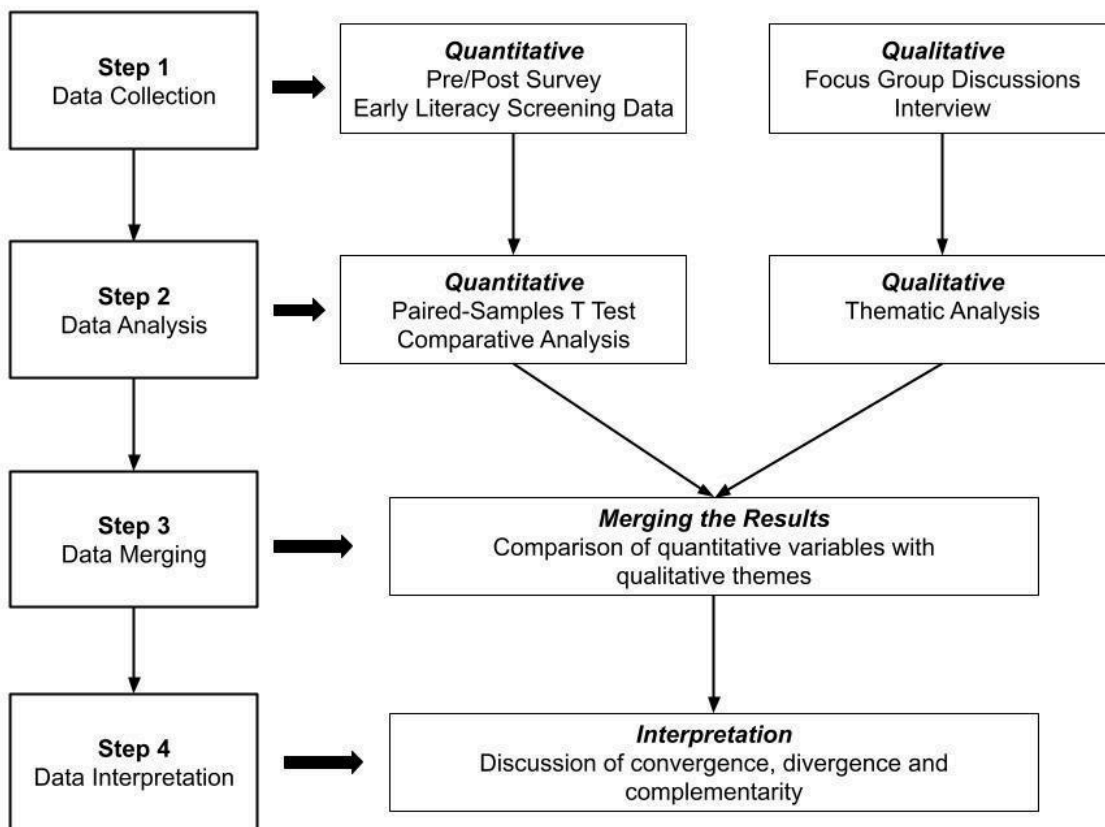
There are three research questions that guide this study. In each of these research questions, the term “parents” refers to the parents of preschoolers who participated in the study. (RQ1) How does parent-facilitated support of STEAM activities at home influence parent perceptions on their ability to facilitate STEAM learning? (RQ2) How do preschool parents perceive the influence of STEAM activities at home on their children’s early literacy development? And (RQ3) How are changes in parent’s perceptions of their ability to facilitate informal learning at home associated with the early literacy skills of their children? In addition to the research questions, the researcher is also interested in how the families use their own FoK to support informal learning. The hypothesis is that supporting parents in facilitating STEAM activities at home will positively influence their perceptions on their ability to facilitate STEAM learning. The working assumption is that informal STEAM learning may help build a child's early literacy skills.

### **Methodology**

This study was part of a larger study with several components. The current study used a convergent parallel mixed-methods design (QUAN+QUAL) where quantitative and qualitative data were collected concurrently but separately and carried equal weight in answering the research questions (DeCuir-Gunby & Schutz, 2017). The methods for the current study are explained in detail in the following section. See the flowchart in Figure 2 for the convergent mixed methods process used in this study.

### **Figure 2**

### Mixed Methods Flowchart



### Participants

Purposeful sampling was used to recruit parents of preschoolers with diverse backgrounds living in the metropolitan area surrounding the university in the southeastern United States where the study took place (Maxwell, 2013; Palys, 2008). The intent of the outreach measures was to recruit families who were self-designated as lower-income, but no family was turned away who wanted to participate. Fliers were distributed to the local Head Start preschool programs, and the study was also advertised on the university's School of Education social media site. The recruitment materials were printed in English and in Spanish. The number of participants who completed the initial survey was ( $n = 43$ ). The final number of participants, or

participants who completed the post-survey was ( $n = 30$ ). See Table 1 for a representation of the racial/ethnic, primary language, and household income demographics of the participants.

**Table 1**

*Participant Demographics*

Demographic	Category	Number of participants
Race/ Ethnicity	Black or African American	14
	White	12
	White and Latino	2
	Latino	1
	Asian	1
Primary language	English	28
	Spanish	1
	Gujrati	1
Income	Below 30,000	3
	30-60,000	4
	60,000 and above	18
	Prefer not to answer	5

**Setting/context**

For the purpose of the study, an at-home informal STEAM experience was designed for parents and their preschool children, the intent of the experience being to support parents in facilitating informal STEAM activities at home. The experience consisted of giving parents access to a website with six learning modules. The first module was designed to teach parents four different facilitation techniques: providing feedback, modeling, asking for explanations and

problem solving. The remaining five modules were STEAM activities for parents to engage in with their preschoolers while using the newly-learned facilitation strategies.

### *Parent Sessions*

For the duration of the study period, as parents were working through the modules with their children, parents were invited to attend monthly virtual support sessions. The parent sessions were not required, but participation was encouraged. Spanish captions were provided for each session. The support sessions followed the same format each month, (1) facilitators discussed one of the facilitation strategies and gave examples of how it could be used, (2) parents discussed how they had used that particular strategy with their children, (3) parents were offered time to share successes and/or challenges they were having with the STEAM activities, and (4) facilitators gave examples of ideas for final projects. The topic of each session and the number of parents in attendance can be seen in Table 2.

**Table 2**

#### *Parent Support Session Participation*

Session	Facilitation Strategy	Number of Participants
Month 1	Providing Feedback	23
Month 2	Modeling	23
Month 3	Asking for Explanations	16
Month 4	Encouraging Problem Solving	20

As is evidenced in the table, the number of attending parents each month remained similar with a range of 20-23 parents participating, except for the third month in which there were only 16 participants. This may have been due to the timing of the third session, which happened in July during the middle of summer break.

### *Project Showcase*

At the end of the study, parents assisted their children in completing a final STEAM project based on their child's interests. The families were invited to showcase their projects at a family event held at the local science museum. A total of 19 families participated in the project showcase to present their child's project. They were encouraged to invite family members and friends to the event which lasted from 6-8pm on a Wednesday evening. The event was set up in a project forum style, with tables set up around the perimeter of the room. Members of the university community were also invited to attend. A list of the projects and project developers can be found in Table 3.

**Table 3**

#### *Project Showcase Projects*

Project Title	Developers
Balloon Cars	Mother, father, son
Fizzy Chemy	Mother and daughter
Fairy Garden	Mother and daughter
Water Rainbow Ring	Mother and daughter
Lego Balloon Racers	Father, son, grandfather
Rainbow Birdhouse	Mother, daughter
Erupting Lemon Volcano	Mother and daughter
Pom Pom Drop	Mother, daughter, siblings
Underwater Fireworks	Mother, daughter
Magical Magnets	Mother, father and daughter
Rain Cloud Experiment	Mother, father, daughter
Alka Seltzer Powered Rocket Ship	Mother, father, son
Stethoscope	Mother, father, son



Girls Can _____!	Father, mother, daughter
Bottle Rockets	Mother, son
Racing Balloon Rockets on a String	Father, son, grandfather
Investigating Backyard Snakes	Mother, son
Ladybugs and Life Cycles	Mother and daughter
It's Goopy, It's Sticky, It's Slime!	Mother, daughter, granddaughter
Spiderman Kite	Father and son

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## Measures

### *Pre/Post Parent Survey*

A pre- and post-survey was administered to the parents who participated in the STEAM experience. Once the parents signed up to participate in the study and had been provided with the information sheet, they were emailed a link to the survey. The survey questions were adapted for the purposes of this study from the *YouthInsight STEM Influencer Survey* (Barwell, 2021). There were 46 survey questions, the first seven of which were for the purpose of determining the demographics of the participants. Following the section on demographics, the survey questions were multiple choice, with a Likert scale, and short answer to ascertain participants' understanding of, attitudes about, and experiences with STEAM. The questions were categorized by the following themes, (1) the participants' beliefs about the importance of STEAM, (2) the participants' beliefs about the usefulness of STEAM, (3) the participants' interest in STEAM, (4) the participants' confidence in guiding their children in STEAM projects, and (5) the participants' perception about the need for STEAM skills for acquiring jobs in the future. The surveys were administered online, to individual participants, with seven months of time in between them. For the purposes of this study, the questions around the theme of parents' confidence were examined. Examples of these items were, "How confident would you feel if you

had to support your child with projects related to STEAM in general?”, and “How confident would you feel if you had to support your child with projects related to science?” The survey questions can be found in Appendix A.

### ***Focus Groups***

Parent participants were offered the opportunity to participate in focus groups. The focus groups were held at the end of the intervention period, in three sessions, with a total of 14 parents who participated. One parent couple was unable to attend a focus group session, but still wanted to be included, so they were interviewed as a couple using the same questions that were used in the focus groups. The transcript data were analyzed in a three-stage process, (1) the data were chunked into units and codes were assigned to the chunks, (2) the codes were then grouped into categories, and (3) the chunks were analyzed for patterns and themes were assigned to the patterns (Bhattacharya, 2017; Onwuegbuzie et al., 2009). In order to ensure validity in the coding process, 3 researchers worked together to code the transcripts. See Appendix B for focus group protocol.

### ***Early Literacy Screening Data***

Parents who participated in the study were asked to voluntarily share their child’s fall 2024 early literacy screening scores. The literacy screening is administered during the fall and spring to all students enrolled in public schools in the state in grades PK-3. This screening gives a snapshot of critical literacy skills and identifies students who may be at risk for developing reading difficulties. For the purpose of this study, the summed scores of the children who participated in the STEAM experience were compared to the benchmark score for children of their same age.

### **Data Analysis**

The data were collected and then analyzed according to the research questions. The data was analyzed using paired samples t-test, transcript coding to draw out themes, and descriptive statistics. See Table 4 for an explanation of the methods, data sources and data analysis process for answering the research questions.

**Table 4**

*Method of Data Analysis by Research Question*

Research Question	Method	Data Source	Data Analysis
RQ1 How does parent-facilitated support of STEAM activities at home influence parent perceptions on their ability to facilitate STEAM learning?	Mixed Methods (QUAN + qual)	Pre/post parental survey data; focus groups	Paired T-test Examine transcripts for themes related to confidence
RQ2 How do preschool parents perceive the influence of STEAM activities at home on their childrens' early literacy development?	Mixed Methods (QUAL + quan)	Focus group data; early literacy screening data	Examine transcripts for perceptions of literacy development; compare benchmark score to reported scores
RQ3 How are changes of parent's perceptions of their ability to facilitate informal learning at home associated with the early literacy skills of their children?	Mixed Methods (QUAN + qual)	Pre/post parental survey, early literacy screening data, focus group data	Triangulation of the data from focus groups, surveys and literacy screening

## Results

In this section, the results of the quantitative analyses and qualitative findings are triangulated and interpreted by how they answer the research questions. The interpretation of the results will be explained by three possible outcomes: convergence if the results of the quantitative and qualitative findings are closely identical, complementarity if the results are similar but difficult to produce from one to the other, and divergence if the results are contradictory (Morgan, 2019).

### **Research Question 1: Change of Parents' Perceptions**

Results related to the change of parents' perceptions on their confidence in engaging their child in STEAM projects were based on data from the pre- and post-survey and focus groups/individual interview. Most of the questions related to parent confidence in the survey did show growth in the mean differences. However, the data from the pre- and post-survey and the focus group analysis are divergent in answering this research question. There was a type II error for the hypothesis that parents' confidence would be positively impacted by participating in the STEAM study as there was no statistically significant evidence to support the hypothesis. The focus group data does suggest that participating in the STEAM experience positively influenced parents' confidence in their ability to engage their children in informal STEAM activities. The data analyses from both measures are reported here.

#### ***Survey Results***

There were six survey questions related to parents' perceptions of their confidence in engaging in STEAM projects with their child. Four of the six survey items on parents' confidence increased from pre- to post- mean scores, although no statistical difference was identified. For the survey question about how confident parents feel in supporting their child with projects related to STEAM in general before they participated in the STEAM experience ( $M = 4.10$ ,  $SD = .80$ ) and after participating ( $M = 4.17$ ,  $SD = .79$ ). Similarly, for the question about parents' confidence in supporting their child with projects related to technology before participating ( $M = 3.93$ ,  $SD = 1.11$ ) and after ( $M = 4.03$ ,  $SD = 1.07$ ). For the question about supporting their child in engineering projects before participating in the experience ( $M = 3.5$ ,  $SD = .97$ ) and after ( $M = 3.8$ ,  $SD = .93$ ). Parents' confidence in supporting their child in projects related to the arts also increased from before ( $M = 4.10$ ,  $SD = 1.06$ ) and after the experience ( $M$

= 4.33, SD = .88). The parents' confidence did not change for the question about supporting their child with science projects. The survey results show that parents' confidence in supporting their child in mathematics went down slightly from before ( $M = 3.77$ ,  $SD = 1.01$ ) and after ( $M = 3.67$ ,  $SD = 1.27$ ). The descriptive data on the pre-/post- mean scores can be found in Table 5.

**Table 5**

*Means and Standard Deviations of Scores*

Category	Pre- Survey	Post- Survey	<i>p</i>
STEAM in general	4.10 (.80)	4.17 (.79)	.339
Science	4.13 (.73)	4.13 (.86)	.500
Technology	3.93 (1.11)	4.03 (1.07)	.299
Engineering	3.50 (.97)	3.8 (.93)	.111
Arts	4.10 (1.06)	4.33 (.88)	.122
Mathematics	3.77 (1/01)	3.67 (1.27)	.620

A paired samples t-test was conducted to compare parents' perceived confidence in supporting their child in STEAM projects before participating in the STEAM experience and after participating in the STEAM experience. Specifically, a paired samples t-test was conducted to compare the parents' perceived confidence in supporting their child in projects related to STEAM in general, science, technology, engineering, arts, and mathematics, respectively, before participating in the STEAM experience and after participating in the STEAM experience. No significant difference was found in any one of the five areas ( $p > .05$ ).

***Focus Group Results***

The researcher also used the focus groups and interview transcripts to determine participants' perceptions of their confidence in facilitating informal learning. The participants in this study expressed that since participating in the STEAM experience, they feel much more

confident in providing learning opportunities for their children at home. The theme of parent confidence was explicitly stated by 8 different participants. For example, one parent excitedly stated,

It's very empowering. I think all these things are super hard. I see them being done [by other people] and I think, wow, I could never be that person. And then I just try it. And first of all, now I am like a magician to my child, because these projects are like science magic. So, then I feel wonderful as a parent, because I'm teaching her, but she is also showing me all of the things that she knows and that she is grasping.

Another parent said, "This [STEAM experience] has been helpful for us. I now feel confident and feel that I can be competent in teaching [my child at home]." Another parent explained her new-found confidence in this way,

I would say the first [module] was the biggest eye opener. We did the nature walk activity where we made the Venn diagram. I was really hesitant that she would not understand the concept. But I was incredibly impressed. So, I felt really empowered that I, we, could do this, and I could show her something and she could actually understand what I was trying to explain to her. Especially when I was kind of blown away that we're asking a four-year-old to do a Venn diagram. But she did fantastic with it. And she still talks about it, like comparing her objects, and how things are the same and different. So, it felt like I could do this!

Another parent explained the couple's growth and confidence as facilitators in this way,

I think that she changed and we changed. She became more curious and easier to engage. I noticed the difference in her attention span. But when we first started,

she would lose interest. And we were fighting to keep her motivated, to keep her engaged and see it through. But that has become easier for us. It's easier to redirect her as needed. And she's more vocal about how she would like to see something go or how she would like to do things. I think that we've grown by allowing her to be more expressive, and to be more encouraging toward her, to be okay with silence and let her figure it out, and we ask better questions. So, I would say that there has been some growth on both ends.

### **Research Question 2: STEAM and Early Literacy**

The data from the focus groups and the data from the early literacy screening are complementary in answer to research question 2 regarding parents' perceptions of whether informal STEAM learning influenced their children's early literacy skills. The data analyses from both measures are reported here.

#### ***Focus Group Results***

There are six skills that are considered under the umbrella of early literacy development (1) print motivation, which considers a child's interest and motivation for reading/being read to, (2) the development of a child's vocabulary, (3) narrative skills, or the child's ability to retell the events of a story and/or explain something that has happened, (4) print awareness, (5) letter knowledge, and (6) phonological awareness (Lonigan & Shanahan, 2009; Snow et al., 1998; Snow 2017). None of the focus group questions prompted parents to discuss early literacy skills explicitly, however two themes around early literacy did arise in the conversations organically: increased vocabulary and narrative development. Moreover, the early literacy screening results for their children that 5 of the parents shared all show that their children are well above the expectations for early literacy outcomes.

As mentioned previously, during the focus groups parents revealed two early literacy skills that they perceived were influenced by the STEAM experience: gains in their child's vocabulary and evidence of narrative development. The idea of how STEAM may increase a child's vocabulary was coded 12 times by different participants in the focus groups and interview. One participant stated, "We would use the scientist skills, like using your senses and observation, and try to make some of that language accessible for them and build their toolbox in that way." Another parent commented that the projects helped them see what vocabulary their child was lacking and they were then able to teach them new vocabulary as they worked through the projects,

The module where we collected nature things and then put them in groups, I thought that went really well. But also, that's where I realized that vocabulary was associated with things. She was calling things large that really were heavy, and she was calling things different names that were maybe more generic, but not understanding some of the more descriptive words. So that was eye opening to me.

The skill of narrative development was coded fifteen times in the transcripts. For example, one participant explained how their child can now communicate better about what they are doing at school when they are away from the parent. They stated,

I just think this helps keep that communication open. We're getting to see how they are processing, what they're learning, and [then] them being able to express themselves confidently. Because my daughter's kind of shy. But once we started to do this, she now tells everybody, "This is what we're doing this week!"

Another parent explained how her child is able to narrate her own thinking process,



Instead of telling her the solution, I sat back and I asked her a question that's more open, that makes her think, what would be the best way to solve this problem? Like, for example, we were cleaning up the toy room. And she was getting frustrated because she didn't know where things went. So I said, "Well, where would you rather this go? Why would you put these things together?" And she was able to explain. She's like, "Oh, I'm putting all the people together, and putting all the dinosaurs together, but not the flying dinosaurs, just the dinosaurs with legs." She owned where she was putting her things and she was making her own categories, and the STEAM project has helped her learn to let her solve her own problems.

Along these same lines, parents mentioned that the STEAM activities created so many opportunities for conversations with their children. One parent said, "What really struck a chord with me as we were doing this project was how much collaboration and conversation plays a role in STEAM." Another parent explained that the strategy they learned to ask open ended questions really helped their child work through and narrate their problem-solving process,

I think the open-ended questions really helped me with my daughter in the projects because it [helped] her to really understand what she was doing and how she was doing it. It was the questions that kind of helped us know when she had an answer. There were not so many yes or no questions, but "Why do you think this happened?" And, "How do you think it went?" and stuff like that so that she can really think about [and explain] the process.

In addition, one parent mentioned how both conversations and vocabulary growth from the STEAM activities have helped prepare her child for school,

I think that these activities have definitely helped prepare my child for kindergarten. I think it's helped her language skills in being able to communicate her ideas and really just be able to express her thinking and I think that really helps in the academic setting. And, everything [from the modules] gives extra background knowledge, and when they are listening to books and learning to read and that sort of thing, I think anytime they can draw connections to knowledge that they've already learned or experiences that they've already had, I think that really supports their comprehension moving forward.

### ***Early Literacy Screening Results***

Five of the parents who participated in the study volunteered to share their children's early literacy assessment data with the research team. The scores on the literacy screenings support the qualitative findings. All five of the students entered kindergarten in the fall after the families participated in the STEAM experience. The benchmark score for students at this level is twenty-nine. The children in this study all received summed scores well above this benchmark. The range of the summed scores for the participants was 63-112. These data support the focus group findings of the positive influence of participating in STEAM and early literacy development in the parents' willingness to share the screening scores and in the high scores in relation to the benchmark.

### **Research Question 3: Association of Changes in Parent Perceptions with Early Literacy**

The data from all three measures, the surveys, focus groups, and early literacy screenings, were triangulated and interpreted to suggest that parents' perceptions of their ability to facilitate informal learning at home is positively associated with the early literacy skills of their children.

The data are mostly complementary in supporting research question three, as the means did change from the pre-test to the post-test on four of the related survey items, although the changes were not statistically significant.

The complementarity is evidenced in the following examples. One participant said that their understanding of STEAM changed which influenced their ability to facilitate activities at home, “I learned how to facilitate learning through different types of activities, how to make it more fun and how to use [things that happen] in everyday life.” This participant’s child scored 34 points above the benchmark on the literacy screening, and their confidence rose in all STEAM categories on the survey, except for the arts, which remained the same. According to the survey data, another parent felt high confidence in all of the STEAM categories before the project, and their confidence rose even higher after participating in the STEAM experience in the areas of science, technology and engineering. This parent’s child scored 83 points above the benchmark on the literacy screening, and they also reported growth in their facilitation skills in the focus group. “This experience had me be more intentional about putting time on the schedule to do something that is more structured and more tailored to meeting an end.” They also stated, “In scenarios that have nothing to do with science, I [encourage my child] to use scientific skills.”

There was also some divergence in results in answer to this research question. For example, one participants’ survey results showed that they have less confidence than before in five of the six survey questions. However, their responses in the focus group suggest a growth in confidence to be able to facilitate STEAM activities at home and their child showed above average scores on the literacy screening. They stated, “I think the most important thing I have taken away from this is just how easy it can be to do these activities in our own home.” Another parent similarly didn’t show growth in confidence from the survey, but did report more patience

for working with their child at home and increased skill in using modeling as a facilitation strategy. Their child scored 49 points above the benchmark on the literacy assessment.

### **Discussion**

This study adds to the literature in several educational categories such as parent involvement, informal learning at home, early STEAM learning and early literacy. Moreover, the research herein creates a new pathway for studying the intersectionality of early STEAM experiences and the relationship to the acquisition of early literacy skills. Approaching these educational domains through the lens of CRT offers the opportunity for perspective of the achievement gap as it relates to white dominance in U.S. public schools.

### **Implications for Practice**

The findings from this study are positive in that supporting parents by teaching them facilitation strategies may improve their confidence and skills in guiding their children in informal learning at home (Archer et al., 2012; Fang et al., 2021; Tazouti & Jarlégan, 2019). This was shown to be true regardless of the family's race/ethnicity and/or SES which suggests that schools should make efforts to support lower SES families to help them engage in informal learning at home (Calzada et al., 2015; Tan et al., 2020). Educators, stakeholders, and school officials should also be made aware of the Black educational inferiority narrative to see more clearly how achievement has been racialized in U.S. schools (Horsford et al., 2021; Ladson-Billings, 1994). With this awareness, more emphasis should be put into outreach for families whom our systems have historically marginalized, particularly for early informal learning opportunities and STEAM engagement (Milner et al., 2021).

The parents who participated in the STEAM experience were excited to continue engaging their children in informal learning experiences at home and in their communities. The

findings suggest that when parents are taught specific facilitation strategies within the context of STEAM, they also see ways to use the strategies at other times, in conversations with their children, during everyday outings, and when creating intentional learning activities. Providing online modules and virtual parent sessions is one way that schools and communities can support parents in this way. The findings of this study also suggest that providing parents support with informal STEAM learning at home can help them gain an understanding that learning can happen without monetary investment and elaborate resources (Dou et al., 2019; McClure et al., 2017). For example, everyday conversations and routine chores and activities can serve as opportunities for informal STEAM learning (Alexandre et al., 2022; Tal & Dierking, 2014).

The results of the study also suggest that engaging in informal STEAM activities may benefit children's understanding of STEAM concepts while developing early literacy skills simultaneously (Hoff, 2006; Kennedy et al., 2006; Lonigan & Shanahan, 2009; Rivera & Molina, 2017). Parents can be encouraged to engage with their children in STEAM activities while emphasizing content vocabulary and offering their children opportunities to narrate the process and explain the results. Educators and educational stakeholders can invest in books and resources that can be sent home to families to help bridge the gap between home and school (Abdul-Adil & Farmer, 2006; Evans et al., 2016; Lee & Bowen, 2006).

Furthermore, the findings show that the families used their own funds of knowledge in all aspects of the STEAM experience (Esteban-Guitart et al., 2019; Moll, 2019; Moll et al., 1994). This was evident in the discussions that evolved in the parent support sessions, as parents would share successes and challenges of engaging in the STEAM activities. Parents reported how they would tweak the activities in the modules to work with the resources they had at home and in their neighborhoods to meet the needs of their individual children. Other parents benefited from

hearing these ideas and then would try them at home with their own child. FoK was also evident at the project showcase night. There was a wide array of projects that families engaged in based on their own child's interest and the resources available to them. Some families had three generations in attendance to support their preschooler and to enjoy the other projects. The excitement that evening was palpable and accumulated knowledge was shared as children, families, members of the community, and researchers came together to engage in the family-created STEAM projects.

### **Implications for Research**

This study contributes to the existing literature with several implications for future research. Gaps were identified in the measurement of STEAM related empirical studies. The current study used convergent parallel mixed-methods design to collect quantitative and qualitative data concurrently, which generated rich data for triangulation. However, due to the limitations of the survey measure, there could be missed opportunities for collecting additional data if the focus groups were conducted prior to the survey. Future research could apply sequential mixed-methods designs with one measure informing the other throughout the research process leading to stronger outcomes (DeCuir-Gunby & Schutz, 2017).

The current study focused on engaging parents of children, with the assumption that teachers of these children would “buy in” the approach, helping to bridge the gap between home and school (Esteban-Guitart, 2019; Moll et al., 1992). Future research could explore both parents and teachers' engagement across settings, because the ultimate goal of the project is to get children ready for school. This study did not collect observation data of parent-child interactions. Future research could incorporate onsite observations or recordings to demonstrate parent-child

interactions as engagement evidence. The field could benefit from further research with a crossover between STEAM and early literacy.

Additionally, this particular study could be broadened with a larger sample of parents (i.e.  $n = 100$ ) with a focus on families with lower incomes and those who are historically underrepresented in STEM fields. Longitudinal research that follows the children who participate in the STEAM experience could be conducted to attempt to determine the long-term academic influences of early informal STEAM experiences and long-term impacts on interest in STEAM subjects.

### **Limitations**

Parents who signed up for the study may have likely been parents who were already engaging in informal learning activities at home before they entered the study. This limitation may have impacted their children's scores on the early literacy screening. This limitation also made it difficult to engage with the results through a CRT lens, as participants who volunteer for studies such as this may already feel a part of the larger system and those who are marginalized might not feel comfortable engaging in a study such as this, nor might they have the cultural knowledge of the white dominant system in order to engage and participate. There was no psychometric information available for the survey that was used for the study, so validity is difficult to ascertain. In addition, the survey results showed that parents' confidence in supporting their children in mathematics projects went down. This could be due to there not being any modules in the project that were explicitly mathematics activities. Another limitation was access to participants' early literacy screening scores. Many of the participants' children were not attending public preschools/schools during the fall semester that the study ended, so their early literacy data was not available. This contributed to the very low sample of early

literacy data. Additionally, the study's lens of CRT has a limited scope in this case because even though the participants were diverse racially, only one family who participated falls below the poverty threshold. It is always important to name white dominance when reporting academic outcomes, but for the reason stated above, it was not possible to compare the results of participating in the STEAM experience between groups based on demographics.



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## Appendix A

### Parent Survey

#### Part I: Parent profile.

What best describes your gender?

- Male
- Female
- Non-binary
- A gender not listed here
- Unsure how to describe myself
- Prefer not to say

What is your age?

- 18-24 years old
- 25-34 years old
- 35-44 years old
- 45-54 years old
- Others

What is the highest level of education you have attained?

- Some high school, no diploma
- High school graduate, diploma or the equivalent (e.g., GED)
- Some college credit, no degree
- Trade/technical/vocational training
- Associate degree
- Bachelor's degree
- Master's degree
- Professional degree
- Doctoral degree
- Other/Prefer not to say

What is your employment status?

- Full time
- Part-time/Casual/Contractor
- Stay at home parent
- Unemployed/Not looking for work/Other

What is your marital status?

- Single, never married
- Married or domestic partnership
- Widowed
- Divorced
- Separated

Please specify your ethnicity.

- White
- Hispanic or Latino
- Black or African American
- Native American
- Asian/Pacific Islander
- Other

What is your first language?

- English
- Spanish
- Other, please specify: \_\_\_\_\_

## **Part II: Parents' understanding and perceptions of STEAM.**

Please tell us what you believe the term "STEAM" stands for.

How much do you agree or disagree with the following statements about STEM education?

(1=strongly disagree; 3=neither agree or disagree; 5=strongly agree)

- Most or all jobs will require at least a basic understanding of mathematics and science
- STEAM skills are important when considering employment opportunities
- We need more emphasis on STEAM education from an early age
- STEAM skills will enable children to have well-paying careers in the future
- Preparing children for careers in STEAM should be a top priority for schools
- Most future jobs will require STEAM skills
- Compared to other countries, the U.S. is doing a good job of teaching STEAM

How much do you agree or disagree with the following statements about STEAM skills and how they can impact future careers?

(1=strongly disagree; 3=neither agree or disagree; 5=strongly agree)

- STEAM skills are applied in everyday life
- The number of jobs requiring STEAM skills is growing
- STEAM skills will provide security to future workers
- Interest in STEAM is cultivated from young age
- There are many STEAM related jobs currently available for graduates
- It is easier to engage boys with STEAM subjects compared to other subject areas
- It is easier to engage boys with STEAM compared to girls

- Boys have a better chance to succeed in a STEAM career compared to girls
- It is easier to engage girls with STEAM subjects compared to other subject areas
- It is easier to engage girls with STEAM subjects compared to boys
- Boys are better suited to STEAM careers than girls
- Girls have a better chance to succeed in a STEAM career compared to boys

How interested are you in topics related to STEAM and each of the individual STEAM subjects?  
(0=no interest; 1=low interest; 3=medium interest; 5=high interest)

- STEAM in general
- Science topics
- Technology topics
- Engineering topics
- Art topics
- Mathematics topics

How confident would you feel if you had to support your child with projects related to STEAM?  
(0=no confidence; 1=low confidence; 3=medium confidence; 5=high confidence)

- STEAM in general
- Science
- Technology
- Engineering
- Arts
- Mathematics

Which of the below would help increase your confidence to support with projects related to STEAM?

- Specific resources for parents
- Instructions from the school for parents about how best to support children with specific tasks
- General STEAM information from the school
- STEAM short course
- Don't know
- Other/None of these

In your opinion, how important is it for your child to have STEAM skills in order to acquire a good job in the future?

(1=not important; 3=somewhat important; 5=very important)

- STEAM as a general set of skills
- Science skills
- Technology skills
- Engineering skills
- Arts skills
- Mathematics skills

(Source: Items are adapted/selected from STEM Influencer Survey, YouthInsight, 2021)

## Appendix B

### Focus Group Interview Protocol

#### Introduction

**(Moderator):** Hello, thank you so much for taking time to talk with us today. My name is XXX (moderator) and I am a Ph.D. student at Virginia Commonwealth University. XXX is also joining us for this meeting as an assistant moderator.

**Assistant moderator:** Hi, I'm XXX and I am.. I will be helping out with notes today and I might chime in with some questions. Thank you so much for being willing to help us learn more about all the great work that you do.

Before starting, I would like to give you a very quick background of this afterschool project. The purpose of the project is to support parents to engage their children in learning informal STEAM related knowledge and skills. Parents participate in the project as facilitators to encourage children to learn new knowledge and to problem solve.

I've got a number of questions that I want to ask, but my job is really to listen. You are kindly requested to provide answers about the topic based on your current experiences and personal opinions. There are no wrong answers, only differing points of view. Please feel free to share your point of view even if it differs from what others have said. You are also free to ask for clarification at any time if you do not understand the question.

We're recording the session because we don't want to miss any of your comments. People say really helpful things in these discussions, and we can't write fast enough to get them all down. Do not worry about giving your opinion with full transparency. The discussion taking place will be kept confidential, and your names will be kept anonymous. You can withdraw from the discussion at any time.

Our discussion will take about 90 minutes at the most. We want this to be a group discussion, so feel free to participate without waiting to be called on. However, we would appreciate it if only one person speaks at a time. Be assured that all of you will have equal opportunity to express your opinions and please be respectful to opposing attitudes/statements expressed by other participants. There is a lot we want to discuss, so at times I may move the discussion along a bit.

If you have a cell phone, please put it on silent mode. If you need to take a call, please step out and then return as quickly as possible. For recording purposes, please state your first name before you answer each question. Your name will be replaced with a pseudonym during the transcription process. Does anyone have any questions before we begin? Is it okay if we start the recording now?

#### Understandings/experience

1. How would you define informal learning?

2. How would you describe your understanding of early STEAM learning? (Explain STEAM)
3. Has that understanding of STEAM changed since participating in the study? If so, how?
4. How often do you participate in your child's education related projects? What roles do you usually play in your child's projects?
5. Describe what strategies you would use to encourage your child to engage in STEAM activities and problem solve.
6. Have you ever attended a workshop, seminar, or training on STEAM related learning?
7. If yes, what strategies have you learned, and how have you applied these with your child?
  - a. What additional seminars would you like to receive to be more effective when working with your child on project development?
8. If not, what resources would you like to receive related to engaging your child in STEAM activities?
9. Please describe your child's final project. Did they initiate/decide the final project idea or was it parent initiated?

### **Attitudes**

1. Tell me about a time you worked with your child on a STEAM related project. How did that experience make you feel?
2. Did your child's interest and motivation with STEAM change from the beginning to the end of the modules? How so?
3. Do you think participating in your child's project activities helped/would help prepare your child for school/kindergarten? If so, In what ways?

### **Technology use**

1. How comfortable are you with using technology for educational purposes with your child/ children?
2. Did you encounter any challenges using a tablet for STEAM education? If so, what were they?
3. What types of support do you think parents would need to effectively use tablets?
4. Do you think the use of a tablet for STEAM activities enhanced your child's (children's) learning experiences?
5. What specific types of STEAM modules/ activities do you believe were more effective/ useful using the tablet?

### **STEAM learning and engagement**

1. What types of ongoing support can be offered to ensure the sustainability of this project?
2. Of all the things we discussed today, what do you see as the most important?
3. Is there something else you want to say? Have we missed anything?

## **Conclusion**

This dissertation confirms the importance of family/caregiver involvement and the need for more outreach to support parents in offering learning opportunities to their children outside of classroom walls. The project adds to the educational research literature in the fields of early STEAM learning, parent involvement, and early literacy development. The findings support the literature in emphasizing the benefit that informal learning can have on children's school readiness and early literacy. The study confirms parents' positive influence on children's school readiness and long-term outcomes. The findings also add to the body of educational literature in that supporting parents with facilitating informal learning can build their confidence in engaging their children in learning activities. This project offers suggestions for how schools, educators and communities can offer this support within the context of informal STEAM learning. The papers also offer a new perspective by way of the intersections of STEAM and early literacy and supporting parent involvement through facilitations strategies for early informal STEAM. A synthesis of the results of all three papers is organized here by implications for practice, implications for research, and implications for policy.

### **Implications for Practice**

Informal learning for young children can and should be considered a top priority for researchers, educators, policymakers and stakeholders. Children spend more than 80% of their time outside of formal school settings, even after they have entered kindergarten, so the importance of authentic learning opportunities in informal settings must not be overlooked. Parents' and caregivers' involvement in their children's learning and development happens naturally, but they may not realize it. Therefore, providing parent support and skill-building of facilitation strategies may help them realize their important role and build self-efficacy and



intentionality for doing so. Informal STEAM activities can serve as a powerful and motivating academic tool and parents can be empowered with support to implement informal STEAM learning at home. Communities who have been historically, and continue to be, marginalized should be supported first and foremost.

The findings of this project also suggest that cultural funds of knowledge should be recognized, honored, and capitalized upon in order to maximize academic success for students. Schools should make concerted efforts to bridge the gap between families and schools by learning about the cultural backgrounds of the children they serve. Recognizing each child's culture as wealth can support the learning process. Stakeholders and educators need to understand the impact of SES and the bigger picture of how those deficits came about in order to address the disparities head-on and effect positive change for those who are most vulnerable, our young children.

### **Implications for Research**

Researchers should be aware of how reporting results related to the achievement gap can result in further harm to communities who are marginalized by systemic racism. This dissertation is an example of how CRT can be used to frame educational research by naming systemic racism and marginalization as factors of disparate achievement outcomes. The first paper in the project, the systematic literature review, is an example of the lack of educational studies that consider research through the lens of CRT. Out of the 29 papers reviewed, none give mention to systemic racism and its impact on achievement outcomes. Researchers should commit to reporting findings in ways that recognize this marginalization. Further research that examines the connections between STEAM and literacy can benefit educators and families alike. A study similar to this can be undertaken with a larger sample to glean statistically significant data to

support the qualitative findings. Similarly, longitudinal studies that follow students through school after their families have participated in the STEAM experience could help determine possible long-lasting influences of participating in this type of study.

To further engage families from Spanish-speaking communities, researchers can work to build relationships before engaging in research. Community outreach can be attempted by hosting informal educational activities at local libraries and in community centers with bilingual facilitators. Accessibility of online modules for the purpose of informal learning should be considered when engaging with families who may not have readily available internet resources.

### **Policy Implications**

When considering policy on school readiness through a CRT lens while honoring funds of knowledge, stakeholders should consider the cultural wealth of communities who have been historically marginalized by U.S. public schools. What and who determines school readiness? Rather than relying on White cultural norms and traditional testing practices that may deem a child “ready” for school, policymakers should consider the funds of knowledge and skills that children gain from within their own families, neighborhoods and communities and build early elementary classroom environments and instruction to further support children’s development. It should be considered that perhaps children are already prepared and ready to learn in ways that cannot be addressed by current testing practices. Can new measurement approaches be developed to capture students’ strengths rather than what they are lacking? The intersectionality of sociocultural theory and funds of knowledge theory with a consideration of how power impacts educational policy should be considered in order to impact systemic change.

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