The Adoption of Children's Mathematics Education in Public Libraries for Underserved Communities in the United States: An Exploratory Qualitative Study from a Critical Perspective

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Dedication

This dissertation is dedicated to Daniel Goldstein, my family, my ancestors, the Chicana and Chicano communities, the American Indian communities of Mexico; my parents, Fructuoso Aviles and Maria Guadalupe Aviles; my siblings, Rey, Virginia, Josefina, Herlinda, Dolores, Fred, Lucy, and Abraham; and to all my nieces and nephews and aunts and uncles and cousins. And to the librarians who allowed me to interview them.

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Abstract

The purpose of this study was to explore the adoption of children's mathematics education for underserved children in public libraries the United States from a critical perspective. This study specifically explored access and the role of power in the application of Rogers' Diffusion of Innovations Theory (DoI) and the concept of culturally responsive mathematics instruction (CRMI) and utilized the critical exploratory research design that served to critique and challenge the notion that math education falls outside of the realm of library services and that math instruction is a culturally neutral activity. Application of the DoI theory to the phenomenon under study helped reveal how the factors that influenced adoption were characterized in the adoption of children's math in public libraries, which has been slow to spread among public libraries despite the need and obvious advantages. The concept of culturally responsive mathematics instruction explained how the innovation, children's math education for public libraries, was being communicated to those for whom it was designed to benefit.

Participants were selected through a purposive and snowball sample of librarians who provided children's mathematics education in public libraries to underserved children. This study utilized a theory/concept-driven deductive thematic analysis and a data driven inductive driven thematic analysis. A priori codes were identified based on concepts and constructs from Rogers' DoI theory, and these codes were used to generate themes through a thematic analysis. In addition, deductive codes were drawn from the transcripts to further generate themes and build theory through a thematic analysis.

Some of the themes that emerged from the theory-driven deductive coding process included: *librarians are teachers*, *librarians connect with underserved families*, *decentralization of power*, *innovation enhanced and created better quality of service*. The themes that emerged

from the inductive coding process extended the constructs of the perceived attributes of Rogers' DoI to include *access to resources* and *access to the innovation*. The emerging themes from the inductive coding also extended CRMI to include culturally responsive *library-based mathematics instruction*. Access and the role of power were expressed across concepts and constructs from Rogers' DoI theory and in CRMI.

Key Words: children's mathematics, critical perspective, Rogers' diffusion of innovations theory, the perceived attributes, adopter categories, access, power

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CHAPTER 1

INTRODUCTION

The current trend of librarians providing math instruction to children marks an exciting evolution in public library services. This innovation in children's mathematics instruction has been offered as a service in children's departments of select public libraries, mostly for children from prekindergarten through fifth grade (Cerny, 2004; Diamant-Cohen, 2007; Rupp, 2009; Wallace, 2010). Research on children's mathematics education in public libraries in the US is largely unchartered territory; recent studies have opened exploration into a part of children's public library services that had gone unnoticed for years.

Although a handful of articles address the experience of public librarians in implementing children's mathematics education programs, the research of Kliman, Jaumot-Pascual, and Martin (2013A, 2013B) appears to be one of the first significant studies on the topic. Their themed Math Off the Shelf (MOTS) research (2013B) consisted of a three-year survey experimental study that involved designing mathematics materials specifically for children's public libraries. These materials (referred to as *mathematics resources*) were introduced to children's librarians, in some cases through workshops, in four different regional library systems in Connecticut, Massachusetts and New York. The study found that when children's librarians were provided with access to library-specific math materials, librarians integrated mathematics into their program goals and formats; the study also referred to the public library participants in their study as *library-based informal educators*, or LBIEs, a label that implies that the librarians adopted the role of a teacher.

This topic of children's mathematics education is of particular interest in light of the inequities evidenced by the education research that indicates the presence of a math knowledge

gap between ethnic minority and White low-income children and their middle to high income White counterparts (Jordan, Kaplan, Ramineni, & Locuniak, 2009; Klibanoff, Levine, & Huttenlocher, 2006; Starkey, Klein, & Wakeley, 2004; Wang, 2008). This issue presents an opportunity for public libraries to provide supplemental access to math education for children from ethnic minority and White low-income backgrounds.

The math knowledge gap, the need for children's math education in public libraries, and the handful of successfully implemented mathematics education services presented an opportunity for the current study to explore the experiences and perceptions of librarians who adopt and teach children's mathematics programs to underserved children in public libraries of the United States.

Statement of Problem

Research on mathematics education has shown a need for programs that address the math knowledge gap (Wang, 2008) that is especially apparent among ethnic minority and White children from low socio-economic backgrounds. (Starkey, Klein, & Wakeley, 2004; Wang, 2008). The National Council of Teachers of Mathematics (NCTM) and National Association for the Education of Young Children (NAEYC) have recommended that institutions beyond the classroom should provide resources that will assist children to succeed in dealing with barriers to mathematical proficiency (NAEYC, & NCTM, 2010). Similarly, as some scholars and educators recognize the need to provide supplemental education outside of the traditional classroom to address knowledge and achievement gaps, they have suggested that communities "expand the walls of the traditional schoolhouse to encompass a much wider environment and set of resources" (Stage, Asturias, Cheuk, Daro, & Hampton, 2013, p. 8) because schools cannot be solely responsible for creating math rich environments for children. Since public libraries have a

history of addressing knowledge gaps among ethnic minority and White children from low-socioeconomic backgrounds by creating educational and literacy services (Arnold & Colburn, 2012; Howrey, 2003; McDowell, Stevenson & Mabbott, 2014), it makes sense that public libraries have taken on the task of providing mathematics education in public libraries, although not many have done so at present (Cerny, 2004; Diamant-Cohen, 2007; Rupp, 2009; Wallace, 2010).

Despite the need for mathematics education programs (Wang, 2008) and the benefits of supplemental programs for underserved children (McDowell, Stevenson & Mabbott, 2014), public libraries have been slow to adopt children's mathematics education programs. Furthermore, a review of the literature has revealed a gap in the research on math education in public libraries and in research from a critical perspective that has explored the experiences and perceptions of public librarians who have adopted and provided instruction for children's mathematics education programs to underserved children. More specifically, no previous research has explored the role of power and access in the application of the concepts of Rogers' DoI theory and the concept of culturally responsive mathematics instruction in the adoption of children's mathematics education for underserved children in the United States.

Purpose of Study

A critical qualitative exploratory approach was applied to the research design for this study. The primary focus of this study was to explore the perceptions and experiences of public librarians who work in libraries that have adopted and offered children's mathematics to underserved children in the United States. This study drew on the critical perspective to explore access and the role of power in the application of Rogers' Diffusion of Innovations theory (DoI)

and the concept of culturally responsive mathematics instruction in the adoption of children's mathematics education for the underserved in the United States in public libraries.

Research Questions

Research questions were informed by a theoretical framework. Since this study utilized a critical qualitative exploratory methodology, the term *characterize* was employed to maintain the qualitative nature of the research in order to offer openness and flexibility even though the study was theory/concept-driven. The following research questions guided the study:

RQ1: How are the factors that influence adoption characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ2: How is the role of power characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ3: How is access characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United Sates?

RQ4: How do public librarians characterize their mathematics instruction for underserved children in the United States?

Significance of the Study

The significance of this study can be found in the research concerns and recommendations from previous studies. Landmark research on mathematics education in public libraries recommended that public librarians learn more about integrating children's mathematics into their services (Char & Clark, 2011); thus, the relevance of applying Rogers DoI theory, which seeks to understand the adoption of innovations. Battey (2013) conducted research on "good" math teaching for children of color and children from low-socioeconomic backgrounds

and recommended research on instructional practices that impact math learning among ethnic minority children and children from low-socioeconomic backgrounds. That study asserted that the cultural aspects of a classroom, and other knowledge spaces, cannot be overlooked if researchers are to understand access to mathematics for students of color in addition to the role of teacher support.

The current study contributes to the work of both Char and Clark (2011) and Battey (2013); it also supports previous criticism of Rogers' DoI theory for its inadequacy when applied to contexts with social structures that are unequal (Salinas-Amescua, 2007). The current study applied Rogers' DoI theory to the phenomenon under investigation, coupled with the application of the concept of culturally responsive mathematics instruction from a critical perspective, in order to extend the theory to include two new constructs to the perceived attributes: access to resources and access to the innovation. By providing a more adequate application, this extended version of the Rogers' DoI theory does not overlook culturally and linguistically diverse and low-socioeconomic populations.

Delimitations, Limitations, and Assumptions

Delimitations

This study is bounded by delimitations for the purpose of narrowing the scope of the study for significance factors. This study includes the following delimitations:

1. the experiences and perceptions of public librarians or public library staff that provide or had provided children's math instruction at their public library.
2. public librarians that provide or had provided children's math instruction to underserved children in their math program.
3. public libraries in the United States.

Limitations

In quantitative studies limitations are typically features that may affect the results negatively and limit the generalizability; however, since this is a qualitative study, the limitations affect the transferability of the findings. The research focused on the experiences and perceptions of children's librarians regarding the adoption of children's mathematics education in public libraries and their experiences in teaching mathematics to underserved children. The participants were selected from a sparse population in locations across the United States, which resulted in the exclusion of some locations; as a result, transferability may have been compromised. Also, just as quantitative research data collection is biased, qualitative data collection may be similarly biased.

Assumptions

The names and email addresses of the participants (i.e., librarians) are assumed to be accurate. Also, it is assumed that the researcher maintained a lack of bias in conducting the study.

Definitions of Terms

The terms in the study that may be unfamiliar to the reader. Although some of these terms have commonly understood meaning in ordinary usage, particular definitions as used in this study are clarified as follows:

1. Adoption – This describes "[m]aking full use of a new idea as the best course of action available" (Rogers, 1995, p. 37).
2. Characterize – A term used "to describe the qualities of" (characterize, n.d.).
3. Children's mathematics – This indicates mathematics for early childhood, primary, and/or elementary age children, mostly pre-K through 5th grade.

4. Common Core Standards – The standards devised in order to "ensure all students are ready for success after high school, the Common Core State Standards establish clear, consistent guidelines for what every student should know and be able to do in math and English language arts from kindergarten through 12th grade. The standards were drafted by experts and teachers from across the country and are designed to ensure students are prepared for today's entry-level careers, freshman-level college courses, and workforce training programs. The Common Core focuses on developing the critical-thinking, problem-solving, and analytical skills students will need to be successful" (Common Core State Standard's Initiative, 2017).
5. Federal Financial Institutions Examination Council's (FFIEC) Geocode Census Report – "Geocoding refers to the Metropolitan Statistical Area/Metropolitan Division (MSA/MD), State, County, Census Tract combination (address information) that must be provided for each reported loan application and the System allows institutions to enter a street address to determine the corresponding geocode. The System also provides Census demographic information about a particular census tract, including income, population, and housing data." "FFIEC publishes certain census, income, and Metropolitan Area data for geographies" (FFIEC, 2017).
6. Innovativeness – A term used to describe "the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system" (Rogers, 1995, p. 37).
7. Math knowledge gap – This is "a significant gap in math knowledge that divides low-income [ethnic minority or White] students from their more affluent peers" (McCall & Fraser, 2010).

8. National Council of Teachers of Mathematics (NCTM) – The NCTM, founded in 1920, is the world's largest mathematics education organization throughout the United States and Canada, and "advocates for high-quality mathematics teaching and learning for each and every student" (NCTM, 2017).
9. National Association for the Education of Young Children (NAEYC) – This is "a professional membership organization that works to promote high-quality early learning for all young children, birth through age 8, by connecting early childhood practice, policy, and research; and [that works to] advance a diverse, dynamic early childhood profession and support all who care for, educate, and work on behalf of young children" (National Association for the Education of Young Children, 2010).
10. Rejection – In research, this is "a decision not to adopt an innovation" (Rogers, 1995, p. 37).
11. Underserved – This is a term understood to refer to those who have historically been provided inadequate opportunities and services by institutions (Green, 2006, p. 23).

Conclusion

Chapter 1 introduces the topic of the adoption of children's mathematics education for underserved communities in public libraries in the U.S, and indicated the critical perspective used to explore access and the role of power in the application of Rogers' Diffusion of Innovations theory and the concept of culturally responsive mathematics instruction. To present the statement of the problem, this study identified a gap in the previous research and supporting literature of the problem (i.e., math knowledge gap, need for math services in public libraries, and the slow adoption of math education programs for underserved children in public libraries). The chapter addresses the significance of the study in the recommendations and concerns about

the Diffusion of Innovations theory, the integration of children's mathematics in public libraries, and recommendations to further study math instruction environments that offer instruction to culturally and linguistically diverse children. Definitions and terms used in the study and the delimitations, limitations and assumptions associated with the study are also included in Chapter 1.

Organization of Dissertation

Chapter 2 provides a review of the literature pertaining to this study and a justification for the proposed research questions and theoretical framework. The review of the literature also explores critical perspective, power, access, Rogers' DoI, and culturally responsive mathematics instruction. The review of the research explores studies of the adopter categories, perceived attributes, culturally responsive mathematics instruction, mathematics education, math knowledge gaps among ethnic minority and White low-income children, children's mathematics education in public libraries, and the efforts of public libraries to reach the underserved. Chapter 2 also identifies gaps in the literature regarding mathematics education in public libraries.

Chapter 3 discusses the critical qualitative exploratory research methodology used in this study. It also provides explanations for the role of theory in qualitative research, and the study's research design, participants, samples, data collection, data analysis procedures, data-driven inductive and theory/concept-driven deductive coding, and trustworthiness.

Chapter 4 includes the qualitative data analysis of the study and findings as they relate to the theoretical framework.

Chapter 5 provides discussion, conclusions, and recommendations. It also includes implications for practitioners and for future researchers as reflected in the findings.

CHAPTER 2

LITERATURE REVIEW

Chapter 1 provided an overview of the statement of the problem, purpose, research questions, significance, delimitations, limitations, and definitions of this study. Chapter 2 reviews literature on the critical perspective, concepts from Rogers' 'Diffusion of Innovations Theory: the four main elements, the five attributes, the characteristics of adopter categories, the types of innovation decisions, the concepts of access and power, research on culturally responsive math instruction, and research on math education in public libraries. This review presents a conceptual and theoretical framework, provides literature on the concepts applied, and supports literature that placed the framework and concepts in the context of math education for underserved children in public libraries. The study engaged four research questions:

RQ1: How are the factors that influence *adoption* characterized in the *adoption* of children's mathematics education for underserved communities in public libraries in the United States?

RQ2: How is the role of *power* characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ3: How is *access* characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ4: How do public librarians *characterize* their mathematics instruction of underserved children in the United States?

Chapter 2 includes synopsis of the search used to locate bodies of literature pertinent to this study. The headings and subheadings that indicate the search process include: (a) Model of Theoretical Framework, (b) The Critical Perspective – Power and Access, (c) Rogers' 'Diffusion

of Innovations Theory – Four Main Elements that Influence the Diffusion Process, The Adopter Categories, The Types of Innovation Decisions, and The Perceived Attributes for the Persuasion Stage of the Innovation Decision Process, (d) Culturally Responsive Mathematics Instruction, (e) Review of the Research: An Overview, (f) A Review of the Research on the State of the Innovation, (g) Compensating for the Gap in the Literature, (h) A Review of the Research on the Adopter Categories, (i) A Review of the Research on the Perceived Attributes, (j) A Review of the Research on Culturally Responsive Mathematics, and (k) Summary.

The Search Process

This study employed online databases, including those of UTK Hodges, for the literature search. The primary databases were Library & Information Science Source, Library Information Science & Technology Abstracts, Education Source, Communication & Mass Media Complete, Business Source Complete, CINAHL Complete, ProQuest Dissertations and Theses Global (1861-present), and UTK Dissertations & Theses (Trace), and dictionary and encyclopedia databases as well as other online databases of Hodges Library. Google Scholar was used to locate any articles that may not have been included in the University of Tennessee databases. In addition, Google was used to locate articles and websites for background readings and to find miscellaneous articles. Articles were also accessed through the Interlibrary Loan Services catalog of Hodges Library. Key words used in these searches included: children's mathematics, math readiness, math*, early childhood mathematics, numeracy, libr*, public library, public libraries, library, libraries, science, technology, engineering, and mathematics, STEM, science, diffusion of innovations, perceived attributes, Rogers' attributes, adoption, public libraries, access, mathematics, power, qualitative, critical perspective, critical theory, critical, exploratory, characterize, among other terms. Phrase searches and Boolean operators were used in searching

for these terms. Given the limited number of research articles on the topic of math in public libraries, the literature review includes practical and informal case presentation articles and reports in addition to the peer reviewed articles.

Theoretical Framework

This study, draws on the critical perspective of Rogers' Diffusion of Innovations Theory and the concept of Culturally Responsive Mathematics Instruction (CRMI) (Figure 1). The Critical Perspective highlights the ways in which access and the role of power intersected with Rogers' DoI theory and the CRMI concept as applied to the phenomenon under study. Using the Critical Perspective and combining Rogers' DoI theory and the CRMI concept made it possible to explore the phenomenon layer by layer. Application of this theoretical framework resulted in a comprehensive analysis of issues of power, access, decision-making processes, hierarchies, the underserved, librarians (and library staff), the math knowledge gap, and math instruction with regard to the adoption of math education for underserved in public libraries in the United States.

The Critical Perspective

The critical perspective has its roots in Karl Marx's work on production and capitalism; in the 1930s the Institute for Social Research of the University of Frankfurt further advanced Marx's work on critical theory (Crotty, 2015). Although different interpretations of the critical perspective have been presented through the years (Denzin & Lincoln, 2011), the critical perspective has continued to bring attention to issues of power, oppression, privilege, inequity, injustice, and relationships between power and culture that intentionally or unintentionally create oppression (Crotty, 2015). Freire, a Brazilian educationalist who created literacy programs for the peasant class of north-east Brazil, placing attention on the oppressed members of society by developing a conscientisation – a critical consciousness (Crotty, 2015).

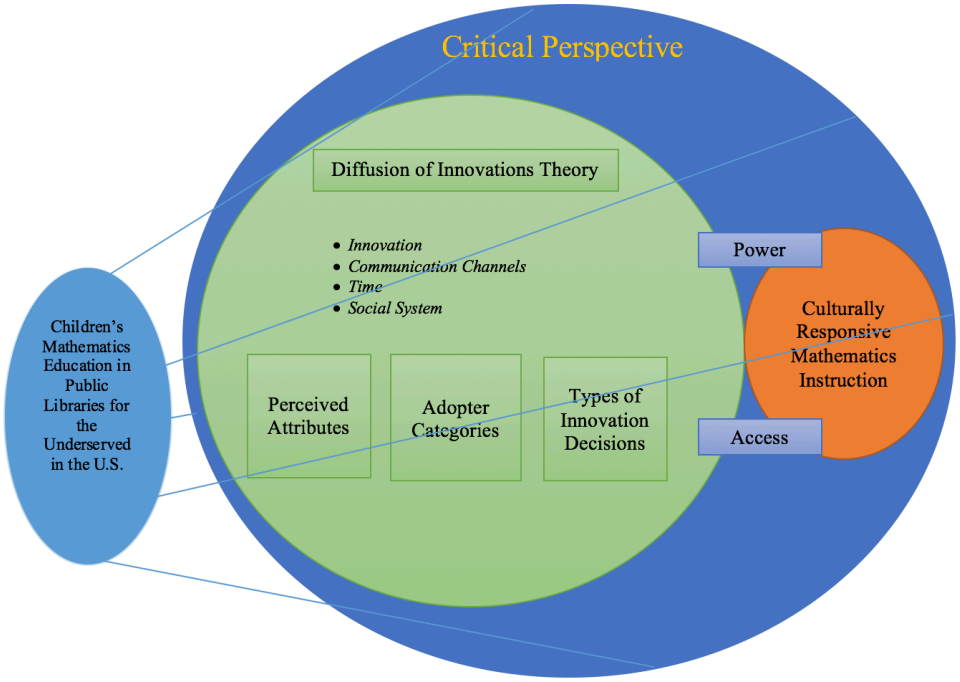

Figure 1. Representation of a theoretical model of the adoption of children's mathematics program for the underserved in public libraries in the United States as an exploratory qualitative study from a critical perspective.

Freire wanted to see the oppressed become critically aware of their true situation and take charge of their futures.

Using the critical perspective as the primary lens in the framework for this study challenged the prevailing assumptions about the social reality under investigation (Alvesson & Willmott, 1992), with the intention to bring about change (Crotty, 2015). This study permitted: (a) a deeper insight into the role of power and access of the decision-making process in public libraries, (b) a better understanding of access as it related to math instruction and math knowledge gaps among underserved children, and (c) a close examination of Roger's DoI theory in the midst of its application to a phenomenon that dealt with knowledge gaps and underserved communities. Furthermore, using the critical perspective not only provided an opportunity to

scrutinize the various layers of the hierarchies and decision-making processes of public libraries, but also assessed the public librarian's understanding of the math knowledge gaps found among underserved children. In addition, it opened up interview questions on race, culture, and class in regard to math instruction. This inspired awareness of an issue that appeared to be neutral or that had gone unnoticed by some participants as math instruction is sometimes seen as a neutral activity.

Power

The concept of power has been applied to different domains over the years and has accrued a series of definitions to match the complexity of the concept. *Merriam Webster* defines power as the "possession of control, authority, or influence over others" (power, n.d.). Max Weber (1947) linked power to bureaucracy, authority, and rule, and as dependency on another's direction or will while one's own opposition exists. Weber associated power with domination – based on economic or authoritarian interests – and hierarchic in bureaucratic frameworks. "Weber saw the organizational power of the bureaucracy [as] a threat to the freedom of the human spirit" (Sadan, 2004, p. 35). Manke (1997) believed that power was a structure of relationships and that this power, not the individuals who created it, shaped peoples' actions. Gaventa (1980) described power as something that can be used to prevent the participation of groups and individuals from participating in decision-making processes and can also be used to obtain a silent agreement, mute compliance with a situation (Sadan, 2004; Lukes,1974). When connected with control over resources, power has been described as having the potential to be used as a means to control or influence others (Emerson, 1962; Pfeffer, 1981; Turner, 2005). The influence of power can be based on rewards, costs, and positive or negative outcomes as "desired, valued or needed by others and which make them dependent upon the influencing agent

for the satisfaction of their needs or reaching their goals, and that different types of resources confer different types of power leading to different kinds of influence" (Turner, 2005, p. 2). Power has also been connected to access to resources in that resources can be used to influence the actions of others (Menge, 2018).

Access

Just like power, there are different variations of the definition of *access*, a concept used in multiple domains as well. As this study involved an adoption and decision-making process, and focused on those library services provided to the underserved in public libraries, the explanation of access will relate to the context under study as much as possible. The definitions that seemed most applicable came from a dictionary and peer-reviewed articles.

The *Collins English Dictionary* (2014) defines access as "the condition of allowing entry… the right or privilege to approach, reach, enter, or make use of something" (Access). De Jong and Rizvi (2008) defined access as "the match between societal commitment and institutional capacity to deliver rights and services and people's capacity to benefit from those rights and services" (p. 4). Emanuel and David Ackroyd's (1996) definition of access encompassed physical/structural/environmental, emotional/psychological, communication/ information, and financial characteristics. For Ribot and Peluso (2003) access involved "all possible means by which a person is able to benefit from things" (p. 156). Consolidating these definitions, access is the right to gain entry and have the privileges to use and benefit from something by all possible means without the obstruction of financial, emotional, or physical barriers.

Rogers' Diffusion of Innovations Theory

Rogers' (2003) DoI theory is based on his synthesis of 50 years of diffusion research. Diffusion of innovations research can be traced back to the 1940's. Rogers' DoI Theory has been used to understand how new ideas become incorporated in an organization. Organizations that are interested in learning how new ideas spread and become adopted have found Rogers' DoI theory useful in understanding this process (Lundblad, 2003). This theory has been of particular interest to those organizations that have had difficulty, despite its advantages, getting a new idea to spread (Ratts & Wood, 2011).

Public libraries in the United States have a history of adopting innovations. Some of the innovations at public libraries include: (a) learning, (b) civic and community engagement, (c) collections, (d) customer service, (e) economic and workforce development, (f) health, wellness, and safety, (g) operations, (h) organizational change and strategic management, (i) positioning the library, and (j) sustainability (Anthony, 2014). The dissemination of an innovation in public libraries is not necessarily about the adoption of a new idea in every public library in the United States but about considering the needs of the community and local circumstances and adopting innovations that create value in the lives of community members (Anthony, 2014).

Although Rogers' DoI theory has been used as the theoretical basis or part of the theoretical basis for several studies on the adoption of innovations in public libraries, it has not been applied to the adoption of children's mathematics education for the underserved in public libraries in the United States. Given that only a handful of children's mathematics programs exist in public libraries, and that there are even fewer offered for underserved children, the innovation is still considered a new idea that has not caught on.

Research on the adoption of innovations has been studied in a variety of disciplines, which makes application of the DOI theory to math education for the underserved in public libraries in the United States appropriate for the current study. Moreover, Roger's DoI theory has become one of the more widely used adoption models (Sherry & Gibson, 2002), possibly due to its multidisciplinary nature, practical appeal, generic theoretical model, and simplicity in research (Rogers, 2003). Rogers' DoI theory provides a conceptual lens for the explanation of the process that influences the adoption of innovations (Rogers, 2003).

Four Main Elements that Influence the Diffusion Process

The DoI theory provides a lens for identifying factors that could potentially influence the adoption of innovations. Rogers (2003) described diffusion as a process that involves the communication of an innovation among the members of a social system through certain channels over time. According to this description, any diffusion process is influenced by four elements: (a) innovation, (b) communication channels, (c) time, and (d) a social system. The current study focused specifically on the adoption of an innovation, that is, on the first element – innovation – of the diffusion innovation theory.

Innovation. An innovation is defined as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers, 1983, p. 11). If an innovation has been around for a long time, it can still be considered new if members of the social system perceive it as new. The concept of innovation is important in research terms because the perceived newness of the idea for the individual determines reaction to the innovation (Rogers, 2003).

Communication channels. The second element refers to the mediums used to exchange information between members of the social system. In order to introduce members of a social

system to an innovation, information about the innovation needs to be disseminated among its members (Rogers, 2003).

Time. The third element addresses the pace of progress and people's roles during the period in which the changes are being made. Time refers to the *innovation diffusion process,* the time between the introduction of a new idea and the decision to accept or reject the new idea. Time also refers to the *individual innovativeness* or the extent of the change and rate at which an individual in the social system accepts the new idea. Also included in this element is the relative speed with which a new idea is adopted, the *innovation's rate of adoption*.

Social system. The fourth element is represented by a set of interrelated individuals, groups, organizations, or subsystems working toward a common goal. The nature of the social system is key as Rogers (2003) claimed that it affects innovativeness of an individual; thus, its relevance in categorizing adopters.

Adopter Categories

Rogers (2003) defined adopter categories as "the classifications of members of a social system on the basis of innovativeness" (p. 22), which includes innovators, early adopters, early majority, late majority, and laggards.

Innovators. Innovators have been described as respected members of the social system, they are the gatekeepers who introduce the innovation to their system, and thus to potential adopters or rejecters. Innovators are willing to experience new ideas, able to handle some degree of uncertainty, and deal effectively with an innovation that fails to be adopted (Rogers, 2003; Sahin, 2006).

Early Adopters. According to Rogers (2003), early adopters tend to occupy leadership roles. They are well respected, sought out for advice, and provide information about the innovation. As leaders, their attitudes toward the innovation are important because they "play a central role at virtually every stage of the innovation process" (Light, 1998, p. 19); moreover, their adoption of the innovation decreases uncertainty about the innovation (Rogers, 2003; Sahin, 2006).

Early Majority. The individuals classified as the early majority are "deliberate in adopting an innovation [,] and they are neither the first nor the last to adopt it" (Sahin, 2006, p. 20). The early majority adopt the innovation before their peers, and "their innovation decision usually takes more time than it takes innovators and early adopters" (Sahin, 2006, p. 20).

Late Majority. The late majority are influenced by peer pressure and economic need. They tend to adopt the innovation only after most of their peers adopt the innovation, which allows for the reduction of uncertainty in the election of the innovation and makes those members of the social system feel safe to adopt it (Rogers, 2003).

Laggards. The laggards tend to be more skeptical about adopting the innovations and changes because they hold on to more traditional views. The decision to adopt or reject an innovation tends to take longer among this group; they want to make sure that the innovation is a successful idea and join in the adoption only after the innovation has been adopted by other members (Sahin, 2006).

The Types of Innovation Decisions

Another part of the Diffusion of Innovations Theory takes into account the various types of innovation decision: "Innovations can be adopted or rejected: (1) by individual members of a system, or (2) by the entire social system, which can decide to adopt an innovation by a

collective or an authority decision" (Rogers, 1983, p. 29). The categories of decision are as follows:

1. Optional innovation-decisions, which are *"*choices to adopt or reject an innovation that are made by an individual independent of the decisions of other members of a system" (p. 347);
2. Collective innovation-decisions, which are *"*choices to adopt or reject an innovation that are made by consensus among the members of a system" (p. 347);
3. Authority innovation-decisions, which are *"*choices to adopt or reject an innovation that are made by a relatively few individuals in a system who possess power, status, or technical expertise" (p. 347).

In addition, contingent innovation-decisions are "choices to adopt or reject that can be made only after a prior innovation-decision" (p. 347).

Innovation Decision Process

Rogers (2003) described the innovation-decision process as "an information-seeking and information-processing activity, where an individual is motivated to reduce uncertainty about the advantages and disadvantages of an innovation" (p. 172). The stages of the innovation-decision process are (a) knowledge, (b) persuasion, (c) decision, (d) implementation, and (e) confirmation; these stages follow one another chronologically. This study focuses on the persuasion stage by applying the perceived attributes from that stage to the phenomenon being examined.

Perceived Attributes of the Persuasion Stage

The five attributes of the DoI theory – relative advantage, complexity, compatibility, trialability, and observability – are concepts from the theory of perceived attributes. These five

attributes are also constructs of the persuasion phase, which is the second of the stages in the innovation-decision process directly influence the persuasion stage.

The persuasion stage, which is based on "feeling," follows the knowledge stage, which is more cognitive. Thus, the individual is more emotionally involved with the innovation at this stage. Uncertainty about the innovation in this stage is influenced by the peers or colleagues of the individual, which affects the individual's beliefs about the innovation (Sahin, 2006). The attitude of the individual toward the innovation is shaped in this stage, and uncertainty can be reduced (Sahin, 2006). The persuasion stage is identified and influenced by the five attributes of relative advantage, compatibility, complexity, trialability, and observability. These attributes help to decrease uncertainty about the innovation and influence its adoption or rejection. Rogers (2003) stated that "individuals' perceptions of these attributes play a role in the adoption of innovations" (p. 219).

In Rogers' Theory of Perceived Attributes, he identified the following five key attributes of an innovation that can influence uncertainty of the persuasion stage: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability. If individuals of the social system recognize or experience the relative advantages, compatibility, ease of use of the innovation, they will be more likely to adopt the innovation. Also, if they are able to observe the innovation in action and experience the innovation on a trial basis, this will address uncertainty surrounding adoption and rejection (Rogers, 2003; Sahin, 2006).

Relative advantage. The construct of relative advantage refers to the perceived benefits of the innovation by the individual in terms of economics, social prestige, convenience or satisfaction. Being seen as an improvement is an incentive to adopt the innovation. When a

member of the social system perceives the innovation as having a greater relative advantage, then the rate of adoption increases (Rogers, 2003; Sahin 2006).

Compatibility. The construct of compatibility refers to how well the innovation fits in with the existing community's values, practices, and norms, as well as its relevance to past experiences and needs. An incompatible innovation has less chance of spreading and being widely adopted (Rogers, 2003; Sahin, 2006).

Complexity. The construct of complexity refers to the extent to which an innovation is considered to be difficult or simple to use or understand. An innovation has more chance of being adopted when it is perceived as being simple (Rogers, 2003).

Trialability. This construct indicates the degree to which users can experiment with the innovation. Trialability provides a degree of control to the users/adopters and may influence early adoption of the innovation. The potential adopter has a chance to experience or modify the innovation without having to fully commit to it (Rogers, 2003; Sahin, 2006).

Observability. This construct refers to the visible beneficial results of an innovation. If individuals are able to see the results of the innovation, they are more likely to want to adopt the innovation. When individuals experience noticeable results, they are less uncertain; this also encourages conversation about the new idea with colleagues (Rogers, 2003; Sahin, 2006).

Positive and negative perceptions of the attributes play a significant role in influencing adoption. Since potential adopters form an opinion based on their perceptions of the innovation, the obvious benefits influence its adoption or rejection.

Culturally Responsive Mathematics Instruction

Understanding how aspects of Rogers' DoI theory are characterized in the adoption of children's mathematics education for the underserved in public libraries in the United States

provides significant insight into the innovation from the adoption component, given the relevance of underserved children in this study. However, by itself this framework would overlook the critical component of accountability for how the math instruction is being provided. Crucial in the framework of this study is the concept of culturally responsive mathematics instruction as it serves to include both children of color and low-income White children and is one of the main reasons this term is included in the study.

Culturally Responsive Pedagogy

Culturally responsive pedagogy is a concept and teaching approach developed in the early 1990s by educational theorist and university professor Gloria Ladson-Billings (Ladson-Billings, 1992: Ladson-Billings, 1995). Howard (2012) noted, "Culturally responsive pedagogy is an approach to teaching that incorporates attributes and characteristics of, as well as knowledge from, students' cultural background into instructional strategies and course content to improve their academic achievement" (p. 550). This teaching approach was designed to deal with the knowledge gaps between children from mainstream cultures and children from ethnic cultures and low-socioeconomic backgrounds. Culturally responsive pedagogy adapts curriculum, instructional materials, and teaching methods to the values and cultural norms of the students (Ladson-Billings, 1992: Ladson-Billings, 1995). Incorporating this form of instruction creates a learning environment that allows students to draw from their cultural experiences and cultural background. This, in turn, allows the students to learn new content, which enhances their educational experience and promotes academic success (Howard, 2012). In this context children of color and low-income White children are recognized as coming from vital cultures that were different from and clashed with the White middle-class culture of the schools (Branch, 2012). Furthermore, "The learning styles and values systems of these children were substantively

different from the learning styles and values systems that were expected and rewarded in the schools" (Branch, 2012, p. 512).

Culturally Responsive Mathematics

Culturally responsive mathematics instruction draws on the concept of culturally responsive pedagogy. Traditionally the practices of teaching mathematics were dominated by views that perceived mathematics instruction as culturally-neutral (D'Ambrosio, 2002; Gay, 2009). Research has shown that teaching mathematics effectively to children of color and low income White children involved instruction that met the learning and problem-solving styles of children whose cultures were incorporated into the instruction. Despite views that maintained that mathematics instruction was culturally-neutral, some scholars have exposed the cultural bias in mathematics instruction and claim that this cultural bias in math instruction has played a major role in affecting the success of students whose cultures were different from the White middle-class culture of schools they attended (Gay, 2000; Tate, 2005).

Aguirre and del Rosario Zavala (2013) posited that culturally responsive mathematics teachers must see math instruction as a "political activity rather than a neutral activity" and must develop a socio-cultural-political consciousness and "an awareness of the role power plays in school policies and curriculum practices, and actively seek to dismantle structures and practices that perpetuate inequities in mathematics education" (p. 167-168).

When a teacher "views the teaching and learning of mathematics as solely objective and culturally-neutral" (, 2011, p. 48), their teaching practices fail to meet the learning and problem-solving styles and processes of students who are not part of the dominant culture (Tate, 2005). This approach to teaching and learning mathematics that regards math as culturally-neutral has contributed to low motivation and lack of interest and success in mathematics learning

(Ukpokodu, 2011; Tate, 2005). Thus the relevance of an approach to teaching math that "uses students' cultural knowledge as a 'conduit' to facilitate the teaching-learning process" (Assembly of Alaska Native Educators, 1998; Ladson-Billings, 1995; Villegas & Lucas, 2002).

A Review of the Research on the State of the Innovation

Developing an understanding of the innovation of children's mathematics education in public libraries meant exploring a multilayered issue that drew from research on public libraries and math education. This review of the literature on the state of the innovation consists of literature on the importance of mathematics in the early years, mathematics knowledge gaps among the underserved, the experience of public libraries and their experience with underserved, and children's math education programs in public libraries in the United States.

The Importance of Mathematics in the Early Years

Children demonstrate an interest in mathematical concepts early. They count steps, create patterns, and observe differences among physical features, as well as exhibiting other curiosity in-line with their investigative natures (Brenneman, Stevenson-Boyd, & Frede, 2009). Exploring and understanding mathematics in the world around them helps children make sense of their physical environment. Through understanding numbers and shapes children find meaning in their world (Fromboluti et al., 1999). Mathematics is much more than performing operations, following the order of operations, and remembering a set of rules. Mathematics helps children learn to see connections, reason, think logically, and see relationships in things (Fromboluti et al., 1999). In short, mathematics is an essential part of everyday life from its earliest stage.

The National Council of Teachers of Mathematics (NCTM) and the National Association for the Education of Young Children (NAEYC) announced that mathematics education must be accessible in order to build a foundation for the future learning (NAEYC and NCTM, 2010).

Researchers found that early mathematical knowledge had an impact on a child's rate of growth in mathematics (Aunio & Niemivirta, 2010; Aunola, Leskinen, Lerkkanen, & Nurmi, 2004). Good predictors of later mathematics performance have been characterized by the development of early math skills (Aubrey, Dahl, & Godfrey, 2006; Aubrey & Godfrey, 2003; Jordan, Kaplan, Locuniak, & Ramineni, 2007; Kavkler, Tancig & Magajna, 2003).

Mathematics Knowledge Gaps Among Underserved Children

According to the National Assessment of Educational Progress (NAEP), the academic performances of United States students in mathematics were reported as falling between mediocre to extremely poor, and the average NAEP 2015 math scores among 4th and 8th graders indicated a significant achievement gap. Latino, Black, American Indian, and Native Hawaiian/other Pacific Islander groups of students demonstrated lower levels of math proficiency than White and Asian students; moreover, only 40% of all 4th grade and 33 percent of all 8th grade students performed at or above the proficiency level in NAEP mathematics. In addition, NAEP math scores also indicated differences among students from different socioeconomic statuses (The Nation's Report Card, 2015).

Research has also shown that knowledge gaps are more profound among children from marginalized communities. Knowledge gaps in mathematics between low-income children exist as early as kindergarten, which is made up of a disproportionate number of African American and Latinos/as, and middle- to upper-income children. Studies have shown that children from low socioeconomic status (SES) backgrounds tested more poorly in mathematics than middle-income children (Jordan, Kaplan, Ramineni, & Locuniak, 2009) and possessed less math knowledge than students from high- and middle-SES backgrounds (Klibanoff, Levine, & Huttenlocher, 2006), findings that were confirmed by the work of Starkey, Klein, and Wakeley

(2004). In research conducted by Wang (2008), a sampling of children nationwide were followed from birth to preschool age and found that there was a significant difference in mathematics knowledge and skill level between the 4-year old African American and White Children. Moreover, in terms of the achievement and skills gaps among racial minorities, African American and Latina/o children were reported as lagging behind White students in their overall academic skills upon starting kindergarten, some of which was attributed to low socioeconomic status (Duncan & Magnuson, 2005).

Studies have also shown a need for children's mathematics education that provides all children the opportunity to be prepared for the instruction and curriculum prior to starting kindergarten (Bottia, Moller, Mickelson, & Stearns, 2014). Receiving a strong foundation of mathematical knowledge in their early years has been shown to be critical for children's success in math in later years (Jordan, Kaplan, Locuniak, & Ramineni, 2007).

Public Libraries Working with the Underserved

A review of the literature reveals that public libraries have a history of providing services to the underserved as well as creating services that help alleviate knowledge gaps faced by underserved children. Public libraries often create services that meet the needs of underserved communities (Arnold & Colburn, 2012; Asher, 2011; Canham-Clyne, 2009; Howrey, 2003; Kuglin, 2009; McDowell, Stevenson, & Mabbott, 2014), for instance, Black storytime (Arnold & Colburn, 2012), Spanish-English bilingual storytime (Howrey, 2003), outreach to the poor (Bailey, 2014), services for immigrants (Asher, 2011), and services for refugees (Padgett, 2016). Public libraries make their services accessible to the underserved by removing barriers (Terrile, 2009) and modifying existing services to incorporate the needs of people from low socioeconomic backgrounds (Terrile, 2009) and/or ethnic minorities (Arnold & Colburn, 2012;

Witteveen, 2016). In their research, McDowell, Stevenson, and Mabbott (2014) found that children who participated in their local library summer reading program "scored higher on reading tests at the start of fourth grade and did not experience summer learning loss" (p. 2). These findings are relevant to the issue of knowledge and achievement gaps given that children from low socioeconomic backgrounds have been shown to be at risk for missing important reading milestones and to experience the loss of reading skills over the summer months (McDowell, Stevenson, & Mabbott, 2014).

Children's Mathematics Education in Public Libraries in the United States

The existing literature authored mostly by practitioners reveals that children's librarians have extended the role of the library by teaching children's mathematics through a hybrid library and "classroom" approach. Public libraries have a history of serving as teachers through literacy programs. As early childhood educators, public librarians have prepared young children for kindergarten and provided support to parents and caregivers and showed them how to further support their children's learning (Herb & Willoughby-Herb, 2001). Although public libraries have been widely recognized for their contribution to children's literacy (Herb & Willoughby-Herb, 2001), the literature also demonstrates that public libraries have incorporated both school-age and early childhood math education programs and practices into their children's library programs (Cerny, 2004; Kliman, Jaumot-Pascual, & Martin, 2013B; Rupp, 2009; Wallace, 2010).

Public libraries have implemented a diversity of children's math education programs, as well as integrating a math curriculum into their program goals, formats, and library practices. Some of the math programs documented in the literature include the How Tots Learn Lots Program at Queens Borough Public Library (NY), which introduced basic math and science

concepts to preschool children and prepared preschoolers for kindergarten (Cerny, 2004), What's the Big Idea?, a program that provided librarians with tools and instructional approaches introduces math and science to preschool and kindergarten children through literature by emphasizing child-directed, hands-on, personal acts of scientific and mathematical investigation (Rupp, 2009), and Math4U that was designed to develop and shape early math skills for preschoolers and kindergartners through fun activities like games, music, picture books (Wallace, 2010).

Mathematics Education in Public Libraries Makes a Difference

The literature indicates that How Tots Learn Lots Program, Math4U, and What's the Big Idea? and the math resources offered in the MOTS research all had an impact on the children, parents, and librarians.

These math education programs resulted in changing attitudes about mathematics among public librarians. Cerny (2004) discovered that there was an attitudinal shift among library staff to a more positive view of math and science; moreover, librarians were pleased with the training sessions and the books and other materials. In the What's the Big Idea? where the librarians also received training, Rupp (2009) noticed significant changes in librarian practices over time. Rupp (2009) found that the use of math and science vocabulary increased among the participating children's librarians, along with the availability of math and science-based resources for children. Also, more librarians used graphs and charts in day-to-day contexts (Rupp, 2009). These findings echoed those of Kliman, Jaumot-Pascual, and Martin (2013) whose study revealed that librarians reported more confidence in providing math activities and explaining math to children after being exposed to math resources and attending math workshops. These librarians reported integrating mathematics into crafts programs, story times, book clubs and

weaving math language into conversations with children (Kliman, Jaumot-Pascual, & Martin, 2013).

Improvement in Math Knowledge Among Children and Noticeable Parent Involvement

Cerny (2004) found that the math programs of How Tots Learn Lots were well received by parents and children: the librarians reported that toddlers were engaged and learning as they showed off their counting skills, ability to name animals, and/or the ability to successfully match objects. Rupp (2009) concluded that most parents of children in the What's the Big Idea? program reported that their children enjoyed the program and spoke about their experiences at home; most parents were pleased with the hands-on projects, the linking of books to activities, and the social aspects. Studying Math4u, Wallace (2010) described how parents reported that their children participating in the program used their new math skills at home (i.e., by counting cookies, flowers, fence posts, Cheerios, blocks, etc., in Spanish as well as English) and also that their children were more conscious of colors and shapes, and numbers in their environment, and more able to recognize patterns. The findings of Cerny (2004), Rupp (2009), and Wallace (2010), were in-line with those of Kliman, Jaumot-Pascual, and Martin (2013). According to Kliman, Jaumot-Pascual, and Martin (2013) librarians reported that children gained confidence in mathematics, developed math skills, showed enthusiasm for math, acquired confidence in explaining math, and perceived mathematics as relevant to their everyday lives.

A Review of Research on Adopter Categories

Of the research reviewed for this section, the studies on adopter categories provided a deeper insight into the complexities that result from the application of the adopter characteristics to phenomenon. Researchers mostly reported finding that participants fell into a specific

category as defined by Rogers' adopter categories, while at least one study reported that participants might change adopter categories.

In researching faculty innovativeness with technology, Jacobsen (1998) reported that early adopters had a tendency to be more self-sufficient in regard to technology support, relied on self-training for computer use, and were eager to experiment with the computer technology and ask for more computer access and assistance from colleagues, matching the adopter characteristics as defined by Rogers.

In a cross-case study on organizational change, the school classroom and technology, in two cases, Slamecka (2011) found that the teachers either fell into the innovator or early adopter categories as they matched the characteristics of Rogers' Adopter Categories (2003). Although Jacobsen (1988) and Slamecka's (2011) reported participants falling in line with one of the adopter categories, in a study on technology and EFL Learners that used the interview method, Polat (2016) concluded that the adopter categories might change from one person to another and that adopter categories might change in time or based on the technology that the participants decided to adopt. These conclusions suggest that adopters might display either different adopter characteristics at different stages of adoption; moreover, one might even conclude that adopters might have characteristics from multiple adopter categories.

A Review of Research on Perceived Attributes

This literature review included studies using mixed methods, case studies, and basic qualitative research that applied the perceived attributes to research. Most of the research in this review consists of qualitative research on the topics of technology and education. In the review of research on perceived attributes, coding was used to distinguish the prominent overlapping themes in the literature.

Construct 1: Relative Advantage

A review of research on the concept of relative advantage revealed three main themes: innovation was better than prior service, innovation enhanced and created better quality of service, and innovation met the needs of unique community. The studies mostly showed that relative advantage was key to its role in the adoption model.

Although the theme of innovation was better than what existed before is included in Rogers' definition of relative advantage, it was also a prominent theme in the literature on the perceived attributes as well. In a study of the experiences of high school language arts teachers who integrated technology in their courses, the adopters added the innovation of technology to their teaching and agreed that its advantage was in providing an education to the students that was more current (Byous, 2006). The adopters felt that it would have been a disservice to the students to not incorporate a much-needed component to the classroom like technology that would bring their classroom up-to-date (Byous, 2006).

In a similar study that investigated the concerns and perceptions of Iranian university instructors on technology integration in their classes, the findings revealed that incorporating this innovation provided better learning opportunities, and motivated the users (Ashrafzadeh & Sayadian, 2015).

Adopters experienced similar advantages in a study about an English as a Second Language (ESL) program that involved the adoption of a technology-enhanced blended learning (Grgurović, 2014). The innovation provided students with the opportunity to hone in on a specific type of academic skill that would benefit them in future courses (Grgurović, 2014).

Research on public welfare where the innovation involved a new parenting model also showed similar findings. One study on the implementation of Circle of Security (CoS), an

attachment-based model designed to promote positive parent–child relationships in public welfare showed that the new innovation was better than the prior service of didactic parenting classes (Blome, Bennett, & Page, 2010). In the application of another innovation when parents were able to view themselves on video, their empathetic capacity response to their children was strengthened (Blome, Bennett, & Page, 2010). Lee's (2006) study, which involved the use of new media-technology in a local church, found that the computer and software applications enabled the workers to achieve their tasks more quickly, thus improving worker productivity.

Much of the qualitative research on the perceive attributes discovered that innovations enhanced or created better quality of service. In the study on the perceptions of Iranian university instructors on the integration of technology, the adopters found that the innovation enhanced their service, i.e., quality of instruction (Ashrafzadeh & Sayadian, 2015).

In their interviews with teachers where Jwaifell and Gasaymeh (2013) applied the perceived attributes to research on the use of interactive whiteboards (IWBs) by English teachers, the researchers found that the innovation enhanced the quality of service for both the teachers (adopters) and the students. The innovation was perceived as a positive tool that facilitated the educational process by increasing students' attention span, showing the content in different ways, and proving to be a more efficient use of time and effort for both teachers and students (Jwaifell & Gasaymeh, 2013).

Perceived attributes were also applied to a study on notions of ABA-accredited law school deans with regard to distance education. The distance education innovation was perceived by the law school deans as an innovation that forced more engagement, more student involvement, and the development of richer curriculum (Oswald, 2017). In Saint Rain (2005), a study where the innovation involved the inclusion of a character education dimension to

teaching, the participants found that the innovation (which involved producing favorable behavior from students) was an essential necessity to successful teaching, i.e., to the success of their service, even though the innovation was initially perceived as slowing down the teaching process and interfering with planned course material.

The idea of meeting the needs of the community is essential in the survival of public libraries. In a study by Anh Tran, 2005 that applied the perceived attributes to community information networks (CINs) in public libraries in New Zealand, the adopters found that the innovation, CINs, provided access to information to users throughout the region on demand. This included elements of strong interest to the local community and served the needs of the community. In another study by Blome, Bennett, and Page (2010) on the new parenting model, there was an initial benefit to the parents, which in turn benefitted the children of those parents.

Construct 2: Compatibility

Three primary themes for the concept of compatibility emerged from the literature: innovation well matched for values and philosophy of adopting agency, innovation represents new shift from traditional approach, and the innovation well match for adopters' skills and abilities.

In Blome, Bennett, and Page's (2010) study, the innovators identified compatibility between the innovation (CoS model) and the program's philosophy and goals. This innovation matched key child welfare values such as stability and permanence for children and the agency's interest in finding a program that met the specific needs of parents who were involved in the child welfare system.

Mâsse, Naiman, and Naylor (2013) explored the adoption of publicly sanctioned physical activity and nutrition guidelines in schools and found that the schools or teachers perceived the

nutrition guidelines to be compatible with the their expectations of the school learning environment. The same study interviewed participants who stated that the innovation fit their school's philosophy and that they were pleased with the innovation.

Adopters or participants in some of the studies identified their values and philosophy as matching the innovation as well. In Jwaifell and Gasaymeh's (2013) study on the use of interactive whiteboards (IWBs), the teachers had favorable perceptions regarding the implementation of IWBs as it matching their values and beliefs. In Saint Rain's (2005) study, although the participants found it challenging to implement the character education innovation, their values matched the innovation, since the participants worked to inspire good character in the children anyway. The work of Lu (2006) on the diffusion of wireless internet technology amongst university faculty reported that the adopters of the innovation perceived wireless technology to be compatible with their teaching practices, philosophy, and needs.

Another theme of compatibility noted in the research was that the innovation represented a new shift from the traditional approach; some adopters embraced the new shift. Jwaifell and Gasaymeh (2013) observed that the innovation of the educational tool IWBs resulted in a shift from traditional classes to interactive classes.

In another study of the perceptions of law school deans toward the innovation of distance education, although the innovation was seen as one that enhanced and created better quality of service, the findings showed a negative response toward a shift in the traditional way of doing things (Oswald, 2017). The innovation of distance education was described as incompatible with many of contemporary teaching essentials utilized in the law school classroom. Also, the faculty lacked interest in changing their traditional approach to teaching. Nonetheless, despite the

innovations incompatibility, distance education was seen as an important supplement to existing services (Oswald, 2017).

Another relevant theme in the findings of the research on compatibility was innovation well matched for adopters' skills and abilities. In the study on community information networks (CINs) in public libraries in New Zealand, Anh Tran (2005) concluded that the innovation was well-matched to staff's skills, abilities, and expertise; the study and further reported that staff members were interested in using new technologies related to CIN development. In Blome, Bennett, and Page's (2010) study, the adopters or participants already had prior experience in providing parenting classes, so that incorporating another model promoting positive parent–child relationships matched their skills; moreover, it matched the agency's interest in adopting a program that met the specific needs of parents involved in the child welfare system. Slamecka's (2011) study involved applying the perceived attributes to the implementation of the Classrooms For the Future (CFF) initiative, an innovation designed to provide technology and tech support to schools), and study participants reported positive results in their teaching practices.

Construct 3: Complexity

The concept of complexity literature review revealed three major themes: easy to use, learning curve, and putting the innovation into practice.

Easy to use was seen as a theme that made adoption of the innovation more attractive to potential adopters or study participants even when some aspects were not particularly encouraging. In Saint Rain's (2005) study, the participants reported ease of use with the character education methods in the classroom even though the methods required mental effort, frustration, inconvenience, and sometimes failure to achieve desired goals. Although study participants identified the innovation as matching their skills and abilities, they reported

complexity of the innovation due to incompatible hardware and software confusion for staff in the selected libraries.

In Jwaifell and Gasaymeh's (2013) study on the use of IWBs, a teacher/participant noted that even though IWBs were easy to use, lack of experience made it difficult to operate them, unlike the students who could operate it without training. In the study by Anh Tran (2005) on the innovation of community information networks (CINs) in public libraries in New Zealand, the innovation was described as requiring a many IT skills from staff. In addition, "staff involved with CIN development need to understand user requirements for community information, their IT abilities, ability to use the interface, [and] etc." (p. 276).

In Blome, Bennett, and Page's (2010) study, the CoS was considered to be the state model, but CoS was not selected partly due to its "level of expertise that would be difficult to find in many areas of their state" (p.439) because it required videotaping equipment and technical expertise, which was seen as "unrealistic and unattainable in some regions" (p. 439). Another innovation also proved to require a high learning curve as well. In Bostock, Lynch, Newlands, and Forrester's (2018) study of children's services, motivational interviewing (MI) – a type of therapeutic practice – was introduced to multi-disciplinary teams that included social workers, substance misuse workers, and mental health workers for the purpose of both enhancing direct practice with families and enabled teams to work together with a common language relating to the families they served. Study participants reported that MI required skills that were complex and required a great deal of thought, planning, and implementation (Bostock, Lynch, Newlands, & Forrester, 2018).

A study of high school language arts teachers (Byous, 2006) found that they had difficulty with the integration of technology in their courses. Two of the study participants did

not know how to set up the equipment in order to do their PowerPoint presentations. Also, they did not understand how to use the scanner.

Another issue associated with complexity occurred when putting the innovation into practice. Bostock, Lynch, Newlands, and Forrester (2018) found that, according to most workers, limited confidence and required high level of skills were common barriers to implementation of the innovation MI.

In Anh Tran's (2005) study, the problems with technology were identified as complexity issues that required resolution and/or skills that needed to be acquired by staff to operate the innovation effectively. Blome, Bennett, and Page (2010) found that, in addition to complexity of the CoS as noted in the dimension learning curve, cost was also a barrier to putting the innovation into practice on a statewide level. Two participants in Byous (2006) noted that technical difficulties were barriers to putting the innovation into practice.

Construct 4: Trialability

The literature revealed three major themes for the concept trialability: the implications of the opportunity of trying the innovation, trial of the innovation in its applied context, and modifying the innovation upon trying it. In these studies participants looked more favorably on those innovations that offered some form of testability, especially if the testability could be carried out in the context in which the innovation would be used.

In Grgurović's (2014) study, two participants were able to try the innovation, and their experience was observed by colleagues, which influenced the innovation-diffusion process in a positive way. Participants in Jwaifell and Gasaymeh's (2013) study tried the IWB but were free to choose to stop or continue the use of the innovation. Although the participants were not required to use the IWB, they chose to use it for all their future courses (Jwaifell & Gasaymeh,

2013). As noted in the findings of Slamecka (2011), one of the participants who had experience using Smartboard reported that people often contacted him to set up after-school technology-mentoring and to employ him as a resource for technology lesson planning. The participant commended the people for contacting him and for their efforts in trying the innovation (Slamecka, 2011). There were no sample innovations (community information networks) for the New Zealand Library staff to follow or try out as noted in Ahn Tran's (2005) study; however, from the beginning the staff acquired the new technology skills for community service development. In Lee's (2006) study, a favorable aspect of the innovation was that most of the software applications offered some testability before it was purchased.

Some participants noted that although they saw the relevance in trying the innovation, they were most interested in trying out the innovation in the context in which they would be applying or using it. In the Byous (2006) study, three participants were able to both practice using the software and observe their instructor using the software during the Technology Academy For Teachers (TAFT) class. However, the participants "were not able to implement a technology-related lesson in their classroom and discuss the lesson with the instructor or their peers before the TAFT class was completed" (Byous, 2006, p. 148). Russell's (2016) study involving fire chiefs reported that the majority wanted those using the innovation to have adequate training as they wanted to make sure they could apply it to various scenarios that might be encountered during fire department operations.

In Blome, Bennett, and Page's (2010) study, the original CoS model had no requirement to include professionals or family outside of the group. However, the pilot CoS researcher adapted and modified CoS to involve other family members to provide support for the parents'

change efforts. Blome, Bennet, and Page (2010) noted it's necessary to be cautious in the use of the innovation as the integrity and fidelity of the model could be compromised.

Construct 5: Observability

The literature review revealed two major themes for the concept observability: observable changes, and potential adopters receptive to positive reports by fellow coworkers.

Studies have found that observing the changes caused by the innovation in the organization or work environment provided desired experiences among adopters and users. In Anh Tran's (2005) study, library staff could observe the changes because they were able to access the service online. One of the caseworkers in Blome, Bennett, and Page (2010) study reported observing changes in the client's parenting skills, which reinforced the caseworker's belief in the innovation. Lee (2006) found that the use of computers and the software application in the local church provided observable results in a short amount of time, which was perceived as positive.

Blome, Bennett, and Page (2010) determined that caseworkers were receptive to the changes that their coworkers reported and were motivated by these reports to look for comparable changes in their own clients. In Russell's (2016) study, the researcher found that receiving feedback from comparable departments that had already adopted the innovation influenced fire chiefs in their decision-making process and in their willingness to adopt the technology.

Additional Themes in the Research on Perceived Attributes

In reviewing the research that applied the perceived attributes, it emerged that some of the themes did not adequately match the definitions of the constructs of the perceived attributes. Those themes included: adequate training, ongoing support, and affordability. Although adequate

training can technically fall under the construct complexity, it is considered here to be an additional theme as it does not completely conform to the concept of complexity.

Adequate training. In Bostock, Lynch, Newlands, and Forrester's (2018) research, practitioners reported that they were "ill-equipped to practice MI with parents in contact with children's services" (p. 123). In Slamecka's (2011) study respondents, especially English teachers, reported that additional training and communication would be helpful to facilitate the adoption of the innovation and to increase positive experiences. Russell (2016) studied fire chiefs' perceptions of the technological innovation of unmanned aircraft systems that would be used in responsibilities encountered during fire department operations; the majority of the fire chiefs reported that they would require training to be sure that those operating the system would be proficient in the technology and its capabilities.

Administrative, operational, and ongoing support. The work of Ashrafzadeh and Sayadian (2015) revealed that the technology innovation was likely to be integrated more effectively if attempts were made to provide administrative support and adequate facilities. In Byous (2006), the findings showed that teachers and students lacked the support of sufficient computer lab personnel. Oswald's (2017) research identified insufficient technology support as an issue. One of the participants/adopters in Slamecka's (2011) study reported in reference to the innovation that "people often contact him via email to arrange technology-mentoring meetings after school and to use him as a resource for technology-related lesson development" (p. 110).

Affordability. In Mâsse, Naiman, and Naylor's (2013) research, although the FBSS nutrition guidelines innovation were perceived as healthy and favorable a health, school revenues fell. Oswald (2017) found issues of higher initial costs for distance education than for in-class courses. Also, as noted in for the theme putting innovation into practice, Blome, Bennett, and

Page (2010) as identified cost as a barrier to putting the innovation into practice on a statewide level.

Review of Research on Culturally Responsive Mathematics Instruction

As noted above, the concept of culturally responsive mathematics instruction is crucial to this study. The adoption of a mathematics education program is coupled with the type of instruction that the library staff plans to provide; if public library staff work with underserved children, developing an awareness of culturally responsive mathematics instruction is essential. Research conducted on culturally responsive mathematics instruction has revealed the importance of understanding the "whole" child (economically, developmentally, culturally and linguistically), the importance of giving attention to the families of culturally and linguistically diverse children, and of showing the children that their teacher believes in their intellectual abilities.

In Harding-DeKam's (2014) case study, in trying to develop a definition of culturally responsive mathematics, participants identified the relevance of the ability to understand children's backgrounds, which refers to culture, worldviews, experiences, beliefs, traditions, and family connections. Along that same line, Bottoms' (2016) study of the experiences of elementary teacher candidates working with "culturally and linguistically diverse children" and their families revealed the importance of creating an inclusive learning environment, focusing on "hands-on and minds-on activities," "bringing in various intellectual resources from families," and using "flexible structures to include diverse participants" (p. 6). Participants from Ukpokodu's (2011) study provided different results than those of Harding-DeKam (2014) and Bottoms (2016). In Ukpokodu's (2011) study the participants perceived math as "an abstract subject, a universal language, that numbers are the same across time, culture, and space, and

therefore, mathematics instruction does not have anything to do with culture" and described math as being neutral (p. 50).

The participants in Bottoms' (2016) research reported the importance of positioning families as assets and collaborators. A participant in Harding-DeKam's (2014) study recruited Spanish-speaking parents to help with bilingual math instruction. In Hernandez, Morales, and Shroyer's (2013) study, student teachers communicated with parents in their native language as a part of a prejudice reduction approach.

A key element in Harding-DeKam's (2014) study was that every child is able to understand math or everyone is a mathematician and to develop mathematics content based on the what children already know. In the same vein, Hernandez, Morales, and Shroyer (2013) showed that participants maintained high expectations of their students and supported knowledge construction based on familiar experiences for children to recognize what they already knew. Aguirre and Zavala (2013) associated high academic expectations of students with strong and positive intellectual support.

Summary

Chapter 2 is intended to provide some insight on the theoretical approach used in this study and offer some insight into the phenomenon and the application of aspects of the theoretical framework to phenomenon through the literature. The innovation under examination for this study is children's mathematics education in public libraries. No previous work has applied the concept innovation from Rogers' DoI theory to children's mathematics education in public libraries. As a result, the research on the state of the innovation simply included research on the math knowledge gap and on math education in public libraries. Research on the adopter categories included a handful of qualitative research studies on the topic; research on the

perceived attributes was a little more robust as this component of Rogers' DoI theory has been applied to a diversity of disciplines. Research on culturally responsive mathematics instruction also presented a fair amount of literature on the topic. This literature review does not contain literature on the types of innovation decisions as this study did not intentionally intend to include this aspect of Rogers' DoI theory. Types of innovation decisions emerged during the coding. Although no research on the types of innovations is included here, there is a section covering types of innovation in the theoretical framework.

CHAPTER 3

METHODOLOGY

Chapter 1 provided an overview of the purpose, research questions, and significance of this study. Chapter 2 reviewed the recent and relevant past literature specific to the critical perspective, power, access, Rogers' DoI, culturally responsive mathematics instruction, mathematics education in public libraries, underserved communities, the math knowledge gap, adopter categories, and perceived attributes. A review of the literature in Chapter 2 of this study revealed a gap in literature on the application of perceived attributes and adopter categories to research on public libraries that utilizes a critical qualitative methodology. There is also a gap in the literature on culturally responsive mathematics for library settings. Given this gap, a critical qualitative exploratory study that investigates power, access, Rogers' DoI, and culturally responsive mathematics will help inform future studies on the adoption of children's mathematics education for the underserved in public libraries in the Unites States The purpose of this study is to explore how library staff characterized power and access, the factors that influence the adoption of children's mathematics education in public libraries, and how librarian staff characterize the mathematics instruction that they provide to underserved children.

The following research questions guide this study:

RQ1: How are the factors that influence adoption characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ2: How is the role of power characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ3: How is access characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ4: How do public librarians characterize their mathematics instruction for underserved children in the United States?

Chapter 3 discusses the methodology used in this critical qualitative research study, outlining the research design, participants, sample of the study, data collection procedures, data analysis, and trustworthiness. This study utilizes a critical qualitative research design and applies components of this method to approach the phenomenon and uses the data collection and data analysis procedures of critical qualitative research to explore the phenomenon of the adoption of children's mathematics instruction for underserved communities in public libraries in the United States Library staff who provided instruction for the children's mathematics education programs at public libraries that served underserved communities, as a segment of their patron base, participated in this study through interviews. Qualitative data analysis software was used for the management and analysis of the data. Deductive and inductive thematic analyses were used to code, analyze, and identify themes and subthemes in the data. The findings of this study provide insight into how librarians characterize power and access, the factors that influence adoption, and their approach to mathematics instruction. In doing so, this study provides public libraries with information that will allow them to make more informed decisions as they incorporate children's mathematics education into their children's services. This study extended the Diffusion of Innovations Theory and broadened its application to be more inclusive of underserved communities. Additionally, this study built on the concept of culturally responsive mathematics instruction.

Research Design: Critical Qualitative Exploratory Research

This study explored the perceptions and experiences of staff in regard to the adoption of children's math education for underserved communities in public libraries in the United States by utilizing a critical qualitative exploratory approach that is theory/concept-driven as well as data-driven. The critical research design was appropriate for this study as power dynamics and access were at the core of this research. The following paragraphs in this section provide descriptions, definitions, and explanations for critical inquiry and qualitative, exploratory, and theory/concept-driven critical research. These elements come together to make up the critical qualitative exploratory research design with a theory/concept-driven and a data-driven approach.

The methodology of this study was informed by the ideology of the critical perspective, which suggests that research is driven by freedom, oppression, power, and control (Denzin & Lincoln, 2013). The overarching theoretical perspective applied in this study was critical as it brought to light issues of power, privilege, oppression, and inequity (Crotty, 2015). This study adopted a subjectivist epistemology and a hermeneutic, dialectical methodology (Lincoln & Guba, 2013) and is further defined by a philosophy that contends "human nature operates in a world that is based on a struggle for power," which "leads to interactions of privilege and oppression that can be based on race or ethnicity, [and] socioeconomic class" (Denzin & Lincoln, 2013, p. 208).

Critical Inquiry Research

The critical research design, unlike basic qualitative research, phenomenology, ethnography, grounded theory, and narrative analysis, does not just seek to study and understand society (Patton, 2002), but the goal of critical inquiry is to "critique and challenge, to transform and empower" (Merriam, 2009), as well as to change society (Patton, 2002). Utilizing a critical

qualitative research design provided the librarians in this study not only with the opportunity to share their lived experiences, but also with a platform to share experiences about access – an issue connected to power – in regard to underserved children, an issue that often goes overlooked in library research.

Qualitative Research

Merriam (2009) described qualitative research as being defined by process, understanding, and meaning, with the researcher serving as the primary instrument of the data collection, and data analysis: “The overall purpose of qualitative research is to understand how people make sense of their lives and their experiences" (Merriam, 2009, p. 23). The researcher is interested in understanding the phenomenon from perspective of the participants, emic, or insider (Merriam, 2009), which is a central theme in all qualitative research. Qualitative research involves exploring a phenomenon through real-world situations and experiences (Denzin & Lincoln, 2013). As the interviews in the current study were conducted over the phone, most of the participants were either at their workplace or at home in a natural setting, which allows the researcher to make more sense of a phenomenon through the meanings that the participants bring to it in their natural setting (Denzin & Lincoln, 2005). Due to the substantial deductive nature of this current study, which is the theory/concept-driven approach, the data analysis process included *a priori* codes. Although this study is largely theory/concept-driven, the qualitative research design prioritizes understanding the phenomenon from the participants’ perspectives and not the researcher’s (Merriam, 2009) and analyzing the participants’ individual and collective actions, beliefs, thoughts, and perceptions (McMillan & Schumacher, 1993). Another feature of qualitative research is rich description in the presentation of the research (Liamputtong, 2009), which is associated with trustworthiness.

Exploratory Research

This study is exploratory in that it seeks to understand the perceptions and experiences of librarians and library staff members in the adoption of children's mathematics education for underserved children in public libraries in the United States It is exploratory since the subject of the adoption of mathematics education in public libraries is still a relatively new phenomenon (Babbie, 2010). As there is a gap in the research regarding mathematics education for the underserved in public libraries (Kliman, Jaumot-Pascual, & Martin, 2013B), an exploratory study is considered apropos for studies with limited previous research (Babbie, 2010). Babbie (2010) described exploratory studies as valuable in social science research as they are useful "whenever a researcher is breaking new ground, and they almost always yield new insights into a topic for research" (p. 93). An exploratory study can also pave the way for future research on the phenomenon (Babbie, 2010).

Theory/Concept-Driven Research

As this study is more theory/concept-driven than data-driven, and as qualitative studies seem to be more identified with a data-driven inductive approach (Merriam, 2009), this section is mean to clarify how the theory/concept driven dimension fits into a qualitative study. Merriam (2009) suggested that researchers tend to engage in qualitative research due to lack of theory or the failure of existing theory to explain a phenomenon; therefore, qualitative research tends to be inductive as "researchers gather data to build concepts, hypotheses, or theories rather than deductively testing hypothesis as in positive research" (p. 15). Merriam (2009) characterized qualitative research as inductive for the most part, while Grbich (1999) and Sandelowski (1993) observed that qualitative studies can be theory/concept-driven and include a deductive approach as well.

Sandelowski (1993) described the application of existing theory to a qualitative study as providing context to a phenomenon. In theory-driven qualitative research, Nimmon, Paradis, Schrewe, and Mylopoulos (2016) stated that "theory informs various stages of the research process and can clarify the scope and nature of a problem; it also guides the development of research questions and contextualizes the insights drawn from the analysis of data" (p. 437). In a theory/concept-driven study, the "emphasis [is] placed on meaning rather than measurement of the phenomenon" (Anderson & Kragh, 2010, p. 50); it involves theory building rather than theory testing. During the coding process of a theory/concept-driven qualitative study, which is defined by a deductive approach, the researcher begins with *a priori* codes from the theory or concepts of the theoretical framework of the study, to which and the researcher can add codes, and/or discard existing codes, and modify or discard the initial theory (Anderson & Kragh, 2010). or further develop that theory or concepts. Also, in maintaining the spirit of qualitative research, this study applied a data-driven inductive approach to the coding as this study is open to emerging themes and to extending the theory.

Summary

Through a critical qualitative exploratory research design with a strong theory/concept-driven approach, this study obtained an understanding of the perspectives of librarians on the adoption of children's mathematics education in public libraries that serve underserved children and of their mathematics instruction approach with underserved children. This approach explored where power and access intersect with theories and concepts in application to the phenomenon.

Selection of Participants

In a qualitative study, participants can be selected through a nonprobability purposive – or purposeful – and snowball sampling method; nonprobability sampling is chosen in most

qualitative research (Merriam, 2009). A researcher who uses nonprobability sampling expects to use the data to discover "what occurs, the implications of what occurs, and the relationships linking occurrences" (Honigmann, 1982, p. 84). A form of nonprobability sampling is purposeful sampling, which is used more often by qualitative researchers. In the purposeful sampling method, the researcher makes an informed judgment about whom to interview (Lindlof & Taylor, 2011): "Purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight" (Merriam, 2009, p. 77) and therefore must select a sample from which the researcher can obtain rich data (Merriam, 2009). Snowball sampling can be used in conjunction with purposeful sampling. In snowball sampling the researcher starts with participants from the purposeful sampling and asks if they would be willing to refer other participants relevant to the study (Auerbach & Silverstein, 2003). The researcher needs to determine the criteria for selection of the participants in the selection process in the purposeful sampling (Merriam, 1998).

The first criterion for participant selection in this study was that the participant must be employed as a librarian or library staff member in a public library. The second criterion was that the librarian or staff member must have directly taught a face-to-face children's mathematics program at the public library. The third criterion was that the child patrons in the program were between pre-K and 5th grade. The fourth criterion was that, ideally, the U.S. Census demographic information for the tract in which the public library was located needed to consist of a population that was no less than 10% below the poverty line. The fifth criterion used the Federal Financial Institutions Examination Council's (FFIEC) Geocode Census Report to determine which tracts in each library included ethnic minorities in their demographics. Ideally, a participant would meet the criterion of having taught an ethnic minority population of at least 10%. Both the fourth and

fifth criterions had some flexibility based on the librarian's account of the observed demographics in the library. The FFIEC Geocode Census Reports provide demographics for each tract from the racial categories labeled in the 2017 FFIEC Geocode Census Report: American Indian, Asian/Hawaiian/Pacific Islander, Black, Hispanic, and Other/Two or More Races (Appendix A).

The search for participants was a systematic, multilayered process. The University of Tennessee Library databases were used to search for articles about mathematics education programs in public libraries; searches on Google identified mathematics education programs in public libraries. These searches located specific individuals in the mathematics education programs offered by public libraries. The results were used to search the internet for more libraries that offered these math programs, in addition to running non-program specific searches for math programs in public libraries.

The public libraries that offered math education programs were recorded in an Excel spreadsheet, which also tracked other information: Name of Math Program, Onsite or Online, Year of Last Announcement Posted for the Program, Name of Library, Contact Information of Library (address, phone, fax), Contact Person for Math Program, Age Range Requirement for Children, Description of Program from Library Website, and Duration of Program. Additional columns added later recorded U.S. Census demographic information on median income, poverty rate, and racial/ethnic demographics.

Of the 132 libraries with math programs located, only 125 were useful. Applying demographic criterion to that 125 libraries resulted in only 25 libraries that met the demographic criterion. Phone calls to public libraries from that list of 25 libraries established initial recruitment process for the study; the phone calls also served to conduct snowball sampling.

Although it was challenging to confirm an appropriate sample size, in the end at least fifteen participants were recruited. Each participant was sent a recruitment letter and an informed consent form after phone contact was made. Of the fifteen participants, ten agreed to participate in the study, and of those ten, only nine were viable as one of the participants ultimately failed to fit the criteria. Those nine who verbally agreed to participate in the study were sent official recruitment letters (Appendix B), and an informed consent form (Appendix C). Once a participant returned the signed consent form, the he or she was scheduled for a 45 to 90-minute phone interview and, within a week or two prior to the scheduled interview, was sent the interview questions (Appendix D). Upon completion of the semi-structured (phone) interviews, each participant was emailed a $15 Amazon gift card with a thank-you message. In terms of risks and benefits, the research activities the possibility of breach of confidentiality presented minimal risk to human subjects.

Data Collection

Qualitative data collection can involve gathering data through documents, observations, and interviews (Merriam, 2009). Using interviews as a form of data collection for this current critical qualitative exploratory research design provided librarians who taught mathematics education services to underserved children an opportunity to share their lived experiences and, moreover, provided a platform for some to share their experiences about issues of access as it relates to power for the phenomenon under study that is often overlooked.

Interviews

This study utilized open-ended, semi-structured in-depth interviews. Lindlof and Taylor (2011) referred to the qualitative interview as a "conversation with a purpose" (Bingham, Moore, & Harper & Brothers, 1959; Lindlof & Taylor, p. 172). The researcher selects participants for a

meeting based on the goals of the researcher (Lindlof & Taylor, 2011). Lindlof and Taylor (2011) described the interview as a collaborative process that involves two or more people; interviews allow the researcher to understand "the social actor's experience, knowledge, and worldviews" (p. 173). The semi-structured interview is characterized by "several specific questions that you want to ask everyone, some more open-ended questions that could be followed up with probes, and perhaps a list of some areas, topics, and issues that you want to know more about but do not have information about at the outset of your study to form specific questions" (Merriam, 2009, p. 103). Paget (1983) observed that the responses generated from in-depth interviews "continually inform the evolving conversation" (p. 78) and contribute to an accumulation of knowledge by "collecting stories, asides, hesitations, expressions of feeling, and spontaneous associations" (p. 78). Seidman (2006) stated that "at the root of in-depth interviewing is an interest in understanding the lived experience of other people and the meaning they make of that experience" (p. 9).

The semi-structured in-depth interview approach was used for phone interviews with children's librarians who provided mathematics instruction to underserved children – who were among the children that they served – in public libraries. The interview questions were informed by the research questions which, in turn, were informed by the theoretical framework, made up of the concepts of power, access, the perceived attributes of Rogers' DoI theory, and the concept of culturally responsive mathematics. The interview questions were open-ended, semi-structured, conversational, and in-depth. These interviews relied on interview protocol that described the participants' rights, data collection procedures, data analysis and data storage procedures (Appendix D).

Interviews were conducted over the phone and recorded on either one, two, or all three of the following devices: a TASCAM DR-100mkII 24 bit/96kHz Linear PCM Recorder, the recording app Voice Recorder Version 8.3.6 (8360) [Copyright © 2015 Happy Tap], which was downloaded from iTunes onto a computer, and/or TapeACall, an application downloaded onto a phone. Technical difficulties arose with the TASCAM Recorder, and TapeACall was determined to be the most reliable method of recording. Files were either recorded as or converted to mp3 files. To protect the participants' privacy, the audio files from their interviews were identified by code names.

Although interviews were scheduled for 45-90 minutes, interviews actually lasted between 45 to 120 minutes, with enough time allotted between interviews in case they ran over the scheduled time. Upon completion of the interviews, eight of the nine participants provided their email address and accepted the emailed $15 Amazon gift cards. Interviews were transcribed by the primary researcher and transcribers, who signed a pledge of confidentiality form (Appendix E).

Data Organization and Analysis

Data organization and analysis is a daunting task; as Merriam (2009) observed, it as the most difficult part of the entire qualitative research process. Although it is daunting and difficult, it was during this process of data collection and data analysis that data seemed to enlighten the research process and can lead to a reassessment of research questions, statement of problem, aspects of the literature review and, on the whole, bring more clarity to methodology. Merriam (2009) described data collection and data analysis as a simultaneous process in which "you can be doing some rudimentary analysis while you are in the process of collecting data, as well as between data collection activities" (p. 171).

Data Organization

The research data for this study was stored in digital formats – audio recordings/mp3 files, and transcribed interviews – which were saved in password protected files on a personal computer and secure backup drives. In addition, audio recordings and transcripts were in Nivivo, a Computer Assisted/Aided Qualitative Data AnalysiS (CAQDAS) tool/software, which is a password protected.

Data Analysis

The data analysis process followed in this study included reading the first couple of transcripts, reviewing the purpose of my study, and making notes in the margins of transcripts, and capturing reflections, tentative themes, hunches and ideas, as suggested by Merriam (2009). This study allowed a comparison of the first couple of interview transcripts and my notes, which further refined the research questions and modified and improved interview questions for subsequent interviews. In other words, this comparison informed the data collection, similar to the suggestions of Merriam (2009). In addition, this process included maintaining memos, creating tables and diagramming, taking notes, writing reflections, emailing participants, and organizing the transcripts in Nvivo. This whole process allowed reorganization and refinement of the process prior to beginning data analysis.

Liamputtong and Ezzy (2005) described most qualitative research as both inductive and deductive. As the current study is significantly theory/concept-driven, the primary approach involved deductive coding, while the secondary approach involved a data driven inductive coding process. The inductive analysis does not us the presuppositions, constructs, or frameworks to analyze the data and the deductive approach utilizes existing theoretical frameworks for the data to understand the phenomenon under study (Patton, 2002). This study

employed a combined deductive and inductive thematic analysis approach to identify themes and patterns in the coding.

Deductive Coding Procedures

The use of a theory/concept-driven approach in qualitative research involves theory building rather than theory-testing, which is associated with the quantitative approach (Anderson & Kragh, 2010). In theory/concept-driven qualitative studies the researcher codes the data by using concepts and/or constructs from the theoretical framework (Anderson & Kragh, 2010). These concepts and/or constructs represent the codes or themes that the researcher begins with for the deductive part of the analysis. During this type of coding process, the researcher can add and/or discard codes and can modify or discard the theory that she or he started with (Anderson & Kragh, 2010) or further develop that theory or concept.

The deductive coding involved creating a template, a codebook of a priori codes (Crabtree & Miller, 1999), based on concepts and constructs from Rogers' DoI theory, specifically the four main elements, adopter categories, and perceived attributes (Table 1). The first step of the deductive analysis of the transcripts involved transferring and arranging transcripts in NVivo nodes/codes to organize data. In the deductive coding process, the nodes represented the codes from the deductive codebook. Segments of the text from the transcript of the codes were matched and segments grouped from the transcript to the codes. After the initial coding process, the first round of deductive coded text from NVivo were pasted into the tables and the text placed under the column with the matching a priori code, generating first and second order themes (Table 2). Last, the text from the transcripts that represented the concept/code innovation was transferred from NVivo into the Microsoft Word table to the column with the heading innovation (Table 2).

Table 1. Sample of Deductive Codebook

d = Deductive Codebook

Code	Definition as explained by the theorist	Description
a. Innovation	"any idea, object or practice that is perceived as new by individuals or other unit of adoption" (Rogers, 2003, p. 5).	This includes an innovation that has existed in other contexts where it may not be considered new.
b. Channels of Communication	Channels of communication can involve local/interpersonal channels within the social system and channels outside the social system communicated between an individual of the social system and outside sources (Rogers, 2003).	Information about the innovation is spread to potential adopters inside and outside the social system. In my study, the innovation is also communicated to users of the innovation who may not be identified as adopters. In other words, the communication channels apply to both the adopters and the users of the innovation. In my study that means the librarians and the library patrons.
c. Time	the degree to which, and rate at which an individual in the social system catches on to the new idea, and the "innovation's rate of adoption" or the relative speed with which a new idea is adopted (Rogers, 2003).	For my study, I'm using time to mean rate of adoption.
d. Social System	A set of interrelated units such as individuals, groups, organizations, subsystems that are engaged in joint problem solving to accomplish a common goal (Rogers, 2003).	The social system for my research includes individual public libraries, and the Public Library Association which ties public libraries through together interrelated purposes.
e. Innovation	"any idea, object or practice that is perceived as new by individuals or other unit of adoption" (Rogers, 2003, p. 5).	This includes an innovation that has existed in other contexts where it may not be considered new.
f. Relative Advantage	"the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 1983, p. 15).	Advantages (or disadvantages) can be directly related to the adopter or those that are associated with the innovation, such as those that the innovation is intended for.

Table 2. Sample of deductive coded text from interview transcript

I. Code: a. Innovation
II. d = Deductive
III. Theory: Rogers DoI – concept from four elements

Transcript. Code	a. Innovation	First order themes	Cluster similar themes	Second order themes: synthesize clustered themes	Theme
P1.1da	"their mission [an outside agency] is to identify gaps to figure out where we can improve things to make sure young children have all, have the best opportunities."	Identify gaps to improve opportunity.	1	Underserved children need supplemental mathematics education	T.d.1
P1.2da	"something that our library system has done as a whole is to help, work with people who are figuring out what's missing and what needs are"	Collaborate to assess needs.	1	Underserved children need supplemental mathematics education	T.d.1
P2.1da	"When I was a school librarian, I really felt like I was a teacher librarian more so teacher than a librarian. As a public librarian I am more of a librarian, but I am also a part-time educator though… I feel like we'll always be the addition on to the school as far as educators. We're there to give alternative education."	More of a librarian, but also a part-time educator.	2	Children's librarians are teachers	T.d.2

Table 2, Continued

Transcript. Code	Innovation	First order themes	Cluster similar themes	Second order themes: synthesize clustered themes	Theme
P2.2da	"I mean, it's a hot topic right now is we. We need a stronger math and science education in the United States. The schools aren't able to provide everything, so the librarian can pick up some of the slack in a public library."	Stronger math and science education as schools aren't able to provide everything.	1	Underserved children need supplemental mathematics education	T.d.1
P2.3da	"Maybe I'm taking in the information and doing something with it or exploring more…we're trying to provide that atmosphere as well as collaboration, work together in groups."	Math program involves taking in the information, exploring it more and doing something with it.	2	Children's librarians are teachers	T.d.2

Inductive Coding Procedures

The inductive coding process was next, involving creating a codebook for inductive thematic analysis with codes unconnected to a theory (Table 3), a process occurred during data collection (Merriam, 2009), while identifying patterns/recurring themes, and during the coding of the transcripts. The process involved experiencing the intrinsic quality of the raw data, capturing the core meaning and assigning the code prior to interpreting it (Boyatzis,1998). Coding organizes and groups data to identify emerging themes, which Boyatzis (1998) defined as "a pattern in the information that at minimum describes and organizes the possible observations and

at maximum interprets aspects of the phenomenon" (p. 161). The steps in the inductive coding process were similar to deductive coding; however, there were no a priori codes involved.

The inductive thematic analysis of the transcripts developed from interviews in NVivo with nodes/codes organizing the data. Nvivo started with codes from the inductive codebook, adding codes that emerged from coding the transcripts, grouping segments of text from transcript to the codes. After the initial coding, tables were created using Microsoft Word were transferred from the first round of inductive coded text from NVivo; the text under the column with the matching code generated first, second, and third order themes (Table 4). Some of the themes could be clustered and further synthesized, creating third order themes (Table 5).

Table 3. Sample of Inductive Codebook

i=Inductive Codebook

General Code	Definition or Explanation	Description
a. access1	"The condition of allowing entry… the right or privilege to approach, reach, enter, or make use of something" (access, 2014)	This definition is applicable to both the librarians and the underserved patrons.
b. access2	"all possible means by which a person is able to benefit from things" (Ribot & Peluso, p. 156).	This definition also applies to both the librarians and the underserved patrons.
c. power1	"possession of control, authority, or influence over others" (power, n.d.)	Power not only involves influence over others, but (in this study) also can involve influence over who has access.
d. power2	A structure of relationships, not the individuals that created it, shaped peoples' actions (Manke, 1997).	This definition of power is applicable to both the librarians and underserved patrons.
e. underserved	Those who have historically been provided inadequate opportunities and services by institutions (Green, 2006, p. 23)	Underserved is also open to how or what the librarians interpret it to mean.
f. math knowledge gap	"A significant gap in math knowledge that divides low-income [ethnic minority or White] students from their more affluent peers" (McCall & Fraser, 2010).	Math knowledge gap involves the experiences and perceptions of the librarians about this issue.

Table 4. Sample of Inductive Coded Interview Transcript: 2nd Order Themes

I. Code: a. access
II. i = inductive

Transcript. Code	a. access	First order themes	Cluster similar themes	Second order themes: synthesize clustered themes	Theme
P2.1ia	"So when I'm developing the Crazy 8's program, I've never experienced it, but I get all this material."	Bedtime math/Crazy 8's program offers all the material.	1	Access to Instructional Resources	T.i.1
P4.1ia	"I've been very fortunate to have volunteers from my community that come once a week and staff our centers."	Library volunteers from community staff math centers on a weekly basis.	2	Access to Operational Resources	T.i.2
P5.1ia	"I will say that the Bed Time math people were very supportive."	Bedtime math staff provide support.	1	Access to Instructional Resources	T.i.1
P5.2ia	[In reference to a potential adopter] "I think they would have to look at their staffing, their budget."	Staffing and budgeting are important to providing a math program.	2	Access to Operational Resources	T.i.2
P5.3ia	"Whether it's unemployment or extreme poverty, homelessness, mental illness, or an incarcerated parent. Those are all the things they [the children] are dealing with which makes it harder for them to commit to coming every week to a program."	Underserved children are dealing with issues that make it harder for them to attend the program regularly.	3	Access to the Innovation	T.i.3

Table 5. Sample of Inductive Coded Text of Interview Transcript -- 3nd Order Themes

I. Code: a. access
II. i = inductive

Tran-script. Code	a. access	First order themes	Cluster similar themes	Second order themes: synthesize clustered themes	Cluster similar themes	Third order themes: synthesize clustered themes	Theme
P2.1ia	"So when I'm developing the Crazy 8's program, I've never experienced it, but I get all this material."	Bedtime math/Crazy 8's program offers all the material.	1	Access to Instructional Resources	4	Access to Resources	T.i.4
P4.1ia	"I've been very fortunate to have volunteers from my community that come once a week and staff our centers."	Library volunteers from community staff math centers on a weekly basis.	2	Access to Operational Resources	4	Access to Resources	T.i.4
P5.1ia	"I will say that the Bed Time math people were very supportive."	Bedtime math staff provide support.	1	Access to Instructional Resources	4	Access to Resources	T.i.4
P5.2ia	[In reference to a potential adopter] "I think they would have to look at their staffing, their budget."	Staffing and budgeting are important to providing a math program.	2	Access to Operational Resources	4	Access to Resources	T.i.4

Table 5, Continued

Tran-script. Code	a. access	First order themes	Cluster similar themes	Second order themes: synthesize clustered themes	Cluster similar themes	Third order themes: synthesize clustered themes	Theme
P5.3ia	"Whether it's unemployment or extreme poverty, homelessness, mental illness, or an incarcerated parent. Those are the things [children] are dealing with which makes it harder for them to commit to coming every week to a program."	Underserved children are dealing with issues that make it harder for them to attend the program regularly.	3	Access to the Innovation	3	Access to the Innovation	T.i.3

Limitations

This study had three main limitations: the lack of a pilot study, the type of interviews conducted, and limited number pool of participants.

Due to time constraints, a pilot study was omitted. After the first two interviews, it quickly became clear that a pilot study would have helped refine the interview questions, the prompts for the interview questions, the interview protocol, the informed consent form, the IRB responses, selection of recording devices, length of interviews, and any other issues that came up in the first two interviews. The interviews for this study took place over the phone. The librarians also worked with different types of underserved communities.

Phone interviews limited the interaction only to voice communication, which might have caused led to certain nuances of the conversation and the natural setting of the librarian being missed. Also, since there were only a handful of math education programs offered in public libraries, and even fewer in low-socioeconomic communities that fit the criteria, my participant population was limited to a small pool.

The characteristics among participants varied. Although this was useful in terms of transferability, it raised questions about how the study would have turned out if all of the participants were from the same state or region with even more similar demographics. The participants in worked at main or branch libraries, came from one of nine different states, held different job titles or slightly different job titles, and worked in slightly different hierarchical structures. These differences had their strengths and also had their limitations. With librarians from the same region, the coding of the transcribed interviews might have revealed more patterns.

Other limitations included a defective tape recorder that made it difficult to transcribe the recordings. Also, it is possible that inadvertently overlooked meaningful quotes and unintentionally omitted valuable data. Despite these limitations, the study generated rich diverse data.

Trustworthiness

Trustworthiness is the qualitative researcher's way of addressing issues of validity and reliability (Riessman, 2002; Silverman, 2006). According to Silverman, researchers can put measures in place to deal with issues of trustworthiness. The measures to which Silverman refers have four criteria devised by Guba (1981): credibility, transferability, dependability, and confirmability.

Transferability

Transferability can be referenced as external validity and generalizability in quantitative research (Merriam, 2009): generalizability is represented by extracting "the universal from the particular" (p. 226), the "extent to which a study's findings apply to other situations" (p. 226); there are a number of ways that a researcher can improve the chances of the "results of a qualitative study transferring to another setting" (p. 227). One of these strategies is maximum variation in the sample, whether it is site location or characteristics of the participants. Although the strong variation in the participants and locations of my sample can be perceived as a limitation, it is that variation that increases the chances of transferability of this study.

In addition, context for the phenomenon in the findings was established through the use of the theory in conjunction with thick description from the data and the participants. Thick rich description in the presentation of the research is associated with reliability of the data and the extent to which the study can be generalized to other settings (Liamputtong, 2009).

Credibility

The quality of credibility can be construed as internal validity in quantitative research; it can be determined by considering whether the study answers the research questions and provides an accurate representation of what is going on (Meriam, 2009). Credibility can be checked through any of three possible methods: triangulation, peer debriefing, and member-checking. The difficulty in meeting triangulation in this study was that all the participants were located in different libraries and different states, with different job titles and responsibilities, and some had different math programs at their libraries. Given the differences among the participants, it was necessary to triangulate the data of the participants through the coding and in my findings and discussion sections. Member checking was addressed through confirmation that the participants

provided interviews that were representative of their perceptions. Each participant was emailed his of her transcript. Some of the participants emailed with feedback or revisions. Peer debriefing was satisfied through a review of the coding process. A faculty member with a PhD who teaches courses on coding with software provided some guidance and suggestions.

Dependability

Dependability is satisfied by documenting the steps involved in the study to confirm that the findings are grounded in the data that was collected (Lincoln & Guba, 1985). All steps in the research process were documented through a visual chronological timeframe, tables, diagrams, MS Word documents, many pages of coding, notes on paper, documents in Nvivo, and through documents and files on my computer and backup drives.

Confirmability

Confirmability occurs when those being researched inform the data and not the researcher, which can be related to the objectivity in quantitative research (Lincoln & Guba, 1995). The participants seemed to openly share their perceptions and perspectives despite the overpowering theory-driven approach.

Conclusion

This study used a critical qualitative exploratory research design to explore the perceptions and experiences of librarians who teach children's mathematics education for the underserved in their libraries in the United States. This approach led to exploration where power and access intersected with the theories and concepts amidst their application to the phenomenon. This study involved data collection through open-ended semi-structured interviews over the phone. The interviews were recorded, transcribed, analyzed, and the data was reduced. The theory/concept-driven aspect of the research design allowing the opportunity to apply a

deductive and inductive coding process. The thematic analysis generated themes and data was further reduced. Through the credibility, dependability, transferability and confirmability of this research, trustworthiness was satisfied.

CHAPTER 4

ANALYSIS AND FINDINGS

Chapter 1 provided an overview of the background, purpose, research questions, and significance of this study. Chapter 2 revealed a gap in the literature on qualitative research from a critical perspective on the adoption of children's mathematics education for the underserved in public libraries in the United States. Chapter 3 described how the critical qualitative exploratory research design was used to examine the way library staff characterized access, the role of power, and the factors that influenced the adoption of children's mathematics education for underserved communities in public libraries. It also examined how librarians characterized their math instruction for children from underserved communities.

Data collection involved inductive and deductive approaches to coding in the analysis, conducted in accordance with the following research questions:

RQ1: How are the factors that influence adoption characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ2: How is the role of power characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ3: How is access characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ4: How do public librarians characterize their mathematics instruction for underserved children in the United States?

This chapter presents the findings of the interview data. The interview questions were informed by the research questions which, in turn, were informed by the theoretical framework.

This study involved deductive and inductive coding for the data analysis. The findings included themes and subthemes derived from deductive coding that emerged based on a priori codes from the theoretical framework, and the findings included themes and subthemes derived from the inductive coding process. The inductive process allowed for the inclusion of unexpected themes.

This chapter included background information about the innovation, the participants, the research questions, themes, subthemes, and quotes derived from the coded interview transcripts, along with explanations to guide the presentation of the data. The concepts and constructs from Rogers' Diffusion of Innovations Theory include the four primary elements, the adopter characteristics, the types of innovation decisions, and the perceived attributes.

Research Questions as They Relate to Interview Questions

The interview questions were informed by research questions (Table 6) and theoretical constructs and concepts. The themes are supported by quotes from the participants' responses.

Table 6: IQs in Relation to RQs

Interview Questions	Background	RQ1	RQ 2	RQ 3	RQ 4
Interview Question 1	X				X
Interview Question 2	X		X	X	X
Interview Question 3	X	X	X	X	X
Interview Question 4		X	X	X	
Interview Question 5		X	X	X	
Interview Question 6		X	X	X	
Interview Question 7		X	X	X	
Interview Question 8		X	X	X	X
Interview Question 9		X	X	X	X
Interview Question 10		X	X	X	X
Interview Question 11		X	X	X	X
Interview Question 12		X	X	X	
Interview Question 13		X	X	X	
Interview Question 14		X	X	X	
Interview Question 15		X	X	X	
Interview Question 16		X	X	X	

Overview of Themes Derived from the Inductive Thematic Analysis

Three primary themes were derived from the inductive coding, two of which included relevant subthemes as outlined below:

1. Primary Theme: access to resources
    a. Subtheme: access to instructional resources
    b. Subtheme: access to operational resources
2. Primary Theme: access to the innovation
3. Primary Theme: culturally responsive library-based mathematics instruction
    a. Subtheme: librarians serve the underserved,
    b. Subtheme: librarians teach hands-on children's mathematics,
    c. Subtheme: librarians teach the underserved,
    d. Subtheme: librarians modify math instruction to provide access, and
    e. Subtheme: librarians collaborate with the parents of the underserved

Overview of Themes Derived from Deductive Thematic Analysis

The themes were derived from the deductive thematic analysis. This process involved using a priori codes derived from Rogers' DoI theory (Table 7).

Table 7: Themes Derived from the Deductive Thematic Analysis

Concept or Construct from Rogers' DoI Theory	Respective Themes
Innovation	library friendly math education programs, librarians are teachers, and underserved children need supplemental mathematics education
Communication Channels	librarians share ideas inside and outside their social system, and librarians connect with underserved families
Innovator Categories	adventurous, not afraid of failure, open to new ideas, and leadership
Types of Innovations	decentralization of power, and freedom to make decisions
Relative Advantage	innovation is better than what existed before, innovation enhanced and created better quality of service, and innovation benefits those that need it the most.
Compatibility	in-line with values of adopter, well matched for adopter's skills and abilities, and well matched for those that need the innovation the most
Complexity	easy to use, requires experience and education, and learning curve.
Trialability	trial before adoption, and trial of the innovation in the midst of implementation
Observability	positive reports from colleagues, positive reports from those that the innovation was intended to benefit, and observable changes

Background Information for the Children's Math Programs

Currently public libraries adopt children's math programs designed by different sources. Some are for preschool children, kindergarten through second grade, and third through fifth grade. Although math programs that target sixth grade on up exist, this study focused on math programs for preschool through fifth grade, which seems to be the grade levels to which most children's library programs cater. The librarians that were interviewed used curriculum from one of the following four math programs: Bedtime Math/Crazy 8s Club, Math4U, What's the Big Idea?, or UMIGO.

Bedtime Math/Crazy 8s Club

A program offered by Bedtime Math/Crazy 8s club, is a recreational after-school math program that emphasizes fun, hands-on math while promoting literacy. Children build glow-in-the-dark structures, crack secret spy codes and play games like Toilet Paper Olympics. Bedtime Math provides pre-designed and prepackaged curriculum which makes it easy for people without teaching experience or a strong math background. The program is designed for kindergarten through second grade, and third through fifth grade. Sessions run eight weeks and last one hour per session/per week (P1, P2, P5, P6, P8, & P9).

Math4U

Math4U involves providing instruction with various combination of games, music, picture books, and math. The program involves creating five stations with five different math topics run by five instructors. This math approach requires "five card tables with chairs and an open area large enough to do group activities" (Wallace, 2010, p. 20). Each teacher presents an eight-minute math activity at one of five stations. The program, which runs an hour (Wallace, 2010, p. 19). Children learn about colors, shapes, counting, and so on: "There are no quizzes, no

exams, and no criticism. We take time for every child to learn the concepts. No one is left out and no one fails. Each child leaves the program every week with a sticker and a feeling of self-esteem that can't be measured on any standardized test" (Wallace, 2010, p. 20). The program runs for 8-weeks with 8 sessions, one hour weekly. This math program is designed for prekindergarten and kindergarten aged children. Materials and supplies vary. Materials may include: flashcards, counting books, blocks, etc. Supplies may include: supplies may include: construction paper shapes, glue sticks, and crayons or pencils (Wallace, 2010).

What's the Big Idea?

A program is offered by Vermont Center for the Book, What's the Big Idea? is "based on standards established by state departments of education, the National Council of Teachers of Mathematics (NCTM), and the National Academy of Sciences (NAS)" (Rupp, 2009, p. 28) This program involves open-ended, curiosity, reflection and experimentation. It emphasizes child-directed, hands-on exploration rather than adult-mediated instruction. The program includes numbers and operations, patterns and relationships, change over time, and geometry and spatial sense (Rupp, 2009). It is a versatile program, adaptable to a variety of approaches, teaching styles, and needs (p. 30). Materials may include books, tangrams, wooden blocks, straws and connectors, foam shapes, sets of linking cubes, sets of dominoes, and etc. This math program is designed for prekindergarten and kindergarten aged children. There is no specific duration or time frame for the sessions (Rupp, 2009).

UMIGO

UMIGO is funded in part by a U.S. Department of Education "Ready to Learn" grant and guided by a curriculum team of highly respected educators. "Through fun, stories, music videos and games, UMIGO provides early elementary age children with the building blocks that will

help them acquire early math skills, encouraging them to become active learners, critical thinkers and problem solvers length" (Yoshida, Cohen, Potter & Perez, 2015). Materials include interactive online games, music videos, and iPad apps. The child applies new math concepts and skills to the games and activities included in the "appisode." UMIGO is designed for kindergarten through second grade (early elementary age). There is no specific duration or time frame for the math sessions.

Background Information About the Participants and Their Libraries

In order to maintain anonymity, the participants have been presented through the following identifiers: P1, P2, P3, P4, P5, P6, P7, P8, and P9.

Participant 1

P1 was an early-childhood librarian with a degree in elementary education and some prior teaching experience. P1 stated, "I did student teaching… substitute teaching…taught pre-school for a while. I have enormous respect for teachers." She described herself as "pretty good at math" although she had trouble with math in grade school, high school, and college. P1 stated that she loves math regardless and described math as interesting. P1 felt that children's programs at public libraries can supplement a child's school education or prepare them for school. She taught the Crazy 8s math program at her public library and works with preschool through third grade children. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P1 is employed, 50-55% of the population in that tract fell below the poverty line. The minority population in that tract made up between 40-45% of the population and was identified as predominantly Black and Other/Two or More Races. Additionally, P1 has provided free-book services to people that use a supplemental nutrition program for Women, Infants, and Children (WIC) from low-income communities.

Participant 2

P2 was a part-time youth services librarian. She has a degree in computer science and has had prior teaching experience with children in STEM education. P2 stated, “I taught in high income schools and I've taught in… [low income schools] and I see an issue with math.” P2 described herself as having a strong background in mathematics and said she loves math. She taught the Crazy 8s math program to preschool through third grade children. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P2 was employed 20-25% of the population in that tract fell below the poverty line. The minority population in that tract made up between 25-30% of the population and was identified as Asian/ Hawaiian/ Pacific Islander, Black, Hispanic, and Other/Two or More Races. Additionally, P2 stated that she had provided services to individuals whose first language was Chinese, Vietnamese, Arabic, Spanish, and Russian as well as to immigrants and low-income Whites.

Participant 3

P3 was a children’s librarian in youth services. She had no formal teaching background. Growing up, math was her favorite subject in school. P3 stated that today the new math can be confusing and discouraging for children and she tries to get them involved in math. P3 said, “If you think about math in your life, every single day for the rest of your life, no matter what you do, there's going to be math because you need math to know what your paycheck is, you need math when you're dealing with banks…Everything you do truly does revolve around math.” UMIGO is designed for kindergarten through second grade (early elementary age). P3 taught UMIGO to mostly younger children and a range of age groups. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P3 was employed, 5-10% of the population in that tract fell below the poverty line. The minority population in that tract

made up between 45-50% of the population and was identified as American Indian, Asian/Hawaiian/Pacific Islander, Black, Hispanic, and Other/Two or More Races. Additionally, P3 stated that she had provided services to children with learning disabilities.

Participant 4

P4 was a library director with no formal teaching background. Math was not her favorite subject growing up but she said that math is important, especially for children. She taught Math4U and loved the teaching approach, which involves five centers with different math subjects. She worked with three to six-year old children to prepare them for kindergarten. Although P4 stated that her math knowledge for toddlers and pre-K children was limited prior to offering the math program at her library, she did a good deal of research and engaged pre-K and kindergarten teachers in her community to learn what was important for the children to know prior to entering each grade level so she could suitably adapt her math program. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P4 was employed, 10-15% of the population in that tract fell below the poverty line. The minority population in that tract made up between 20-25% of the population and was identified as Hispanic, and Other/Two or More Races. Additionally, P4 stated that she had provided services to Spanish-speaking, as well as developmentally delayed patrons.

Participant 5

P5 was head of children's services at her library with no formal teaching background. P5 stated that growing up she hated math and had no confidence in her math abilities. P5 described her math skills as average and recognized the importance of math and stated, "it was only after I became an adult that I realized that math could be interesting and fun… I think I have a better relationship with math today than I did when I was a child." She taught Crazy 8s math at her

library, while she also provided math activities for Head Start through the public library, a program for low-income children. For the Crazy 8s program she worked with third through fifth graders. In separate math activities, she worked with preschool children from the Head Start program. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P5 is employed, 35-40% of the population in that tract fell below the poverty line. The minority population in that tract made up between 20-25% of the population and was identified as American Indian, Black, Hispanic, and Other/Two or More Races. Additionally, P5 stated that she has provided services to Somali Refugees and White low-income children.

Participant 6

P6 is a children's services librarian with no formal teaching background. P6 stated that she had excellent math teachers in elementary and secondary school and enjoyed studying and learning math. Although she described her math skills as poor, she said she enjoyed learning math with the children at the library. She taught Crazy 8s math and prior to that she taught UMIGO at another library. She described both programs as very different – Crazy 8s requires a weekly commitment for eight-week, whereas UMIGO can be offered for any number of sessions. For the Crazy 8s program P6 worked with pre-K and third through fifth graders. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P6 is employed, 10-15% of the population in that tract fell below the poverty line. The minority population in that tract made up between 95-100% of the population and was identified as Asian/ Hawaiian/ Pacific Islander, Hispanic, and Other/Two or More Races. In addition, P6 stated that she worked with linguistically diverse patrons, such as immigrants, monolingual Mandarin and Cantonese-speakers, as well as Spanish-speaking patrons. She said, "there are quite a few of the Spanish speaking, but they're not as recent immigrants as the people who speak Mandarin."

Participant 7

P7 was head of the children's department at her library. She had been a head teacher for several years working with underserved children in a non-library setting. She loved math as a child and had good experiences and was considering majoring in mathematics, but it involved "getting the details right," so she changed her mind. P7 enjoyed and appreciated how math is taught today as it is less formulaic and more tangible. She taught the "What's the Big Idea?" math program and worked with preschool and kindergarten children, mostly ages four to six. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P7 is employed, 5-10% of the population in that tract fell below the poverty line. The minority population in that tract made up between 5-10% of the population and was identified as American Indian, Black, Asian/ Hawaiian/ Pacific Islander, Hispanic, and Other/Two or More Races. Additionally, through her library job, P7 stated that she worked with children from Head Start.

Participant 8

P8 is a children's librarian with no formal teaching background. She was homeschooled, and said since math was not her mother's strong point, P8 struggled with math high school. However, in college she developed a strong math background and described herself as pretty good at math. She felt that the problem-solving and logic parts of math were especially important for children. She taught the Crazy 8s math program and worked with kindergarten through second grades. As someone who had no math teaching experience prior to teaching the Crazy 8s program, P8 stated the difference in her skillset before and after the program was not in math knowledge, but rather in greater math teaching skills. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P8 was employed 40-45% of the

population in that tract fell below the poverty line. The minority population in that tract made up between 20-25% of the population and was identified as American Indian, Black, Asian/ Hawaiian/ Pacific Islander, Hispanic, and Other/Two or More Races. In addition, P8 stated that she worked with children from Head Start, Spanish-speaking and monolingual Asian patrons, but was unsure which languages the Asian patrons spoke.

Participant 9

P9 was a programming specialist at her library with prior teaching experience who worked with pre-K through fifth grade. P9 said that while growing up, she experienced learning barriers to math. She said, "I was not a strong math student. I wanted to understand it because I wanted to do well in school because my parents were very strict." She said she loved subjects like chemistry and history, but "when it came to that math, it was almost like there was a brick wall built around that part of my brain." Despite these challenges, P9 said it did not matter because she had so much fun teaching the Crazy 8s program. She taught Crazy 8s math, kindergarten through second, and third through fifth grade. According to the 2017 FFEIC Census Report, in the geographic location of the public library where P9 is employed 35-40% of the population in that tract fell below the poverty line. The minority population in that tract made up between 15-20% of the population and was identified as Black, Asian/ Hawaiian/ Pacific Islander, and Hispanic. In addition, P9 stated that she works with children from Head Start, Chinese patrons that speak English as a second language, and White low-income patrons.

Themes for Four Elements of Rogers' DoI

The four primary elements from Rogers' Diffusion of Innovations Theory are innovation, communication channels, time, and social system.

Innovation

The innovation for this study was children's mathematics education programs for public libraries. The participants in this study provided math education using one of four programs: Crazy 8s Club, Math4U, What's the Big Idea?, and UMIGO. RQ1, RQ2, and RQ3 were the research questions that addressed the concept innovation, defined by the "newness" of an idea.

Theme: Library-friendly math education programs. Although most of the participants (six out of the nine) adopted the Crazy 8s program, some of the participants seemed to still be in the exploratory phase with the innovation and in search of a library-friendly math education program that fit their library and community's needs.

As can be seen by reading the background information about the participants, there was no uniformity in their adoption of math programs. Seven of the libraries adopted the Crazy 8s which comes with a predesigned curriculum, plus a website if the librarian needs further support. P2 stated, "It [Crazy 8s curriculum] was eye opening for me because it was a new way to teach math. I hadn't been familiar with the curriculum at that point. It was a fun way to teach math." P2 pointed out that Crazy 8s was "fun" which is a word that hasn't traditionally been associated with mathematics. Two of the participants had tried UMIGO. P3 stated, "they [UMIGO kits] include alphabet letters, numbers, counting colors, shapes, sorting, matching, patenting, sequencing, science, technology, measurement. And even with the ABC, it's like tactile cards, discovery boxes, match boards, word building puzzles. The numbers would be pegboards, counting charts, but shaped like a dragon so that, you know, that would interest a child to go over

and look." P3's description of UMIGO also represent math as fun. P7 described how using What's the Big Idea? math program allowed librarians to make hard concepts accessible through manipulatives. P7 stated, "It really has to be hands-on, you need to use manipulatives. It has to be tangible, they need to see it. And so sometimes math concepts and science concepts can be more abstract, so it's very difficult to discuss abstract and I would say also particularly with underserved populations. So that's why having images, things to hold, things to, to manipulate is the way to teach math for the younger kids." P4 used Math4U which fits the approach that her library took with their children's programs that involved setting up centers. P4 said, "We just are center based and that's where I got the idea. Math4U is a center-based program, and I think I mentioned that in several of my questions. We work, we call it math for little people...That's colors, that's shapes, that's numbers, that's number recognition, that's patterning, that's sorting, there's all kinds of stuff that goes with math." The librarians describe the math programs at their libraries in a light and fun way and as appropriate for the library environment which is why I chose the theme library-friendly math programs.

Theme: Children's librarians are teachers. In asking the interview questions about teaching, I found that the public librarians had differing perceptions of their identities despite stepping into a role as a children's math teacher. P9 described her responsibilities and what she was doing as "teaching." P9 stated, "[Providing a math program at the library] involves classroom management, lesson planning, practical implementation of a classroom, but it's more informal and you're not teaching for a standardized test; you're not teaching for specific benchmarks. You're not teaching for parent teacher conferences every nine weeks." P2 on the other hand described herself as both a librarian and educator with the librarian identity more emphasized. She also referred to the math education offered by her library as "alternative

education.” P2 stated, “When I was a school librarian, I really felt like I was a teacher librarian more so teacher than a librarian. As a public librarian I am more of a librarian, but I am also a part-time educator though… I feel like we'll always be the addition on to the school as far as educators. We're there to give alternative education.” P5 is on the other end of the spectrum, as not a teacher but a librarian. P5 stated, “I am not a math teacher by any stretch of the imagination neither is anyone on my staff. So, when Bedtime math/Crazy 8s came to us with the [pre-designed] curriculum, we [could] spend time prepping for each session [with this math program]. You know we would read through the lesson, read the concepts to make sure that we understood, what we should be telling these kids about the lessons and the experiments and what we did and what you know what the math concept is.” Although P5’s perception of herself was that she was “not a teacher by any stretch of the imagination,” she went on to describe her teaching responsibilities of providing instruction about math concepts through lessons and experiments. In addition to teaching about math concepts, P4 who works with pre-K children, also taught the children basic motor skills. P4 stated, “[Pre-K] Kids don’t even know how to hold scissors and if you can't hold scissors or write with a pencil, you can't write a worksheet. You can't practice writing your letters or your numbers if you don't have strong fine motor skills. So we do a lot of fine motor to help the kids to get them ready for when it's time to start tracing numbers and writing.” P4, who was a library director, appears to have incorporated preschool at her library. P9 clearly defines librarians who teach math programs at the library as teachers. P9 stated, “Some of us may not have a teaching certificate or formal teaching certificate and we may not be in a classroom and we may not be doing teacher conferences and we may not be filling out observations and report cards every nine weeks, but we're still teaching.” The theme “children’s

librarians are teachers" seemed to truly reflect the identity that some of these librarians had taken on.

Theme: Underserved children need supplemental mathematics education. Public libraries need to show justification for adopting an innovation. The participants in this study shared their perceptions about the necessity of the innovation. P1 described a connection with an outside agency that assessed knowledge gaps. P1 stated, "their mission [an outside agency] is to identify gaps to figure out where we can improve things to make sure young children have all, have the best opportunities…something that our library system has done as a whole is to help, work with people who are figuring out what's missing and what the needs are." P2's perception of the math knowledge gap was that the public libraries should supplement the child's regular school education. P2 stated, "I mean, it's a hot topic right now is we. We need a stronger math and science education in the United States. The schools aren't able to provide everything, so the librarian can pick up some of the slack in a public library." P3 (who had a similar perspective as P2) stated, "… if there are things that we can offer as a library that would help them [the underserved], I think it's vital as a library to be able to do this." P5 was passionate about providing opportunities for the underserved through the library. P5 stated, "It's the right thing to do in terms of providing another opportunity particularly for underserved children to become better or more proficient at math which will make them better students which in turn leads to you know staying in school particularly in the larger cities." P7 pointed out that there were inequities in her city where half-day kindergarten was free while full-day kindergarten required a fee, a situation that could result in knowledge gaps among people from low-socioeconomic backgrounds. P7 stated, "Half-day kindergarten is free in our city, but if you can pay to get full day kindergarten. It does mean that those half-day kindergarten kids are already

starting first grade potentially not having as much experience as their peers who attend the full day kindergarten program." P7 believed that public libraries have the ability to address that inequity. She stated, "the program we offer kind of getting to be a way to offer that additional educational experience for families who aren't able to send their kids for the full day kindergarten." P9's perspective was that public libraries should create opportunities for the underserved. P9 stated, "Knowing that we have kids in our community that have a math knowledge gap… means we have a job to do, to create opportunities for those children to increase their skill set through additional, free programs."

Communication Channels

The communication channels were represented in two ways: 1) adopters spreading the innovation to fellow adopters, and 2) adopters spreading the innovation to those that the innovation was intended to benefit, underserved children.

Theme: Librarians share ideas inside and outside their social system. The data showed that the innovation had been introduced to the participants in different ways. P1 received a phone call from an outside source, she adopted the innovation, and then she encouraged others to try it which is a great way to get an innovation to spread. P1 stated, "I called or I signed up and they called me. So I kind of just did it. It was actually after the fact that I found out another branch had already done it. So I actually I talked to that librarian a little bit but uhm I didn't really get to talk much in-depth. However, I have had people, other children's librarians in the system ask me about it since I have done [implemented the program]. They have asked me about it and I have encouraged them to do it and I told them anything I could about how the program works and about doing the math program. So, I have definitely tried to share that as well." P3 was introduced to the UMIGO program through a training she attended. P3 stated, "UMIGO

program was a program that we purchased through Family Place Library, which is in Middle Country, New York. We had gone up there for trainings and so they would, when they develop programs or whatever or, or bought into programs, um, they would, introduced them to anybody who had been part of their trainings. And so that was basically brought to us through the Family Place Library." P4 discovered the Math4U program in the *Library Sparks Magazine*, where a library documented their implementation of the program. P4 stated, "There was a library in Iowa that did it and I was like well I can do this. So I read that article [in *Library Sparks Magazine*]. I think that might have been seven years ago." P5 was contacted by another librarian prior to adopting the Crazy 8s program. P5 stated, "Well I am sure I was contacted by another librarian in state who was doing the Bed Time Math program and she said they [Crazy 8s] are looking for other libraries to pilot the program." P6 found out about the Crazy 8s club through a fellow librarian. P6 stated, "A librarian colleague shared her successful experience with Bedtime Math's Crazy 8s Club and it sounded fun and educational. I took a webinar on STEM programs in libraries and those ideas sounded fun and educational." P7 found out about "What's the Big Idea?" program through a conference. P7 stated, "She was getting speakers for a conference and one of the speakers with someone from the Vermont Center for the Book talking about their "What's the Big Idea?" program. So, she [my supervisor] was directly in conversation with this person as well as attended their workshop. This was at the time when there was a lot of push for stem activities, everywhere, specifically in the libraries." P7 further goes on to state, "Librarians…are very good at sharing information. So there are lots of opportunities where librarians get together and share program ideas, which is often a way people get ideas for new programs to introduce into their community." P7's quote suggested that a favorable idea can easily spread and be adopted since librarians are good at sharing information. P8 found out about

the math program through a workshop. P8 stated, “I learned about that program through going to a children's library services workshop.”

Theme: Librarians connect with underserved families. Another channel of communication necessary for the adoption of the innovation is connecting with users of the innovation so that they have the opportunity to experience the innovation. In spreading the innovation to the underserved, the participants discussed potential challenges such as language diversity, outreach to patrons, issues of poverty, and the difficult lives of some of the patrons. P1 stated, “My biggest challenge is that getting people to come [to the math program]. Once they do I am, I think they generally have fun and enjoy it.” P5 discussed her connection with Head Start, a program that serves children from low-socioeconomic backgrounds. P5 stated, “When Head Start approached us, we recognized that they generally serve a lower income population, so we realized that this was something that Head Start thought was important, that math education was important to their families.” Building a connection with Head Start was a way to serve the community, address knowledge gaps, and recruit patrons for the math program. In reference to barriers that some underserved patrons face, P5 stated, “[they deal with] …unemployment or extreme poverty, homelessness, mental illness, or an incarcerated parent”, which makes building connections and getting people into the library to use services a challenge. Even if a math program might be successful in one library and easily attract patrons, in other libraries where supplemental math programs are much needed the spreading of the innovation due to the specific channels of communication might require more effort. In P6’s public library, connecting with some patrons involved communicating information and knowledge in another language besides English. In reference to general services at her library, P6 stated, “Materials are translated into Spanish because such a huge percentage of people are Spanish speaking in this community.” P6

went on to state, “Who are those in the library facing barriers. Some staff talk about language barriers, so we end up finding someone to volunteer to translate flyers and step into [other translator responsibilities].” P7 described the importance of outreach to the underserved to make connections. P7 stated, “So the best way for public libraries to reach the underserved of course is by doing outreach, and we do outreach in our community. We get out to all the elementary schools. We’ve done some preschool outreach which I think is definitely one of our goals is to do more outreach.” P8 stated, “I could not figure out whether the parent was looking for a resource for them or a resource for their child. And I don’t know other languages besides English, so I was using Google translate. I was grabbing her daughter to see if she could translate for us. It's definitely a language barrier. But, I did everything I could, you know, to help her find the resources she needed.” P9 described her use of Google translate as a means to communicate with English language learner patrons, P9 stated, “[In reference to communicating with non-English speakers requesting assistance] having visual resources where they can refer back to or being able to do Google translate or things like that. You really kind of dig into your pocket full of tricks, you know so to speak. Because we're a library. We're all about connecting people.”

Time

Merriam (2009) observed that data can be generated in different stages of the research process. This data was generated through the participant selection process not the actual data collection stage. In the process of locating public librarians that met the criterion for participation in the study, the FFIEC Geocode Census Report data showed that more of the public libraries with mathematics education programs were located in higher income communities. Therefore, the innovation was spreading at higher rates in public libraries located in more affluent communities.

While I was in the process of developing my criteria prior to selecting interview participants, through an Internet search I located 125 public libraries that offered children's math education as a library program. My intention was to find a pool of participants from public libraries that offered children's math education programs that had participation from underserved children. As I mentioned, which suggests that lower income children have less access (Figure 2). This data, which was generated while I recorded the demographics from FFIEC Geocode Census Report data and while I applied my criteria to the participant selection phase, provided another level of insight into the math knowledge gap. Math programs in public libraries for this study with higher populations of underserved were located in: Alabama, Arkansas, California, Kansas, Maine, Massachusetts, New Jersey, Ohio, and Virginia.

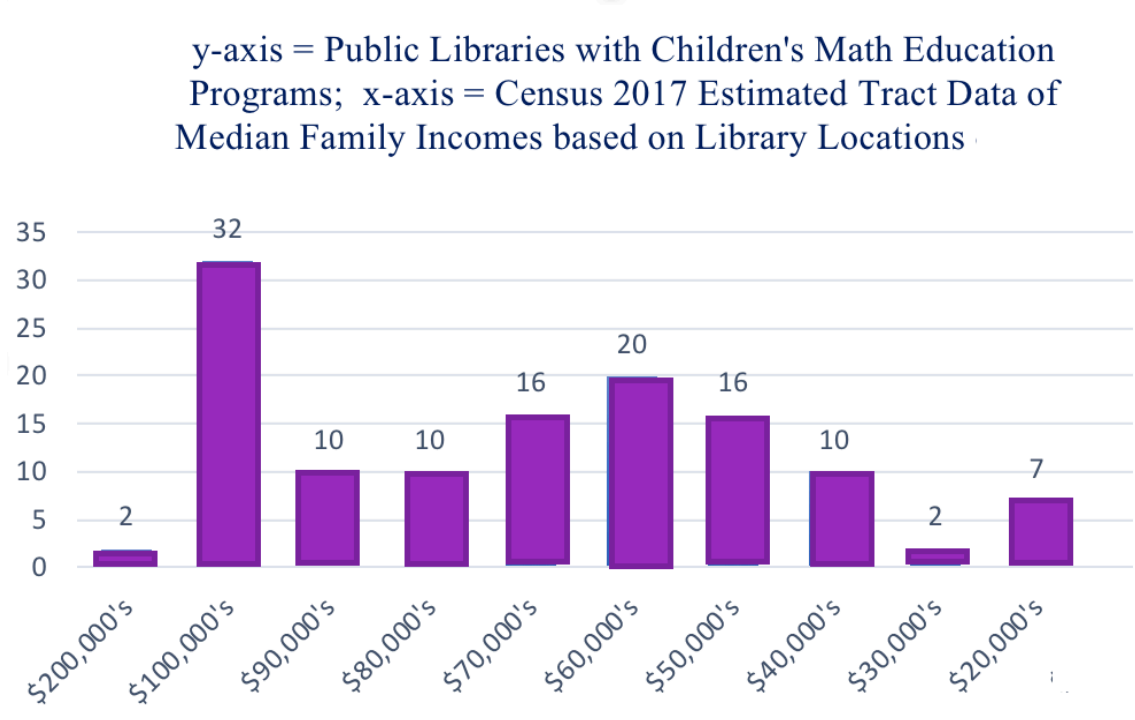

Figure 2. Adoption of children's math education programs in public libraries in relation to household incomes.

Themes for Adopter Categories

A priori themes/codes were provided from the adopter categories of Rogers' DoI theory: innovators, early adopters, early majority, late majority, and laggards. The participants displayed characteristics from only two of the five categories, either innovator or early adopter (Table 8). As a result, the other three adopter categories were not included in this section of the findings. The nine participants were employed in positions at their libraries, ranging from director to children's services librarian, most of whom held children's librarian positions. Seven had a Master's Degrees in Library Science. The interview data showed that most of the participants had characteristics that fell in the innovator and early adopter categories.

Theme: Adventurous. Many of the participants expressed an adventurous spirit in regard to introducing and adopting innovations. P2 stated, "I'm the person to kind of shake things up a little bit. I pitch an innovation even though I'm part time. I push for an innovation like math and science to other librarians." P2, who shakes things up and pushed for math innovation, acted not only with an adventurous spirit but as someone who was innovative as well.

Table 8: Adopter Characteristics of Participants

Participant	**Innovator**				**Early adopter**		
	Adventurous	*Open to new ideas*	*Gatekeeper*	*Not afraid of failure*	*Leadership*	*Role in every stage*	*Greatest opinion leadership*
P1		X					
P2	X	X		X	X	X	
P3	X	X		X			
P4	X	X	X		X	X	X
P5		X	X	X	X		X
P6		X	X		X	X	
P7	X	X					
P8		X					
P9	X	X		X			

P3 advocated for the promotion of her ideas by going to her superiors. P3 stated, “If I wanted a program and I truly believe that it would be successful, and I thought there was a need for this within our community, I would just go to the board of trustees.” P4 would seek out resources to support the adoption of a program that she believed in. P4 stated, “I am the one who would say well what program are you interested in, let's have a discussion about this, how do we want to go about this, where do we find the resources that we need to do this type of programming.” P7 described herself as someone who like to generate ideas. P7 stated, “I love coming up with ideas for programs and then I just have to be careful because I have to make sure I can actually do them. Meaning just time and space and all that.” These librarians displayed the adventurous characteristic of the innovator category as they expressed both adventurous approaches to promoting new ideas. Three of these five participants also displayed the not afraid of failure characteristic, which also fell under the innovator category.

Theme: Not afraid of failure. When it comes to introducing and adopting programs, many of the librarians did not fear failure. P2 stated,“I kind of think of it as an experimental type program in my head and if I can fix it I'll go with it. And if not then I'll just go to her and I'll say this is a mistake. I'm dropping it. I haven't had that happen yet, but I would do that.” Like P2, P3 had no problem letting go of an idea if it wasn’t working. P3 stated, “And I just think they just give me a chance if it’s a success we will keep it, if it doesn't, we just won't do it again, but let's try, let's at least try. I've never been turned down.” P5 mentioned that even if one had a great idea, it can still fail. P5 stated, “They don't always work [programs/innovations]. You know with library services it’s sometimes trial and error. Especially when you are doing programming because you could think you have a great idea for program and everybody is going to be interested in it, and then you put it out there [implement it] and no patrons show up. So, but I am

always willing to try." P9 stated, "You know plan those programs, try them out, if they fail, they fail, we move on…" P9 took on the responsibility of teaching the Crazy 8s program and wasn't afraid to fail. P9 stated, "When I told my boss that I was going to take the Crazy8 program last year, I said I am just going to do it right now. Math is not my strong point and you know what it didn't matter." Four participants had the characteristic of *not afraid of failure* which fell under the innovator category.

Theme: Open to new ideas. All participants fell under the theme *open to new ideas*. Participants described creating or finding new ideas from outside sources. Participants' openness to new ideas was generally motivated by the needs of their patrons. P1 stated, "I go to workshops and training when I can to look for and find new ideas and new ways of doing things." P2 observed that bringing in new ideas to the library attracted patrons while at the same time allowed P2 to be creative. P2 stated, "I get these ideas and I liked to think of things for us to in the library. I think a public library has to entice people to come in and show them what we have. So I am always thinking about what new program I could bring in our way that will fit the need of the director as well as the need of the community and it satisfies my own creativity." P3 was motivated by the benefits that new ideas brought to patrons. P3 stated, "I am very receptive to accepting new and innovative ideas for the programs because I really feel that it makes a difference in some children's lives." P3 added that looking for new ideas was a characteristic of public libraries. P3 stated, "I think as a library system we're always looking for new and creative ideas that get the public to come in." P6 stated, "As I discover or am informed of new library service ideas, I am excited to implement them." P7 opted for creating new ideas in addition to seeking them out. P7 stated, "In my view, you need to create more ideas in addition to finding them from library person." Like other participants, P8 associated new ideas with community

need. P8 stated, “When we develop a new program, it's either because one of us has either found or come up with an idea for something that will be new and innovative that we haven't tried before or because we see a need in our community.” P9 mentioned that library staff that implement these ideas or programs are for the most part utilizing their strengths. P9 stated, “It's a very easy process. You’re doing programs based on your strengths and sometimes your weaknesses.” When P9 referenced “a mathematics weakness,” I recalled that some librarians were not confident with their math skills, yet they still provided much-needed successful math education innovation for their communities. All of the participants displayed the *open to new ideas* theme which was a characteristic of the innovator category.

Theme: Leadership. Less than half of the participants were in leadership roles through their professional position. Those with leadership responsibilities did not seem to use that role to influence others per se. P4 stated, “I have a staff that I trust immensely, and we are a small staff and I am solely responsible for creating, introducing, approving, implementing, promoting and/or accepting new ideas and services.” P4 used her leadership role to create an environment that fostered trust. P4 implemented the Math4U program several years ago and that program has been a success. P4 displayed a strong leadership role in the interview. P5 stated, “I guess my role is as Head of children services.” I used this quote as I thought it was telling that she identified with her functional leadership role. In the interview P5 stated that she trusted the staff to collectively make decisions. Her open approach to leadership seemed to reflect the philosophy of many of the participants. P6 stated, “I am responsible for planning and implementing programs and services for youth in my community… I am free to talk to my manager about decisions and am given lots of freedom and encouragement to try new ideas and implement new programs.” As P6’s supervisor gave her plenty of freedom, it provided her the opportunity to develop her

leadership skill as assigned by her job title. Three of the participants had jobs that allowed them stronger leadership responsibilities, which is not to say that the rest of the participants did not also have leadership qualities. For this study, I was simply looking at leadership as defined by appointed professional responsibilities. Librarians with a leadership characteristic fell under the role of the early adopter.

Themes for Types of Innovation Decisions

Another part of the diffusion of the innovations theory is the types of innovation decisions: optional innovation-decisions, collective innovation-decisions, and authority innovation-decisions (Rogers, 1983, p. 29). The interview questions and responses for types of innovation decisions were aligned with RQ1, RQ2 and RQ3. The themes that emerged from the coded transcripts were *decentralization of power*, and *freedom to make decisions*. Most of the participants praised their superiors for creating a decision-making process that allowed them the opportunity of meaningful participation.

Theme: Decentralization of power. Like most jobs, all of the participants had supervisors that were in positions of power above them; however, in these public libraries most of the participants reported that many of their supervisors looked to the participants for their ideas on creating, implementing, and developing programs. P9's statement, "there's a whole lot of hands-off [from the hierarchy]. You know what you take it, run with it, you're in the position that you're in for a reason." showed that P9 was allowed meaningful input, included in the decision-making process, and provided the space to be creative. P1 stated, "I have a manager who I work with who pretty much trusts me to decide and plan programming uhm and then I do send all my programs to the head of our Youth Services for her approval." P1 was trusted and given the freedom to make individual decisions about programing. P2 was part of a collective decision-

making process. P2 stated “We'll talk over what we want to do; how we want to develop the program.” P3 also was part of a collective decision making-process. P3 stated, “We try to bring this out at the youth services meetings so that everyone is on board. Everybody's on the same page. And inevitably these programs are shared.” P2, P3, and P5 used the pronoun “we” when they discussion their decision-making process. That “we” denoted inclusion of their colleagues. P5 stated, “We do a lot of our program planning together. We sit down as a staff and we talk about what we want to do for the next several months and what where what schools we want to hit with our programming in terms of implementing new services.” P7 liked the shared power she was given in adoption and implementation of a new idea. P7 stated, “Sometimes you can just shoot out an idea and it's, it's easily accepted. So, um, even though I'm not the head of the department, if I come up with an idea and I can support it, it's usually something that we can implement.” P8 stated that ideas were presented to the group and talked over. P8 stated, “I've had this idea and I think this sounds great and I'd like to try it. And then as a department we will talk about the idea. Things like, is this something that our community can benefit from, would they enjoy it, and will there be enough interest, and is it beneficial to them?” P9 stated for adoption and implementation of children's services and programs, the department allowed her to “take it [and] run with it” and she stated their outlook as “You're in the position that you're in for a reason,” and she added that “Administration at this library [recognized the needed to] transfer the power to us and if you're not going to give your staff the power [in order] to be creative”, [then] if you're not going to give your staff the power to be [innovative]…”

Theme: Freedom to make decisions. Some of the quotes from the theme *decentralization of power* overlapped with the theme freedom to make decisions; however, *freedom to make decisions* is a slightly different theme in that this theme deals with being given

the freedom (unencumbered by hierarchical control) and the space to be innovative. P5 stated that her supervisor trusted her with making decisions about the children's program and provided her with support. The feeling of having the freedom to make decisions within one's own program is echoed by many of the participants as well. Both P1 and P2 expressed similar processes at their libraries. P1stated, "I am very glad that I have the freedom to be able to do whatever I think is best especially since I am the one here." P2 stated, "We have a library director that is very free with letting us try things and um, she really likes to see us bringing in new program." P2 stated, that she was given "…a lot of freedom with developing the program content." She stated, "There is space? What I don't have control of is budgets." P3 described a workplace that gave her the freedom to make decisions around programming. P3 stated, "No one has ever said no, I don't think you should do that. Um, they've always given me an opportunity." Like the other participants P5 echoed the similar sentiments around the decision-making process. P5 stated, "I think I have quite a bit of leeway and freedom in my children's programming. I mean I get very few, I don't get much questioning from my director. She is extremely supportive"

Themes for the Perceived Attributes

The constructs of the perceived attributes of Rogers' DoI theory served as codes that included: relative advantage, compatibility, complexity, trialability, and observability. The deductive thematic analysis generated a slew of themes presented in the following paragraphs. The data-driven inductive thematic analysis generated the following emergent themes/new constructs from the coding process: *access to resources* (with subthemes *access to instructional resources* and *access to operational resources*) and *access to the innovation*. These emerging themes from the inductive process extended Rogers' DoI theory by generating new constructs to add to the perceived attributes.

Construct: Relative Advantage

Relative advantage refers to the benefits of the innovation (Rogers, 2003). The subthemes for this construct, which were also informed by the literature review, included: *innovation is better than what existed before*, *innovation enhanced and created better quality of service*, and *innovation benefits those that need the innovation the most*.

Theme: Innovation is better than what existed before. Most of the participants did not have a preexisting program to compare their current math program with. Regardless, participants praised the math programs and their contribution to their public libraries. P2 described the innovation as adding to the existing field of math education. P2 stated, "You're bringing a different field to the education... More inquiry, curiosity, louder. It's a little bit more fun. A different type of education." P5 felt that the innovation offered another medium to reach the children. P5 stated, "I just think that it offers them another avenue to reach kids. It's something different, it's something fun. It's not let's say a book club or story time. It's math."

Theme: Innovation enhanced and created better quality of service. Most of the participants described the children's math education programs as enhancing the public in general. The math programs were described as enhancing the math knowledge of some of the children and making math a positive experience for some children, as well as enhancing the math knowledge of the librarian. P5 stated, "I think anytime we can bring families into the library and they can have a positive experience, that benefits us all." P5 further suggested that a new innovation like math education was a way to improve programming. P5 stated, "As I told you, another librarian told me about the program. She said that they are looking for people. We were looking for ways to improve our programming." P6 described the innovation as a way to bring more patrons into the library. P6 stated, "It brings new children into the library and introduces

them to the wide variety of programs and services the library offers." P6 further added, "I find it very rewarding when I see the kids [in the math program] having fun, making new friends." Participants perceptions and experiences suggested that yes the innovation enhanced and created better quality of service.

Theme: The innovation benefits those that need the innovation the most. Those who needed the innovation the most were underserved children. Some librarians mostly worked with underserved children while others only had a sprinkling of underserved children in their math programs. Most of the librarians were aware of the academic, social and language benefits that their math programs provided for the underserved. P2 described the math program as reinforcing what the children already knew. P2 stated, "Just exposing the kids, opening their minds to a different way of thinking of science and math. I'm reinforcing the skills that they're learning in school," while P3 described the math program as providing more opportunity and enriching lives. P3 suggested that there were advantages to incorporating a children's math education program. P3 stated, "I think that doing math and science programs, doing a mathematics history, any programming that we can produce and develop for children, it's giving them that one more opportunity to learn and to create and to enrich their lives." P6's perception was that the innovation benefited those that struggled with finances. P6 stated, "There are a lot of kids that come to the library almost daily. They live in the community and some of them walk here. And I think because the kids are not involved in other after school activities, it's probably finances are an issue. And the parents are really good about getting them here."

Construct: Compatibility

Compatibility refers to how well the innovation fits in with the existing community's personal values, norms, and practices (Rogers, 2003). Themes that emerged for the construct

compatibility included: *in-line with values of adopter*, *well matched for adopter's skills and abilities*, and *well matched for those that need the innovation the most*.

Theme: In-line with values of adopter. The participants stated that providing educational programs and dealing with knowledge gaps was part of their values. P7 stated, "We're not only dealing with language literacy, but also math literacy." P7's statement suggested that literacy is important to public libraries and therefore so is math literacy. P1 felt there was a need to address knowledge gaps and that it was in-line for public libraries to include math education as a service. P1 stated, "Because of the need, the need to help supplement and fill those gaps, because a library is about books and information and that involves all kinds of topics. So, math being one of them. I think it fits right in with what we do." P4 believed that new program instruction helped those who needed this education. P4 stated, "I think public libraries are researching new programs and instruction to stay current, meet the needs of their growing and changing communities, and to stay relevant. Our job is to educate our community when they can't get it elsewhere!" P7 was interested in addressing math knowledge gaps during the summer. P7 stated, "Libraries talk about that summer gap where kids, kind of lose some of the reading ability over the summer… I was thinking of offering some math programs in the summer that would be tables with different math concepts that kids could kind of practice math so that we're not only dealing with language literacy, but also math literacy over the summer as well." The values of all of these participants echoed the sentiment of filling knowledge gaps and meeting the changing needs of their community through adoption of this innovation.

Theme: Well-matched to adopter's skills and abilities. Some of the participants who provided the math education programs stated that they had some type of experience or background in school related teaching as noted by P1, P2 and P9's responses to the interview

questions on compatibility. P1 stated, “I did student teaching, I did substitute teaching, I taught pre-school for a while.” P2 stated, “I had strong technology background, they asked me to be pre-K through second grade technology teacher. So not only going to have the libraries, I have this other component where I had to teach the children how to use computers.” P7 stated that she taught in Head Start and I worked at a Montessori school prior to her work at the library. P9 said that although she had teaching experience in a pre-K program, “I am having so much fun doing that program like I am learning things and turning that weakness. I don't want to say fear but apprehension with doing those math-centered activities, I have learned more as a person and as a professional in the last year two years than I think I ever have.”

Theme: Well-matched to those who need the innovation the most. The theme *well-matched to those that need the innovation the most* (which is similar to the theme from relative advantage, *the innovation benefits those that need the innovation the most*) expressed that public libraries need children’s mathematics education programs, especially for children from underserved communities, as they lacked the educational resources. P1 stated, “I am working in these communities. I get kids that are excited to participate and excited to do different things and the Crazy8 has lots of fun ways to discover and use math.” P5 described math education programs in libraries as addressing equity issues. P5 stated, “I have always believed that the library levels the playing field for children in poverty. It's one of the only [out of school educational] resources some children will have.” P8 suggested that underserved children needed access to math. P8 stated, “We have the opportunity to provide our patrons services that they may not have access to otherwise. Math education included, specifically for under-served communities at libraries.”

Construct: Complexity

Complexity refers to the extent to which an innovation is perceived as simple or difficult to understand and use (Rogers, 2003). The themes for the complexity construct included: *easy to use*, *requires experience and education*, and *learning curve*. Although some of the participants had a background in teaching and had experience with related subject matter, they did mention that their colleagues shied away from children's math instruction. One participant mentioned that it was difficult to get other librarians involved in providing the math education instruction. A librarian without math teaching experience reported that it was easy to teach the Crazy 8s math program because the curriculum was provided. When it came to complexity the experiences were quite mixed.

Theme: Easy to use. Of the four different math programs, the librarians that used the Crazy 8s program described it as *easy to use*. The librarians raved about the predesigned curriculum. P1 stated, "The cool thing about the Crazy 8s program is not only does it come with your activity kind of planned out (which you can use or you know you can break away from). It comes with math tip-sheets and the math behind the activity…I am working with younger children, I am working with the K through second grade version of their program, so a lot of it is fairly simple." P5 stated, "Having the pre-designed curriculum made it [Crazy 8s program] a lot easier for us to offer it… it was all pre-packaged and ready for us to use." And P6 stated, "I chose Crazy 8s because it is prepackaged with all the instructions and materials that I need. It is easy to implement, fun for the kids, and is very high quality and educational." To improve ease of use P8 stated, "You know, just make sure that your resources and your lesson plans or your workshop plans are appropriate for the age that you're targeting."

Theme: Requires experience and education. Even if participants without teaching experience or math backgrounds had some reservations, they did not seem to be deterred by this.

P4 stated, “My math knowledge for toddlers/pre-K was limited prior to this program. I did a lot of research, talked to our pre-K and kindergarten teachers to find out what was important/necessary to know prior to each grade level and tried to adapt accordingly.” P8 did stress how “scary” it might seem for a librarian who has been placed in a position to teach math. P8 stated, “…unless you get school librarians or previous teachers, we don't have experience teaching math and if it doesn't come natural to you, it can be a scary thing.” P8 further stated, “I'm not comfortable teaching math and I think that's probably what it is for a lot of other librarians.” P8 suggests that a lot of librarians may not being comfortable teaching math and it may even be scary for them. P8 went on to state, “We know what we are comfortable with, with our story time in our after-school programs and things like that.” P8’s comments suggested that maybe math education was outside the realm of the traditional library program. P8 also added that she gained math teaching skills in the process of providing a math education program. She stated, “I have had no math teaching experience. So, um, the, the difference in my knowledge before and after the program really wasn't in math skills, it was in math teaching skills.” Experience in teaching or a math background are not necessary to teach children’s math at a library; however the politics of acceptance of math as a library service is the central issue issue.

Theme: Learning curve. Participants seemed to be aware that children are learning a different type of math. Although some participants admitted to feeling a little intimidated or uncomfortable with teaching math, P8 stated that the prepackaged curriculum of Bedtime/Crazy8’s program made it doable for her. At least two participants mentioned that there was a difference between the math that they learned when they were growing up and the math that is taught today. P1 stated, “I've been out of school for some time, so I can't say that I have used a lot of math. I think some time in the past years or so, my nieces and nephews were doing

their math and it looked so completely different from when I did it as a child." New math may present a slight learning curve. P2 mentioned that other librarians do not want to teach the math class due to their perceptions of a learning curve. P2 stated, "They [colleagues] definitely don't want to teach the Crazy 8s program. Nobody wants to teach the class. I've had some librarians take over the class when I can't make it and they find it difficult. They can get caught up in the math instruction and trying to contain the class." P2 further suggested that many librarians may not feel comfortable teaching math. P2 stated, "In terms of providing instruction? You have to have somebody who's comfortable with doing that. I find a lot of librarians are not." P8 stated, that the lesson plans made a difference. P8 stated, "I was on not real comfortable teaching math, but all of the lesson plans were provided. I was like, Hey, I can, I can do this. Yeah." P9 stated, "Younger children that were part of the underserved community were easier to help because the math concepts were familiar to me."

Construct: Trialability.

Trialability refers to the opportunity to test out the innovation (Rogers, 2003). Some of the participants were dealing with an innovation that had already been implemented or they did not have access to a trial test run of the innovation prior to its adoption.

Theme: Trial before adoption. P5's quote is a reminder of the uniqueness of the settings of each library: services, patron-base, children's programs, among other characteristics. P5 stated, "I talked to my colleague and I asked her to describe what her sessions were like and she had a parent volunteer running her program. We actually manage ourselves here. So, hers looked a little different than ours, but I was able to get a basic overview of what it looked like, and how long they ran the sessions for; what worked and what didn't." Although P1 did not have an opportunity for trialability of the innovation prior to implementation, she stated, "I think most

of what we do in programming is trial and error. You try different programs, you find out if people come and then decide if, if you need to change something, do something different, make it at a different time."

Theme: Trial of the innovation in the midst of implementation. The trialability experience for some librarians occurred in the midst of their on-the-spot first day of instruction of the math education program with the children as an experimental audience. P1stated, "I was glad that people came so it's like it was a success. If they come and they enjoy the program, they are engaged. So, I learned, I guess I became more comfortable with doing it after trying it." The innovation already existed prior to P2's hiring at the library so there was no chance for trialability except in the midst of providing the innovation to patrons. P2 stated, "When I came on board and took the job. The math program had been in existence already. Somebody else had been running it. I took it over and I kind of take it to a different level." P3 and P7's first trial run was in the midst of offering the service. P3 stated, "For my first trial run, I had very, very few kids and we'd still did the setup. We did everything we were supposed to do, but again, it's that you have to kind of sell the programs." P7 stated, "[First trial]… was quite horrible. I had two brothers who just wanted to poke and punch each other the whole time and run around."

Construct: Observability

The concept of observability refers to the visible beneficial results of an innovation (Rogers, 2003; Sahin, 2006). Also, the participants reported observable changes in their department from the implementation of the math program. The themes that emerged for the construct of observability included: *positive reports from colleagues*, *positive reports from those that the innovation was intended to benefit*, and *observable changes*.

Theme: Positive reports from colleagues. Participants reported that they received positive feedback from colleagues about the math program. P6 stated, “The Library is very supportive considering it takes me off the floor a couple of hours a week when I do this, and it’s also held in our meeting room and we run and jump, and it, basically, shakes the entire library. It could be considered disruptive to other customers, but library staff are very supportive.” P6 seemed grateful for her colleagues’ support considering that the math program was disruptive as it involved running and jumping and noise. P3 stated, “I've had people within our own system who've come to observe that haven't done it. So when you have somebody come to observe you, you're passing along another message, you're passing along something that maybe will spark them to want to do it and then we're getting out to more and more children.” P5 stated, “The library staff here were behind the program and thought it was a great idea. My director was certainly supportive of it and so were couple of my colleagues in another library who were also doing bed time math. It was great to have their feedback and talk to them and everyone was, you know, pretty positive about the whole thing.”

Theme: Positive reports from those that the innovation was intended to benefit. The participants in this current study had no opportunity to observe another program, but they did have the opportunity to receive feedback from staff and parents who observed the math program in action. One of the public libraries conducted a survey and received positive responses about their math program. P1 stated, “The parents that came with their children to the math program were really happy about it. They liked it so much that I promised them that I'd offer the second session. I think they would be even more happier if provided math sessions more often.” P2 stated, “You don't get much feedback aside from the parents saying, you know, my kids love the class and they let you know when you are calling them.” P5 stated, “The parents who came

really liked it. The surveys that we did showed positive results also for it." P9 stated, "I had one boy a few weeks ago leave Crazy 8s and say, 'that was fun' to his mom as he was leaving. He was one of the kids who eye-rolled me when we first started this program." Parents whether through a survey, in conversation, or in passing, relayed positive feedback to the librarians.

Theme: Observable changes. Participants did not have the opportunity to observe the innovation prior to applying it to their setting; however, they did get the opportunity to observe their own innovation and observed the changes in the children and families that participated in their math programs. P1 stated, "To me it's the little things. It's when the children are engaged in the activity and I can see that they are understanding the concept. That does it for me." P4 stated, "My little people love coming to math and love coming to the library and I know we are having great successes because my teachers tell me they can tell when a student has gone through our math program." P5 stated, "I think what I did learn was how to look at math; not just putting it into an educational category, but that math could be fun." P6 stated, "Sometimes after the story times, I see parents building on the math concepts with their children and that makes me feel very supported in what I am doing."

Emerging Constructs Generated from Data-driven Inductive Coding Process

Two additional themes emerged from the inductive coding process. The data from the transcripts revealed that access to resources presented as an issue for the adopters, and access to the innovation presented a barrier in some cases for underserved families. Emerging themes from the inductive coding process included: *access to resources* (by the adopter), and *access to the innovation* (by those who it was intended to benefit the most).

Theme: Access to resources. Although the primary theme was access to resources, two subthemes were generated from the inductive thematic coding process: access to instructional resources and access to operational resources.

Subtheme: access to instructional resources. The librarians reported that the Crazy 8s program offered assistance through the Crazy 8s website, which included videos and blogs on the math topics that were useful. P1 stated, "Because I chose the Crazy 8s program, there's a lot of support because they have a lot of information on their website. You could actually, I log in. I have a login to the coach area where I can download and look at all the activities and math tips and they have little videos for each session to help you." P2 stated, the Crazy 8s program, comes with a lot of material. P5 stated, "I will say that the Bed Time math people were very supportive." P6 stated, "I have taken an ALSC webinar on introducing math concepts." P9 suggested that professional development would be valuable. P9 stated, "I would like to see more professional development opportunities specific to math education for librarians out there. Maybe I just need to look harder."

Subtheme: access to operational resources. Participants mentioned the importance of access to operational resources. P4 stated, "I've been very fortunate to have volunteers from my community that come once a week and staff our centers." In reference to a potential adopter, P5 stated, "I think they would have to look at their staffing, their budget." And P7 stated, "Usually the only thing that seems to get in the way when you're trying to do programming, is really comes down to staffing…and money."

Theme: access to the innovation. Many of the participants stressed that it was key to introduce underserved children to the benefits of the math program, while following up to secure every opportunity for them to attend the program.

Subtheme: A*ccess to the innovation by those intended to benefit the most from it*.

Participants provided their perspective on barriers that affected access to the innovation. P1 stated that library funds were distributed based on book circulation statistics and that since the underserved tend to use program services more than checking out books, their libraries got less money. P6 stated, "We want children to have equitable access to learning opportunities, so I would think that would come in many forms. Libraries offer all sorts of programs." P7 stated that underserved patrons deal with barriers such as "transportation and just having an adult who is able to bring a child to the library on a regular basis." P8 suggested that access to the innovation might be related be a barrier to the "The appropriateness of the resources for the age group." P9 suggested that the lack of resources to communicate with an English language learner might affect access to the innovation. P9 stated, "Out of 16 children, 10 of those children were Asian, I did have a few whose English was limited, luckily I had more than a few that volunteered to help translate and assist. My first 3rd-5th session of Crazy 8s went better than I thought it would."

Themes for Culturally Responsive Mathematics Instruction

The themes for the concept of culturally responsive mathematics were linked to interview questions that were informed by RQ1, RQ2, RQ3 and RQ4. The data-driven inductive coding process produced a primary theme which serves as an emerging/new concept. The primary concept/new concept was defined by subthemes as well.

New Concept: Culturally Responsive Library-Based Math Instruction

This new concept is a synthesis of the subthemes. The subthemes for the overarching theme included: *Librarians serve the underserved*, *Librarians teach hands-on children's mathematics*, *Librarians teach the underserved*, *Librarians modify math instruction to provide access*, and *Librarians collaborate with the parents of the underserved*.

Theme: Librarians serve the underserved. Participants described the diversity of patrons that they served. A couple of the librarians mentioned challenges that they faced with language diversity as the librarians only spoke English. P2 stated, "We have a very huge immigrant population. We have our non-English speakers of various languages and I would say those people need the most assistance." P2 added, "We have immigrants a lot from China, also [people] from Vietnam." P3 stated, "underserved could be ethnic, it could be economic, it could be children with special needs, a low teacher ratio to student ratio." P4 stated, "So yeah, we've had Spanish speaking, we have bilingual…developmental…poor families." P5 stated, "we have a very large influx of Somali refugees. They have resettled here. So, they are one of our underserved population because they come here, and they don't know the language and they need a lot of resources and the library does provide them with quite a few resources." P5 added, "We are also located in one of the lowest income areas in the city. So, we see a lot of children who are who come from very low-income households." P6 described low-socioeconomic communities. P6 stated, "It's clear some people have housing problems; they do not have all the resources they need. So, I mean yes I think there are a lot of kids identified as being eligible for the free lunch, which indicates economic need." P6 also added, "Chinese [immigrants], their English language skills they're still working on those; [we] make sure we're meeting the needs of your community; some children are new to the U.S. A lot of them are recent immigrants and they're still trying to learn [English]… African Americans." P9 described culturally and linguistically diverse patrons. P9 stated, "You have a lot of children that are African-Americans, that are Hispanic and then you have a lot of children that are living in public housing or living where they are receiving government benefits… some of the most part our underserved community is those ESL [English as a second language] students… a good number of Muslim, and of course, Asian families…

Korean, Japanese, and Chinese are the three prominent Asian cultures that we have here… We have a large Hispanic community; children that speak Spanish whether they are from Guatemala, whether they're from Mexico, whether they are from Puerto Rico, whether they are from Dominican Republic."

Theme: Librarians teach hands-on children's mathematics. Some of the primary features of math education in public libraries were the hands-on, enjoyable and fun. In regard to the math instruction in her public library, P9 stated that her teaching approach to mathematics allowed for "self-discovery/learning at their own pace, while being patient and offering support" and P9 further added that she was a "huge proponent of learning through play and learning through fun and learning through being messy." P1 stated, "I really like the math that we have done because it's math that's fun and that math is basically involved in a lot of different activities that you don't really realize it's for math or that involve math." The participants shared all the different types of math they use to keep the children engaged. P1 stated, "I was doing a traditional flannel board story with 5-items. So it's 5 pigs basically (laughs), there are lot of rhymes that involve 5 like that and they each take a turn where they jump in the mud and I talked about whether there were more or less in the mud or out of the mud. So things like that where we're kind of adding those things to our talk, when we're doing that. So we're doing some math talk." P3 gets the children engaged in math through math games. P3 stated, "I try to get them involved with the math games. And sometimes they come in just because they're curious what a math game would be, but I think that it also makes them feel better that it's something they can do and a lot of the games are based on things they do every day." P4 gets the children involved through singing, reading and exercise. P4 stated, "Like we read a math book. We sing math songs. A lot of our math songs are like skip counting or counting to a hundred or shaped songs or

we'll do some songs because all little people need to get the wiggles out before they have to sit where they just have to. We do stretching. That's a gross motor activity." P6 engaged children through play. P6 stated, "Provide enjoyable activities in the library that encourage children to experience/play with math concepts in a voluntary, fun and relaxed environment that will lead to an increased competence in math skills." P6 added, "I have done tangrams, paper dodecahedrons, fractals, Möbius strips, Keva planks, Magna Tiles, polygons, Fibonacci sequence, snowflakes, catapults, shapes in architecture." P8 engaged children through hands-on math. P8 stated, "As a librarian with the math program, with a lot of the other programs that I do, um, I try to supplement education to provide them with additional educational experiences that are engaging and hands on and um, that don't feel like they're in the classroom, you know, but that will provide them with an education that is useful and interesting to men that they may not be able to get elsewhere."

Theme: Librarians teach underserved children. As referenced in the literature review, public libraries have a history of providing services to underserved communities. Through the interviews I learned that the librarians were compassionate and made efforts to reach underserved or marginalized communities. P2 stated that their library offered bilingual story hours in different languages such as Spanish, Cantonese and Mandarin. P2 stated, "someone who had learning disabilities and was trying their very best and some of it they were getting and some of it they probably never would have, but still working with him. So when they left, they felt good about what they had done." P3 stated, "Teaching our [underserved] children might mean helping them feel good about themselves. If they can feel good about themselves, they're ready to learn the next week." P4 stated that she had worked with children with developmental disabilities. P7 stated that she believes that "just providing as much scientifically

and mathematically correct vocabulary" can make a difference. P9 stated, "Some children don't speak the language, or they are from a socio-economic status" and as they may not have the advantages of other students. P9 suggested providing services in a "nonjudgmental, low stress environment that exposes them to concepts that they may not know."

Theme: Librarians modify math instruction to provide access. Public librarians have the flexibility to modify the math curriculum, theinstruction, and overall approach of their math education program in order to meet the needs of children that participate in the math services as noted in the quotes that follow. P2 has modified curriculum for children with special needs. P2 stated, "You have to modify it to the group that you have. I had an autistic child and he's very smart, so I had to add a little bit extra for him to maybe do some extra math problems, maybe throw out a question that was a little bit harder and I knew he was there every week, so I would always change it a little bit for him. Lower level kids, I would throw out an easier question, make sure I didn't call so and so because he would know the answer." P3 stressed the importance of "adapt[ing] to the child so that it's a positive experience for them and they want to come back." P5 adapted the program to the needs of the math group. P5 stated, "Well, occasionally we would adapt the program based on the needs of the group because again, when you're dealing in a public library situation, you don't, you don't know all the ins and outs of these children." P5 suggested adapting the curriculum to meet the needs of the community. P5 stated, "Offering math program so much easier because you're not having to develop a curriculum. You have a curriculum and you can tailor it to the needs of your community. Now when we did the first bed time math series that we did." P7 suggested that presentation of the material sometimes needed to be modified. P7 stated, "So we're always trying to be aware of, you know, just like looking out at our audience to see if kids aren't quite understanding. It might mean explaining vocabulary

word. It might mean I'm trying to get down to the more basic concept. First as you're talking. The ideal is that you're adjusting the way you're presenting materials too, based on the group that you have before you." P8 suggested that the different skill levels may present a problem and require modification of the program. P8 stated "There's a big difference in skill level between a kindergartner and a second grader. So to be able to make an impact with your math education, I think you need to be specific and limit your program to children that have the same skill level." P9's statement seemed to be more in-line with culturally responsive instruction as she addressed being aware of "different experiences." P9 stated, "Going forward with our math programs means that we must be aware that the children attending these programs, all have different experiences and skill levels with math. Just because they are in the same grade, does not mean they are on the same level."

Theme: Librarians collaborate with parents of the underserved. Participants, not only provide math access to the children, but get the parents involved as well when the situation presents itself. Institutions can be intimidating to the underserved. The data reflected the efforts that the librarians made to provide access and to support the empowerment of the parents and their involvement in their children's math education. In reference to working with a child with special needs and appreciation of the parents' support, P2 stated, "Sometimes when I have a parent that is responsive, it's great. They can usually help with the child, but when they're not, it's very, very difficult." For librarians, sometimes, collaboration simply involves casual communication about the program with the parent. Librarians shared that parents appreciated the free math program at the library. P3 stated, "They are coming in with a parent, it could be, very honestly, a lot of the children that come in with parents are on the lower end economically and these, like the parents will say, I'm so glad you do these programs because we can't afford to put

him or her in a kindergarten or preschool setting at this time." P5 expressed compassion for parents and stated "They really do have their children's best interests at heart, but they are dealing with a lot of other issues. Whether it's unemployment or extreme poverty, homelessness, mental illness or incarcerated. Those are, those are all the things they are dealing with which makes it harder for them to commit to coming every week to a program." P9 expressed both compassion and cultural awareness for English as second language learners. P9 stated, "I don't have a problem speaking English, that's my first language you know. So putting ourselves in their shoes is I think step 1 and then being able to accommodate them. I think we do a very good job with accommodating people without making them feel marginalized or embarrassed or concerned that they can't communicate." P4 works with parents and communicates to them the importance of education for their child. P4 stated, "We have to work harder at making that parent feel more comfortable and help them understand the importance of beginning their child's education early and not waiting until pre-K or kindergarten. Helping them get a head start on basic skills."

Theme: Librarians collaborate with school teachers. Some public librarians saw value in finding out what the teachers want the children to learn in math so that they were more prepared for school. P3 stated, "I think that these libraries who are dealing with underserved communities, if you're in a library and you're in a youth service position, you deal with the schools and I think that just the fact that you are dealing with schools, this is a natural extension of all of that." P4 worked closely with the teachers to help develop the lessons for her students at the library. She worked with prekindergarten children and prepared them for kindergarten. P4 stated, "We try and work very closely with our pre-K and kindergarten teachers to make sure that we are working on things that they need to know going into either preschool or kindergarten."

Conclusion

The findings from this study highlight the perceptions and experiences of librarians who provided the children's math education programs in public libraries for patrons that included underserved children in the United States. This study utilized the critical perspective, the concepts of power and access, concepts from Rogers' DoI, and the concept of culturally responsive mathematics. These served as elements that made up the theoretical framework which informed the research questions, and which informed the interview questions. Recorded interviews were conducted over the phone, then transcribed, and then analyzed through a theory-driven deductive thematic analysis and data-driven inductive analysis. The findings were based on the coded transcripts.

The presentation of the findings involved introducing the research questions, submitting the themes that were aligned with those research questions, and offering explanations of the themes. The coding led to unexpected emergence of themes, some of which became constructs or concepts that extended the theory or the framework. The unexpected themes included: access to resources, access to the innovation, and culturally responsive library-based mathematics instruction. Through the results from the coded transcripts of participant perceptions and experiences, I was able to collect/acquire more insight into the participants' decision-making processes, their adopter characteristics, the application of the perceived attributes to their experience, their work with the underserved, and their mathematics approaches.

CHAPTER 5

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

Chapter 1 provided an overview of the background, purpose, research questions, and significance of this study. Chapter 2 revealed a gap in the literature on qualitative research from a critical perspective on the adoption of children's mathematics education in public libraries that serve underserved communities. Chapter 3 described how the critical qualitative research design was used to examine how library staff characterized the perceived attributes and adopter characteristics in the adoption of children's math education for underserved in public libraries and how access and power were characterized in this adoption process. Chapter 4 explained the findings of the transcribed interview data. Data collection, inductive and deductive approaches to coding in the analysis were conducted in accordance with the following research questions:

RQ1: How are the factors that influence adoption characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ2: How is the role of power characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ3: How is access characterized in the adoption of children's mathematics education for underserved communities in public libraries in the United States?

RQ4: How do public librarians characterize their mathematics instruction for underserved children in the United States?

This chapter discusses the findings through the lens of the theoretical framework for the critical exploration of the adoption of children's mathematics education for the underserved in public libraries in the United States, and culturally responsive mathematics instruction. Identifying

access and the role of power in researching this phenomenon were central to the exploration of the phenomenon and the application of Rogers' DoI and culturally responsive mathematics instruction. This chapter uses the findings from chapter 4, the theoretical framework, and literature review to present a discussion on the research questions, theoretical concepts, and themes and the new constructs and concepts which extend the perceived attributes from Rogers' DoI and create a new concept for math instruction in public libraries. In addition, this chapter includes: implications for practice, recommendations for further research, and the conclusion.

Organization of the Discussion of the Themes

This chapter is organized by concepts of the theoretical framework. Each concept includes themes and subthemes generated from the data. The responses to RQ1, RQ2, and RQ3 are illustrated in multiple answers throughout the discussion. The four elements (innovation, communication channels, time and social system), the adopter categories, the types of innovation decisions, the perceived attributes, and the concept culturally responsive mathematics all represent factors that influence adoption which are characterized by the themes that emerged from the coding. All of these factors intersect with power and access in some form or another as explained throughout Chapter 5. RQ4, however, is only represented by the themes that emerged for the concept culturally responsive mathematics instruction.

Discussion of Innovation and Themes Relevant to RQ1, RQ2, and RQ3

There were three themes relevant to the concept innovation. These themes are library *friendly math education programs*, *librarians are teachers*, and *underserved children need supplemental math education*.

Theme: Library Friendly Math Education Programs

The participants taught one (or two) of four math programs at their public library: Bed Time Math/Crazy 8s Club program, Math4U, What's the Big Idea?, or UMIGO. These children's mathematics education programs each were distinguished by their different types of curriculum, instruction approaches, eligible age ranges, and duration of instruction. The findings showed that there was no uniformity with the type of math programs provided by the public libraries. Librarians were still exploring and experimenting with math programs, math curriculum, teaching approaches, and grade levels. The articles by Cerny (2004), Rupp (2009) and Wallace (2010) presented three different math programs implemented by three different public libraries which represented the state of the innovation as presented in the findings of my study. This demonstrates that children's math education in public libraries was still perceived as a new idea, which is characterized by exploration and experimentation.

Theme: Librarians Are Teachers

In the findings, librarians appeared to be in the midst of exploring their identities in their roles of providing math instruction. One participant stated that she was teaching like a teacher, another said librarians are not teachers, and a third said she was more of a librarian than she was a math educator. These differing perceptions about identity within this math instruction role signified that the innovation was still considered new. As long as the idea is perceived as new by the potential adopters, the idea is considered an innovation (Rogers, 2003).

Theme: Underserved children need supplemental mathematics education.

In the finding the librarians reported access issues. One librarian referred to a kindergarten school that provided part-time school to all students, and full-time kindergarten to those that could afford it. Those children whose families could not afford full-time kindergarten

were at risk of falling behind those who could afford full-time kindergarten. The findings showed a need for children's math education for the underserved in public libraries in the United States. Also, mathematics education programs at public libraries provided access to children from low-socioeconomic backgrounds to help to alleviate the math knowledge gap. The participants expressed that their libraries had the tools to address the math knowledge gap, an issue which was identified in the research by Duncan and Magnuson (2005); Klibanoff, Levine, and Huttenlocher (2006); Wang (2008); and Duncan and Magnuson (2005). This community need coupled with the library's ability to address knowledge gaps were found to be factors that influenced adoption.

Power, Access and Innovation

De Jong and Rizvi (2008) defined access as "the match between societal commitment and institutional capacity to deliver rights and services and people's capacity to benefit from those rights and services" (p. 4). This definition proved to be relevant to the findings on the *innovation*. Echoing the sentiments of fellow interviewees, Participant 9 stated that given the math knowledge gap, public libraries had a duty to create opportunities for underserved children to increase their skill set through additional free programs. These findings showed that the librarians perceived public libraries to be in a position to support the empowerment of underserved children and to create access to the innovation of children's math education.

Discussion of Communication Channels and Themes Relevant to RQ1, RQ2, and RQ3

Librarians maintained two primary lines of communication. They had to learn of the innovation or spread the innovation through colleagues and those whose lives the innovation was intended to benefit. Communication channels were key to access for underserved communities as the underserved came from linguistically diverse backgrounds.

Theme: Librarians share ideas inside and outside the social system.

The participants identified multiple types of opportunities that allowed for librarians to get together and to share and spread new program ideas. Communication channels are "the means by which messages get from one individual to another" (Rogers, 1983p. 17), conducted through human interaction, something that happens through interpersonal networks, which affect the adoption of a new idea. The findings showed that participants learned of the children's math education programs at their public library, through conferences, professional development workshops, one-on-one conversations with librarians from other libraries, and through marketing calls from vendors. All of these communication channels potentially influenced adoption.

Theme: Librarians connect with underserved families.

The findings showed another dimension to communication channels as well. Interpersonal networks were identified as a necessary factor that influenced adoption (Rogers, 2003). The mass innovation for public libraries would not be adopted without librarians conducting outreach to patrons. The findings showed that public librarians made an effort to address the needs of low income and culturally and linguistically diverse children, immigrants, refugees and children with disabilities.

Participants described multiple ways in which they connected with underserved communities. In public library literature, Bailey (2014) identified outreach as a method to connect with people from low-socioeconomic backgrounds. One of the ways that the participants in this current study reached the underserved was through outreach to schools, and to programs that served people from low socioeconomic backgrounds like WIC and Head Start. Another means of connecting involved communication with patrons who solely spoke another language other than English. Librarians described their attempts to communicate with patrons identified as

English language learners who only spoke Spanish, Somalian, Cantonese, Mandarin, Korean, or another language. At least two librarians reported that in order to communicate with linguistically diverse patrons, they had to utilize the limited language resources that they had available to them, such as Google Translate, volunteers, or available bilingual family members. As shown by Terrile (2009), public libraries make their services accessible to the underserved by removing barriers. Librarians reported that connecting with underserved patrons presented challenges since many patrons dealt with unemployment, extreme poverty, homelessness, mental illness, and incarceration.

Power, Access, and Communication Channels

Gaventa (1980) described power as something that can be used to prevent groups from participating. Making an effort to open the channels of communication to English language learner patrons at the library was admirable even with the limited resources that the librarians had. This effort created a means for participation. Hiring translators or library staff with language skills that match the languages of the people in the community would shift linguistic and cultural power, reduce language barriers, and increase access to services and access to the communication channels.

Discussion of Time and Census Data Relevant to RQ1, RQ2, and RQ 3

Rogers (2003) described time as being an aspect of rate of adoption. The findings from my study showed that out of the 125 public libraries with children's math education programs, most were located in affluent communities (Figure 2). This suggested that the innovation was spreading in more affluent communities at a higher rate than in lower income communities despite research which shows a knowledge gap, lower skill level, and, thus, greater need for early math education among underserved children (Jordan, Kaplan, Ramineni, & Locuniak,

2009; Klibanoff, Levine, & Huttenlocher, 2006; Starkey, Klein, & Wakeley, 2004; Wang, 2008). Rogers (1983) stated that if "power, economic wealth, and information are more highly concentrated in a few hands, this aspect of social structure affects not only the nature of an innovation's diffusion but also who reaps the main advantages and disadvantages of the innovation" (p. 123-124). Public libraries are funded by a combination of local, state and federal dollars, as well as donations (Elliot, 2013). A study on per capita local funding for libraries in New York showed that the areas of the state with the wealthiest personal income tended to receive higher per capita support for those libraries (Elliot, 2013). Although my study did not conduct research on the funding practices of each state for libraries with children's math education programs, coincidentally the libraries that were located in communities with median incomes in the $100,000s showed the highest number of children's mathematics education services while libraries located in neighborhoods with a median income in the $30,000s represented public libraries with the one of lowest number of math programs. Also, since wealthier community members may donate more money than lower income individuals to their local libraries, the combination of local, state and federal funding and wealthier donors may account for disparities among the number of public libraries with math programs located in higher income communities versus lower income communities. It appears that in addition to higher rates of adoption more affluent communities have greater access.

Discussion of Social System Relevant to RQ1 and RQ3

According to Rogers "the members or units of a social system may be individuals, informal groups, organizations, and/or subsystems" (Rogers, 1983 p.24). Public libraries exist all across the United States and are linked by the shared overarching philosophies of the American Library Association (ALA) and the Public Library Association (PLA) even though each library

has its own mission statement. Although public libraries are connected to larger social systems (ALA and PLA) and share some similar programs, each library has its own distinct culture based on geographic location. The social system for this study is made up of both main and branch public libraries and librarians located in cities, towns, or rural areas in Alabama, Arkansas, California, Kansas, Maine, Massachusetts, New Jersey, Ohio, and Virginia. As seen in the discussion on the concept time/rate of adoption, the location of the social system can affect funding and, in turn, adoption.

Rogers defines a social system as "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (p. 24). Although there were no specific themes generated for the concept of social system, themes from some of the other concepts and constructs showed a common thread among the participants relevant to *social system*. The participants all stated that their public libraries working toward bridging literacy gaps, a widely recognized shared-goal evidenced in the literature (Herb & Willoughby-Herb, 2001). In addition, the adoption of children's math programs in public libraries represented the efforts of public libraries to fill a community need, provide access to supplemental mathematics to their respective communities, and by default address the mathematics knowledge gap.

Discussion of Adopter Categories and Themes Relevant to RQ1, RQ2, and RQ3

Although Rogers (2003) DoI theory consists of five adopter categories -- innovator, early adopter, early majority, late majority and laggards, librarians fell under the first two categories of innovator and early Adopter.

Adventurous, Not Afraid of Failure, Open to New Ideas, and Leadership

The themes for the concepts from the adopter categories include: adventurous, not afraid of failure, open to new ideas, and leadership. The findings showed that participants had

characteristics from either the innovator or early adopter categories, or both, similar to Polat's (2016) findings which showed that participants adopter characteristics were not so clearly defined (Table 2).

Rogers (2003) described innovators as venturesome, eager and willing to try or experience new ideas and as having some control of financial resources. Innovators bring innovations from outside the social system's boundaries and can cope with a high degree of uncertainty about the innovation at the time of adoption. The innovator can also play a gatekeeping role in the flow of new ideas into a social system (Rogers, 1993). Rogers described the early adopters as an integrated part of the local social system with the greatest degree of opinion leadership in most social systems. Potential adopters look to early adopters for advice and information about the innovation. (Rogers, 1993, 248-250). They "play a central role at virtually every stage of the innovation process" (Light, 1998, p. 19).

One of the participants who served as the director of a small library had some control over the financial aspect of the library. The rest of the librarians only had control over small budgets related to their programs and services; nonetheless, they displayed other adopter characteristics, such as being adventurous, not afraid of failure, eager and open experiencing to new ideas. Some of those same participants that displayed the aforementioned adopter characteristics also exhibited early adopter characteristics as they were an integral part of the local social system and displayed a strong leadership role. All expressed being prepared to cope with unsuccessful innovations, and almost half of them expressed that they played a central role in every stage of the innovation process. P4 had the power to make decisions surrounding the introduction of library programs, adopting library programs, developing them, and so forth. Although she had to answer to someone higher in the hierarchy, she technically had more

freedom to maneuver in the innovator category. Although the other participants had less authority, their supervisors trusted them to come up with programs and make decisions either individually or amongst their peers, even though the supervisors had the final say so. The main issue of power that the librarians dealt with was control over budgets. The adopter characteristics of most of the librarians seemed to be influenced by the structure of the decision-making rules and process of their environments. Access to participation in the decision-making process allowed the librarians to utilize their innovator and early adopter characteristics.

Discussion of Types of Innovation Decisions and Themes Relevant to RQ1, RQ2, and RQ3

Initially, the concept the types of innovation decisions was not part of my framework, but it was later added as themes emerged from the inductive thematic coding process that represented the concept types of innovation decisions. The themes that fell under types of innovation decisions were decentralization of power and freedom to make decisions. The findings showed that power and access played a key role in the decision-making processes, the decentralization of power, and in an environment that allowed for innovativeness to thrive.

Theme: Decentralization of power. For the theme decentralization of power, the findings showed that almost half of the participants explained that they subscribed to a collective innovation decision process while the other half subscribed to an optional innovation-decision process. Some participants stated that their supervisors trusted them to make decisions in regard to the creation and implementation of new programs. The bottom line was that supervisors placed the power of generating ideas for programs and putting those ideas into practice through program implementation and development in the hands of the librarians. The social systems of the participants allowed them the opportunity to talk over ideas, share ideas, and make decisions about ideas in meetings with colleagues. Some of the participants seemed grateful for their

participation opportunities and the group-decision making processes of their libraries. Some librarians discussed work environments that valued everyone being on "board and on the same page" (P3) and/or with "lots of freedom and encouragement to try new ideas and implement new programs" (P6).

Theme: Freedom to make decisions. Some of the librarians expressed how much they valued the opportunity to be able to create and experiment with new library programs. Many of the librarians felt like they had the "leeway and freedom" (P5) to get creative with children's services. Allowing this type of freedom, seemed to create an environment where the participants felt trusted which inspired them to be innovative. Some participants had the freedom to individually make decisions or collectively make decisions (with approval of the primary supervisor of course). Participants were given access to the decision-making process and their ideas were valued and taken into consideration and in some instances, participants were allowed to simply implement their ideas with very little hierarchical restrictions.

The librarians seemed to describe their work environments as places with decentralized decision-making processes that encouraged innovativeness which echoes Rogers discussion about the centralization of power. Rogers (1983) described the centralization of power and control in organizations as being negatively associated with innovativeness. Rogers observed that the more power is concentrated in an organization, the less innovative that organization tends to be" (p. 359), restricting the range of new ideas in an organization. Rogers (1983) subsequently states that initiation of innovations is more frequent in decentralized organizations. From the interviews with the librarians, it was clear to me that their public libraries embraced and were hot spots for innovativeness.

Discussion of the Five Perceived Attributes and Themes Relevant to RQ1, RQ2, and RQ3

The perceived attributes of Rogers' diffusion theory include: relative advantage, compatibility, complexity, trialability, and observability. Through the inductive process, two additional attributes emerged: access to resources and access to the innovation. This section presents a discussion on the attributes and the themes that were generated from both the theory-driven deductive thematic analysis and data-driven inductive thematic analysis.

Construct: Relative Advantage

The themes generated for the construct relative advantage include: the innovation is better than what existed before, the innovation enhanced and created better quality of service, and the innovation benefits those that need it the most.

Theme: Innovation is better than what existed before. Although the theme the *innovation is better than what existed before* suggests another innovation existed prior to the current innovation, this theme refers to the value that the innovation added to the public library. The children's mathematics education programs at these libraries were the first math programs at their public libraries and by default better than what existed before. Participants described the innovation as bringing a different type of mathematics education to the public; one that was more fun, incorporated more inquiry, curiosity, and allowed for loudness/noise, jumping and other types of physical exercises. These findings were in-line with the findings of research of Byous (2006) who applied the perceived attributes to the adoption of technology with teaching, whereas this type of innovation did not exist before in the classroom. Like my findings Byous (2006) findings revealed that the innovation was much needed for the classroom and added to the learning environment.

Theme: Innovation enhanced and created better quality of service. For the theme the *innovation enhanced and created better quality of service*, participants reported that children's math education in public libraries enhanced their libraries in a number of ways. It brought in new patrons (children and their families) which resulted in those patrons using other services of the library. Also, more children were coming to the library daily. One librarian stated that she found it rewarding to see children in the math program, having fun and making new friends. These findings mirrored the results of Ashrafzadeh and Sayadian's (2015) research on the incorporation of technology in the classroom for English as a foreign language which revealed that the adopters found that the innovation enhanced their service, their quality of instruction.

Theme: the innovation benefits those that need it the most. For the theme the *innovation benefits those that need it the most*, librarians described the innovation as creating more opportunity to learn, create and enrich the lives of the children and families attending the math education program. Another librarian stated that she believed that some children can't afford after school activities that require payment for participation. As a result, students, who can't afford school activities that require a fee, came to the library where they had the opportunity to use free programs like the children's math education. One librarian described her math program as reinforcing the skills that the children already learned in school and opening the children's minds and exposing them to a different way of thinking. Like Ashrafzadeh and Sayadian's (2015) findings on their research of the incorporation of technology in the classroom, my study showed incorporating the innovation provided better learning opportunities and motivated the users.

Construct: Compatibility

The themes generated for the construct compatibility include: in-line with values of adopter, well-matched for adopter's skills and abilities, and well-matched for those that need the innovation the most.

Theme: In-line with values of adopter. For the theme in-line with values of adopter, the participants reported that children's math education for the underserved in public libraries fit right into their values and mission. Some of the participants stated that because libraries have the resources, it seems right for them to provide a supplemental math education to deal with the knowledge gap. Also, a participant stated that public libraries are researching new programs and instruction to stay current and relevant in order to "meet the needs of their growing and changing communities" (P4). One participant's perceived the innovation as "leveling the playing field" for those at an academic disadvantage (P5). These findings which showed the innovation to be in-line with the values of the adopter were similar to that of Mâsse, Naiman, and Naylor's (2013) research which showed that the innovation (the nutrition guidelines) was perceived to be compatible with schools' or teachers' expectations of what the school learning environment should provide.

Theme: Well-matched for adopter's skills and abilities. For the theme well-matched for adopter's skills and abilities, some participants reported that their teaching experience and/or teaching background served them well as they took on the task of teaching children's math education at the public library. One participant who reported that, in providing math instruction at the public library, she had learned more as a person and as a professional in the last two years than she thought she ever had (P9). The findings were similar to Slamecka's (2011) study which involved the implementation of a program designed to provide technology and technology

support to schools. The study participants reported that the innovation had a positive influence on their teaching practices.

Theme: well-matched for those who need the innovation the most. For the theme well-matched for those who need the innovation the most, participants reported that the math education program was helping those underserved children that utilized the program. One librarian (P8) stated that it gives the library an opportunity to provide patrons with a service that they may not have access to otherwise. One librarian (P1) described the children as excited to participate. The essence of the findings mirrored that of Blome, Bennett, and Page's (2010) study on the new parenting model, there was an initial benefit to the parents which in turn benefitted the children of those parents.

Construct: Complexity

The themes generated for the construct complexity include: easy to use, requires experience and education, and learning curve.

Theme: Easy to use. For the theme *easy to use*, those participants that offered the Bedtime Math/Crazy 8s program raved about the pre-designed curriculum and the instructional support on the Bedtime Math website. The What's the Big Idea program also came with curriculum support. One librarian described the Crazy 8s program as "pre-packaged and ready for us to use," easy to implement and fun. Other librarians echoed the ease of use a math education program with predesigned curriculum and online support. In the research on the perceived attributes, ease of use was seen to make the innovation more attractive to potential adopters or study participants even when some aspects of the innovation did not seem encouraging. My findings can be compared to those of Saint Rain's (2005) study in which adopters of an education-related innovation indicated that the actual application of the innovation

was easy to incorporate even though it sometimes required a lot of mental effort, involved some frustrating, and some inconvenience. The difference with the current children's math education study is that the participants described the frustrations in a softer tone than that reported in Saint Rains' (2005) study.

Theme: Requires experience and education. For the theme *requires experience and education*, although a participant (without a teaching background) reported initial hesitation about the course, she described the math instruction as doable and even fun. As noted by the data in the construct compatibility, some librarians had teaching backgrounds, so they were comfortable providing math education programs in the children's services at the public library. In the research on the perceived attributes, the findings in the research stressed the importance of more training/gaining more experience in order to aid adoption of the innovation (Russell, 2016; Slamecka, 2011).

Theme: Learning curve. Some of the participants noted that the schools are teaching a new kind of math. One librarian described her math education background as more procedural and now math learning is more conceptual. Some of the librarians did report that fellow librarians shied away from providing the children's math education instruction. Nonetheless, pre-packaged math curriculum eased any hesitancy of any perceived learning curve issues. Children's math education does not seem to require a steep learning curve according to the librarians that were teaching it. These findings are contrary to most of the research that I reviewed in which the innovation required a complex skillset as noted in Bostock, Lynch, Newlands, and Forrester's (2018) study on the innovation, motivational interviewing.

Construct: Trialability

The themes generated for the construct trialability include: trial before adoption, and trial of the innovation in the midst of implementation.

Theme: Trial before adoption. For the theme trial before adoption of the innovation in another setting, most participants did not get to experience a real trial of the innovation before its implementation. One of the participants who had one trialability experience of the innovation explained that her math instruction experience turned out to be completely different from that of a colleague who was employed at a different library. Although her experience was drastically different from her colleague's, having a phone conversation with her colleague was helpful. As her colleague was from another community this may suggest the importance of trying the innovation in your own setting prior to adoption. It may be difficult to find public libraries with math programs in the same geographic area for trialability. The librarians in this study mostly had to learn on their own, which is why many preferred math programs with predesigned curriculum like the Crazy8s program. Although there was no sample innovation in Ahn Tran's (2005) study, the participants/library staff learned the new technology on their own without significant difficulty.

Theme: Trial of the innovation in the midst of implementation. As mentioned in the previous paragraph, most of the participants had to learn how to convey the innovation on their own. Librarians found themselves in a situation where their trial run of the innovation was in the midst of implementation. Most of the participants described a positive experience despite never having taught children's math before. These findings were similar again to Ahn Tran's (2005) study in which the innovation was learned without trialability except in the midst of putting it into practice.

Construct: Observability

The themes generated for the construct observability include: positive reports from colleagues, positive reports from those whom the innovation was intended to benefit, and observable changes.

Theme: Positive reports from colleagues. For the theme positive reports from colleagues, all of the librarians reported that the staff were very supportive even with the "loudness" that accompanied the math activities. One of the librarians stated that it took her away from the desk from her traditional library duties and she thought the math program might be disruptive to her colleagues. Instead of being bothered or upset, she said the library staff seemed pleased by the noticeable excitement of students during the math activities. Another librarian reported that the library staff were supportive of the math program. Another librarian was told it was a great idea. While another librarian stated that people from her own library had dropped by to observe her instruction of the math program. She stated, "when you have somebody come to observe you, you're passing along another message; you're passing along something that maybe will spark them to want to do it …" (P3). This experience of P3 is somewhat similar to Grgurović's (2014) study, in which the innovation diffusion process was positively influenced when two participants were observed by their colleagues as they tried the innovation.

Theme: Positive reports from those whom the innovation was intended to benefit. The theme positive reports from those whom the innovation was intended to benefit refers to feedback from parents and children. Participants reported positive feedback from parents. Most of the feedback was during the math sessions or right after. Simply the acknowledgment of how much the children enjoyed the math class was appreciated by the librarians. One parent sat in the

class and provided assistance with the math session. P5 conducted a survey where she received positive feedback from parents. In Russell's (2016) study, the researcher found that receiving feedback from comparable departments influenced potential adopters and their willingness to adopt the technology.

Theme: Observable changes. The theme observable changes refers to the observed changes of those who used the innovation. In my study children used the math education programs. One of the observable changes that stood out the most was from participant P4. P4 provided preschool math instruction similar to the setup of a school class. She used centers, tables with different stations with a volunteer at each station. P4 collaborated with the local kindergarten teachers to find out what skills she needs to work on with the children patrons that register for the Math4U program at her library. P4 received a compliment from a kindergarten teacher who let P4 know that she could tell which students had gone through P4's Math4U program. Other participants noticed that the children learned and understood the concepts that were taught in the library math class. Another librarian noticed parents building on what they learned in the math education program at the library. These findings can be compared to Blome, Bennett, and Page's (2010) study in which observable changes were reported in the parenting skills of the social worker's client which reinforced the caseworkers' belief in the innovation.

New Construct: Access to Resources

The primary construct access to resources emerged from the inductive coding process. Access to resources was the overarching concept for the subthemes access to instructional resources and access to operational resources. Access to resources refers to resources for the innovator.

Subtheme: Access to instructional resources. For the subtheme access to instructional resources, participants reported that they found it easy to access math instruction resources from blogs and websites, webinars. Librarians reported that vendors of the math education programs offered support online. One librarian suggested a professional development training which is in-line with Russell (2016) and Slamecka's (2011) research.

Subtheme: Access to operational resources. For the subtheme access to operational resources, librarians stated that those interested in providing a children's mathematics education program should consider space, staffing, and in some cases a budget. One librarian who has the bulk of the responsibility for her math program, stated that she recruits volunteers to help her with the instruction. Byous (2006) study, the findings showed that there was a need for a support person in the computer lab for the teachers and students.

New Construct: Access to the Innovation

The primary construct *access to innovation* is a theme that emerged from the inductive coding process. Access to the innovation refers to the patron, specifically the underserved patron, receiving access to the innovation. The following discussion provide more insight into the emerging construct.

Theme: Access to the innovation. For the theme access to the innovation, participants reported that underserved children and their families sometimes faced barriers that interfered with getting to the library in order to use the services – as transportation and economics. Another potential barrier was access to a translator for those parents and children that spoke a language other than English. Yet another barrier was challenges in the home life.

Definitions for New Concepts That Emerged From Coding

Definition of access to resources. The construct access to resources refers to the potential adopter's perception that she/he has sufficient access to resources that provide sufficient support for his/her application or use of the innovation. This may include instructional resources, professional development, funding, staffing, space, and administrative support.

Definition for access to the innovation. Access to the innovation refers to the adopter's perception that those intended to benefit from the innovation have sufficient access to the innovation.

Discussion of Culturally Responsive Mathematics and Themes Relevant to RQ 1,2,3, and 4

Culturally responsive mathematics draws on the concept culturally responsive pedagogy which challenges the idea that mathematics is culturally-neutral (D'Ambrosio, 2002; Gay, 2009). Research has shown that teaching mathematics effectively to children of color, low income White children, and linguistically diverse children involved instruction that met the learning and problem-solving styles and processes of children whose cultures were incorporated into the instruction (Bottoms, 2016).

The research questions aligned with culturally responsive mathematics were R1, RQ2, RQ3 and RQ4. The themes for the concept of culturally responsive mathematics were linked to interview questions that were informed by research questions 2, 3 and 4. The inductive coding process produced a primary theme which serves as an emerging/new concept. The primary concept/new concept was defined by subthemes as well.

Theme/New Concept: Culturally Responsive Library-Based Math Instruction

This new concept is a synthesizes of the subthemes. The subthemes for the overarching theme included: Librarians serve the underserved, librarians teach hands-on children's

mathematics, librarians teach the underserved, librarians modify math instruction to provide access, and librarians collaborate with the parents of the underserved.

Subtheme: Librarians serve the underserved. Librarians have a history of *serving underserved communities*. The librarians in this study reported working with Somali refugees, Latino/a, African America, Asian immigrants (Chinese, Vietnamese, Korean, Japanese), ESL communities, Mexican, Guatemalan, Puerto Rican, and Dominican, children with learning and developmental disabilities, children with special needs, children from low income communities, among other underserved children.

Subtheme: Librarians teach hands-on children's mathematics. For the theme librarians teach hands-on children's mathematics, the participants provided detailed explanation of their instruction approaches. Some of the highlights included: making math fun, playing games, gross motor activity, rhymes, songs, story time math, using manipulatives, getting loud, stretching, and exercise. Teaching and learning math in the library also included learning numbers, counting colors, shapes, sorting, matching, patenting, sequencing, science, technology, measurement, fractals, tangrams, paper dodecahedrons, fractals, Möbius strips, Keva planks, Magna Tiles, polygons, Fibonacci sequence, snowflakes, catapults, shapes in architecture, among other math. In Bottoms (2016) study on the experiences of elementary teacher candidates on Family Math and Science Nights with culturally and linguistically diverse children and families, the findings in Bottoms study revealed that focusing on hands-on and minds-on activities was more relevant to the students. This math approach is similar to that of math education in public libraries.

Theme: Librarians teach underserved children. For the theme librarians teach underserved children, participants emphasized that the math programs were for all children with

underserved children being part of the patron base, in some communities more than others. Those public libraries that were locate in predominantly underserved communities, were more likely to encounter more experiences that required the librarian's cultural competence skills. The teaching of underserved children relates to Harding-DeKam's (2014) study in culturally responsive mathematics instruction in which one of her findings included the importance of understanding where children are coming from in terms (i.e., culture, worldview, experiences, beliefs, traditions, and family connections).

Theme: Librarians modify math instruction to provide access. Some librarians reported modifying the curriculum to meet the needs of the group, to meet the needs of the community, for level of understanding, and if students had disabilities. Although some of the librarians stuck to the curriculum, librarians also reported modifying the curriculum to meet the needs of the group of students, the needs of the community, for level of understanding, and for students with developmental or learning disabilities. One librarian stated "you have a curriculum and you can tailor it to the needs of your community. Now when we did the first Bedtime math [Crazy 8s] series, that we did."

Theme: Librarians collaborate with parents of the underserved. Collaboration with parents of underserved children usually happened in the moment while the parent was at the class. Librarian P4 reported helping parents understand the importance of early learning. This theme of collaboration with parents who brought their children to math programs is consistent with the research of Cerny (2004), Rupp (2009), and Wallace (2010). In my study, these findings can also be aligned with culturally responsive math instruction as the librarians in this study work with the families of underserved children. The research of Bottoms (2016) highlighted the positioning of families as assets and collaborators.

Culturally Responsive Mathematics: A Factor That Influences Adoption

The findings show that culturally responsive mathematics instruction is a factor that influences adoption. If a librarian teaches students with English as their second language, she/he will have to take into consideration the translation aspect. If a librarian teaches immigrant or refugee students, the librarian may have to tailor the curriculum to the needs of that community, as student cultural experiences play a role in effective teaching and learning (D'Ambrosio, 2002; Gay, 2009).

New Concept: Culturally Responsive Library-Based Mathematics Instruction

The new concept that emerged from the inductive coding process and broadened the concept culturally responsive pedagogy is culturally responsive library-based mathematics instruction. As seen from the findings, public libraries have their own learning and teaching culture. Public libraries serve people from all cultures, economic backgrounds, and learning and physical abilities. Culturally responsive library-based mathematics instruction seems to capture the essence of the data that resulted from RQ4.

Definition for culturally responsive library-based mathematics instruction. CRLBMI is a form of children's mathematics instruction provided by librarians at public libraries. CRLBMI is hands-on math that involves playful activities. It incorporates the cultures, economic backgrounds, and the diverse learning abilities of those participating. CRLBMI invites families to participate and involves collaboration with school teachers. It can be taught by librarians or library staff and can include support from library volunteers.

Library-based Math Instruction Is Not Neutral

As explained by D'Ambrosio (2002), Ladson-Billings (1994), and Villegas & Lucas, (2002) math instruction must not be viewed as a culturally-neutral process. Study participants

expressed differing conceptions of math instruction. Some librarians approached math instruction as a neutral activity while other participants believe in adapting curriculum based on the community. As public librarians provide math curriculum to children at the library, this is an opportunity for librarians to use cultural knowledge of underserved children "as a 'conduit' to facilitate the teaching-learning process" (Ukpokodu, 2011, p. 48).

Implications for Practice

The results of this study have implications nation-wide. For public librarians and public libraries, it's important for them to receive acknowledgement and support for the work that they do for underserved communities in general. The findings showed that most librarians are doing math education work alone, without the support of a national librarian-based math movement. With the support of a national library-based children's mathematics movement, librarians can work together to strengthen their programs and open those communication channels to other libraries which might not even know that math programs exist in public libraries. This may serve to increase the adoption rates of children's mathematics education in public libraries in underserved communities. Wang's (2008) research showed that there was a need for programs to address the math knowledge gap among underserved children. In-line with Wang's research, the findings of my research show that it's important for public libraries to partner with educational institutions and participate in an assessment of the math knowledge gaps in their communities. Two of the librarians that I interviewed mentioned that they were doing that already. This will give public libraries insight into the state of the local issue of the math knowledge gap among underserved children. Some scholars and educators recognize the need to do something supplemental about the achievement gap. In fact, some scholars and educators suggested that communities must "expand the walls of the traditional schoolhouse to encompass a much wider

environment and set of resources" (Stage, Asturias, Cheuk, Daro, & Hampton, 2013, p. 8) as schools cannot solely be responsible for creating math rich environments for children. If public librarians plan to incorporate math education programs into their services, it's important that they consider professional development for culturally responsive teaching. A survey conducted by Char and Clark (2011) which involved 148 respondents showed that 88 percent of the survey respondents believed that all librarians should learn more about integrating children's mathematics into programming (Char & Clark, 2011). The findings also revealed that this is a great opportunity for public libraries to write grants to get financial support for the implementation of children's math programs in public libraries for the underserved. The findings also revealed that this is a great opportunity for public libraries to collaborate on a grant to investigate the creation of universal culturally responsive library-based mathematics curriculum. A children's math curriculum designed by and for public libraries might encourage uniformity in children's math education services throughout the nation among public libraries. And finally, public libraries may want to consider conducting an evaluation or assessment of the state of math education programs in public libraries in the United States.

More organized work around math education could have a huge impact on underserved families in the United States. As P3 stated "If you think about math in your life, every single day for the rest of your life, no matter what you do, there's going to be math because you need math to know what your paycheck is, you need math when you're dealing with banks…Everything you do truly does revolve around math." There are so many benefits to public libraries contribution to addressing the math knowledge gap through offering children's math education programs for and by public libraries and by providing culturally responsive library-based math instruction. In order to create or develop these math resources for the underserved which in turn would allow

librarians to create more opportunity, public librarians need funding, money. Just from conducting this research and finding out first-hand the work that librarians are currently doing around math education and in addressing math and literacy knowledge gaps, it's clear that any funding in this area would be money well spent.

Recommendations for Future Research

This research may be one of the first to utilize the critical qualitative exploratory design to study the perceptions and experiences of librarians in the adoption of children's mathematics education for the underserved in public libraries in the Unites States. This study may be the first to apply the combined frameworks of Rogers' diffusion of innovations theory and culturally responsive mathematics to this phenomenon with the intersecting concepts of power and access. Only a limited number of scholars have applied the critical qualitative exploratory design in conjunction with the application of elements of Rogers DoI theory.

Salinas-Amescua (2018) observed that Rogers' DoI theory had been criticized for its inadequacy in the application of contexts with social structures that are unequal; thus, the relevance of research on topics of underserved communities that apply Rogers' DoI theory along with the critical perspective. Through my research I extended the perceived attributes of Rogers' DoI theory to include *access to resources* and *access to the innovation.* These new constructs make the theory more inclusive and possibly applicable to contexts that include marginalized communities or underserved communities.

For future research I recommend a longitudinal study from a critical perspective that investigates the impact of library-based math on the lives of the children and the potential benefits of more math resources. I recommend survey research that uses the perceived attributes as the constructs to design the questionnaire for the survey in order to better understand the

factors that influence adoption. I recommend a narrative inquiry to give more voice to the librarians providing math education to underserved children. In addition, I recommend the application of theories and frameworks that are more useful in exploring issues of equity, diversity, and social justice. The literature on this topic is currently bare so any research on this topic would serve as a contribution.

Conclusion

The primary focus of this study was to explore the perceptions and experiences of children's public librarians who work in libraries that adopted and offered children's mathematics education to underserved children in the Unites States. This study drew on the critical perspective to explore access and the role of power in the application of Rogers' diffusion of innovations theory and the concept culturally responsive mathematics instruction in the adoption of children's mathematics education in public libraries. The research design for this study was a critical qualitative exploratory approach. Though the theory driven deductive approach dominated this study, I also incorporated a data driven inductive approach.

In this study children's mathematics for the underserved in public libraries was considered a new idea/an innovation, as public libraries are still experimenting with children's math programs as well as their teacher identity. The knowledge gap and community need for such programs were identified as influencing factors in the adoption of the innovation. There were two main types of communication networks, librarian to librarian, and librarian to patron. Although the primary language of the communication channels was English, some libraries would surely benefit from hiring bilingual library staff which could bridge the communication gap and provide more access to participation for English language learners. As I was creating the criteria for participant selection, I discovered that most of the math education programs were

offered in public libraries located in affluent communities. This existed even though there was a decidedly greater need for math programs in low-socioeconomic communities. The findings showed that librarians had characteristics of innovators and early adopters or a combination of both. Also, most librarians tended to work in environments with decentralized power systems in which they were given a great deal of leeway in their access to participation in the decision-making process. As noted earlier, organizations with decentralized power systems were identified as producing more innovativeness than an organization with a centralized power structure (Rogers, 1983). In reference to the construct relative advantage the findings showed that the innovation enhanced the lives of the librarians and the lives of the underserved children, by introducing them to fun, social and relevant new math. There was some conflicting data regarding the compatibility of the innovation with the skills and experiences of the librarians as there were only four librarians with some teaching experience and/or math backgrounds who readily understood and were particularly comfortable teaching math. There were also librarians who perceived math to be difficult. The findings showed that for trialability, the librarians tended to learn how to use the innovation on their own and/or through websites. In regard to observability, the findings showed that there were observable changes of the implemented innovation. Some of the observable changes included: children's improved behavior, parents getting involved, and the child truly understanding the math lesson and math concepts. The findings also showed that three main themes emerged that now serve as new constructs or concepts. Two of the new themes extend Rogers' DoI theory. Those themes are *access to resources* (relevant to the librarian) and *access to the innovation* (relevant to the patron). Finally, the last theme culturally responsive library-based math instruction served to broaden the concept of culturally responsive teaching. The culturally responsive teaching approach draws on

"students' cultural knowledge as a 'conduit' to facilitate the teaching-learning process" (Ladson-Billings, 1994; Ukpokodu, 2011, p. 48). In the literature on CRMI, one of the main issues was having the awareness that math instruction is not a neutral activity. Public librarians that worked in libraries located in underserved communities provided math instruction to culturally and linguistically diverse children. Providing access to math knowledge to the underserved means that public librarians have an opportunity to design or modify curriculum based on the cultural backgrounds and experiences of underserved children. In doing so, librarians provide access to the *motivation* to learn and to the *learning* of math, and contribute to efforts made by library educators to bridge the math knowledge gap. As P9 stated, "Knowing that we have kids in our community that have a math knowledge gap… means we have a job to do, to create opportunities for those children to increase their skill set through additional, free programs."

As information science scholars, we have a job to do as well. One of our jobs is to conduct research on underserved communities. Research that public librarians can use to help them secure more grants to add to the educational programs and services for the underserved children and their families. Research from a critical perspective can address issues around access and power and give voice to the underserved or those advocating for their needs.

There was a lot going on in my study, but I genuinely enjoyed the whole process. There was a challenge and accomplishment at every step of my dissertation, including: all research related concepts, broadening understanding of theory, enhancing methodology refinement, and strengthening literature review writing and research skills. One would wish this study will inspire others to do more research on math education in public libraries, or inspire a librarian to create a library-based math curriculum, and hopefully there will be a higher rate of adoption of math programs in public libraries. This subject needs much more visibility and more acknowledgment.

May this study be of wide use to librarians and researchers.

Ya Basta!

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APPENDICES

Appendix A: Sample of FFIEC Geocode Census Report

FFIEC

2017 FFIEC Geocode Census Report

Address: Selected Tract
MSA: [redacted]
State: [redacted]
County: [redacted]
Tract Code: [redacted]

Summary Census Demographic Information

Tract Income Level	Middle
Underserved or Distressed Tract	
2017 FFIEC Estimated MSA/MD/non-MSA/MD Median Family Income	
2017 Estimated Tract Median Family Income	
2010 Tract Median Family Income	
Tract Median Family Income %	
Tract Population	
Tract Minority %	
Tract Minority Population	
Owner-Occupied Units	
1- to 4- Family Units	

Census Income Information

Tract Income Level	Middle
2010 MSA/MD/statewide non-MSA/MD Median Family Income	
2017 FFIEC Estimated MSA/MD/non-MSA/MD Median Family Income	
% below Poverty Line	
Tract Median Family Income %	
2010 Tract Median Family Income	
2017 Estimated Tract Median Family Income	
2010 Tract Median Household Income	

Census Population Information

Tract Population	
Tract Minority %	
Number of Families	
Number of Households	
Non-Hispanic White Population	
Tract Minority Population	
American Indian Population	
Asian/Hawaiian/Pacific Islander Population	
Black Population	
Hispanic Population	
Other/Two or More Races Population	

Census Housing Information

Total Housing Units	
1- to 4- Family Units	
Median House Age (Years)	
Owner-Occupied Units	
Renter Occupied Units	
Owner Occupied 1- to 4- Family Units	
Inside Principal City?	
Vacant Units	

Appendix B: Recruitment Letter

Recruitment letter for a study on
Power, access, underserved communities, and the perceived attributes: A critical perspective in the exploration of the adoption of children's mathematics education in public libraries
UTK IRB-17-03785-XP

<Date>

<Name of potential participant>
<Address>
<City, State, Zip>

Re: *<insert the title of the study and the investigator's name>*

Dear *<insert name>*:

I am writing to let you know about an opportunity to participate in a research study that explores the experiences and perceptions of public librarian toward the adoption of children's mathematics education in public libraries with an interest in meeting the needs of children from underserved communities; this study also explores how issues of power and access play role in this phenomenon. The study will be conducted by myself, Frank Aviles, the personal investigator and a doctoral student in the College of Communication and Information Sciences (CCI) at University of Tennessee, Knoxville. As part of my dissertation research, I am interviewing children's public librarians in charge of children's departments who incorporate children's mathematics education into their library practices. The purpose of this study is to explore the experiences of librarians to determine the factors that influence the adoption of early childhood mathematics education in public libraries.

You will receive a follow-up phone call to this letter. If you decide to participate in the study, please note that no identifiable information will be included about the participants in the study.

If you would like additional information about this study, please call or email Frank Aviles at (619) 677-7276, faviles@vols.utk.edu. Agreement to be contacted or a request for more information does not obligate you to participate in any study. Potential participants can opt out/request no further contact by contacting me through the phone number or email address provided.

Thank you again for considering this research opportunity.

Frank Aviles
The University of Tennessee - Knoxville
P.O. Box 16583
Knoxville, TN 37996
Phone: 619/677.7276
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Appendix C: Informed Consent Statement

UTK IRB-17-03785-XP

INTRODUCTION. You are invited to participate in this study, which explores issues of power and access through the experiences and perceptions of public librarian toward the adoption of early childhood mathematics education in public libraries with an interest in meeting the needs of children from underserved communities.

INFORMATION ABOUT PARTICIPANTS INVOLVED IN THE STUDY. You will be asked to participate in an interview that should take 45 to 90 minutes long. The interviews will either be conducted via phone, online format, or in person at location of participant's choice. Interviews may require more than one interview session. The interviews will be recorded and saved digital files onto a password protected computer. The interviews will be transcribed verbatim, saved onto a password protected computer. You may be asked for follow-up interviews or to repeat an interview in the case of technological failure or malfunction. With your approval, the transcribed interviews will be emailed or snail mailed to you for your review. The expected duration of the study including data collection, and analysis (up to and including completion of the dissertation) will be within one year of the start date of the study.

RISKS. There are no foreseeable risks involved in participating in the interviews other than those encountered in every day life.

BENEFITS. Although you may not directly benefit from the study, public libraries that do not have children's math education programs or services may benefit from research on your experiences. Also, this study will serve as a major contribution to the scant research on the topic of early childhood math education in public libraries.

COMPENSATION

Participants that complete the study will receive an electronic Amazon gift card in the amount of $15. At the end of all interviews the participants will be reimbursed for their participation. Each participant will be required to provide an email address so the researcher can email the participant the necessary information for redeeming the Amazon gift card.

CONFIDENTIALITY. The information from the responses to your interview questions will be kept completely confidential. Only the researcher(s) will have access to your information. The data will be stored on a secure password protected server and no specific identifiers left on the data upon its collection.

CONTACT INFORMATION. If you have questions at any time about this study or the procedures, you may contact the researcher Frank Aviles at faviles@vols.utk.edu or (619) 677-7276. If you have questions about your rights as a participant, you may contact the University of Tennessee IRB Compliance Officer at utkirb@utk.edu or (865) 974-7697. Additionally, Frank Aviles' research advisor, Dr. Vandana Singh, can be contacted at vandana@utk.edu or 865-974-2785; and committee chair, Dr. Carol Tenopir, can be contacted at ctenopir@utk.edu or 865-974-7911.**PARTICIPATION.** Your participation in this study is voluntary. You may decline to participate without penalty. If you agree to participate, you may withdraw from the study at any time without penalty and without any loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed your data will be destroyed.

CONSENT

I have read the above information. I have received a copy of this form. I agree to participate in this study.

Participant's Name (printed) _____

Participant's Signature _____ Date _____

Appendix D: Interview Protocol

Title of Study: *The Adoption of Children's Mathematics Education in Public Libraries for Underserved Communities: An Exploratory Qualitative Study from a Critical Perspective*
UTK IRB-17-03785-XP

Interview #: _____

Date: _____/_____/_____

Start Time: _____ End Time: _____

Job Title: ❏ Children's Librarian ❏ Library Director ❏ Librarian (Dept._____)
❏ Library Technician ❏ Other_____

Name: _____ Code Name: _____

Library: _____ Code Name: _____

Interview Format: ❑ Face-to-Face ❑ Phone
❑ Virtual: ❑ Skype ❑ FaceTime ❑ Zoom ❑ Camtasia ❑ Other _____

Recording Method(s): ❏ Tape Recorder ❏ iPhone Recorder ❏ Virtual Software ❏ Audio Software

Location: _____

1. Introduction Script

Welcome and thank you for your participation in this study today. My name is Frank Aviles and I am a doctoral student at the University of Tennessee, Knoxville, (UTK) conducting interviews to explore the experiences and perceptions of public librarian toward the adoption of children's mathematics education programs in public libraries with a specific focus on underserved communities. This research, which is a qualitative exploratory study from a critical perspective, also explores how issues of power and access play a role in this phenomenon. This study is conducted as partial fulfillment of the requirements for the doctorate degree in Communications and Information. The interviews will include 16 questions and take between 45 to 90 minutes and may require two interview sessions. The interviews will be recorded using video and/or audio software or electronic devices so I may accurately document the information you convey. The recordings will be saved as MP3 files onto a password protected computer. The interviews will be transcribed verbatim and also saved onto a password protected computer. The MP3 files and any recorded interviews will be erased as soon as information has been transcribed or coded and is no longer needed for research. You may be asked for follow-up interviews or to repeat an interview in the case of technological failure or malfunction. All of your responses will remain confidential and will be used to better understand the factors that influence the adoption of children's math education programs in public libraries with a specific focus on underserved communities.

Prior to this interview you and I signed and dated a consent form indicating that you agree to the interview and that I have your permission to video and/or audio record our conversation. *Are you still ok with me recording (or not) our conversation today? ___Yes ___No* If yes: *Thank you!* Your participation in this interview is completely voluntary. If at any time you need to stop, take a break, please let me know. Please let me know if at any point you want me to turn off the video and/or audio recorder or keep something you said off the record. You may also withdraw your participation at any time without consequence.

Do you have any questions or concerns before we begin? If any questions (or other questions) arise at any point in this study, you can feel free to ask them at any time. I would be more than happy to answer your questions. With that said, with your permission, we will begin the interview.

2. Interview Questions

Concept	Interview Questions
Background: Children's services	1. Tell me about your position as a (children's) librarian or library staff for the children's department? • Why you became a children's librarian • What children's services mean to you • What children's math education services mean to you • What else would you like to tell me?
Background: Underserved Communities	2. Describe your experiences of working with children from underserved communities? • What underserved means to you • The needs of underserved communities • How your department assesses and meets those needs • Your understanding of the knowledge gap for math among underserved children • What else would you like to tell me?
Background: Relationship with Math	3. Tell me about your educational experiences with learning mathematics? • Your relationship with math growing up • What you think about math today • The relevance or irrelevance of math to a child's daily life, education and future career opportunities • What else would you like to tell me?
Adopter Categories: Type of Adopter	4. Describe your decision-making process for adopting and/or implementing new children's services (for underserved communities) in your department? • Your role in creating, introducing, approving, implementing, promoting, and/or accepting new ideas and services • The role that the needs of underserved communities play in your decision-making process • Approach to the adoption of new programs – receptive or unreceptive • What else would you like to tell me??
Adopter Categories: Power	5. What does the "role of power" mean to you in the context of the decision-making process for children's programs? • Discuss the decision-makers or decision-making hierarchy at your library • Your role in the decision-making process • What if means for children's programs for underserved communities • What else would you like to tell me?
Perceived Characteristics of the Innovation: Relative Advantage	6. Please describe the advantages and disadvantages of offering children's math education services in your library • Advantages and disadvantages of services that target children from underserved communities – for the library and the underserved children • Also, discuss the advantages and disadvantages of collaborating with parents of children from underserved communities • What else would you like to tell me?
Perceived Characteristics of the Innovation: Compatibility	7. Why did your department adopt math education services? • How it fits into children's library services • How it fits into your daily work activities • It's relevant to the needs of children from underserved communities and to their parents • What else would you like to tell me?

Concept	Interview Questions (cont.)
Perceived Characteristics of the Innovation: Complexity	8. Tell me about your math knowledge and skill level **before** and **after** implementing children's math services? • Your experiences in applying that knowledge and skill level to teach children from underserved communities • The role that the experiences, and backgrounds of children from underserved communities played in designing curriculum, if any • The challenges that you faced in providing math education services in general and to underserved communities • What else would you like to tell me?
Perceived Characteristics of the Innovation: Access (the needs of the Adopter)	9. Tell me about your experiences with incorporating children's math education into your library practices in general and for underserved communities? • How you did it • Your curriculum and why you chose it • A smooth day of math instruction and a challenging day of math instruction • The type of support you received • Additional type of support that you would you have liked to receive • What else would you like to tell me? 10. What suggestions do you have about instruction approaches for librarians who are considering adopting math education services in general and to children from underserved communities?
Perceived Characteristics of the Innovation: Access (the needs of the Constituents of the Adopter)	11. What role does the needs of children from underserved communities play in your decision-making process in the adoption of children's math education services? • Introducing, voting for, or implementing new services • The math knowledge gap among the underserved children • Their feedback and their parents feedback • What else would you like to tell me?
Perceived Characteristics of the Innovation: Trialability	12. What were the upsides and downsides of implementing children's math education programs in general and for children from underserved communities? • Your first session or trial run • What else would you like to tell me? 13. Tell me about the feedback you received from fellow library staff, from children and parents from underserved communities, and from community members in general? • The effects of that feedback on your future math sessions • What else would you like to tell me?
Perceived Characteristics of the Innovation: Observability	14. What do you think about the idea of allowing library staff from other public libraries (that are considering offering math education as a children's service in general and to underserved communities) to observe the day to day operation of your math education program? • Describe your own process • What else would you like to tell me?
Adopter Categories: Type of Adopter	15. Why do you think some public libraries might adopt children's math education programs for children from underserved communities? What else would you like to tell me? 16. Why do you think most public libraries have not adopted children's math education programs in general and for underserved communities? What else would you like to tell me?

3. Closing Script

Is there anything more you would like to add?

I will transcribe the interviews, type up a draft, and I'll be happy to send you a copy to review at that time, if you are interested.

If you have any questions, feel free to contact me by phone at (619) 677-7276, through email at faviles@vols.utk.edu or, or by snail mail at P.O. Box 16583, Knoxville, TN 37996.

Thank you for your time!

4. **Journal Notes**

Concept Corresponding to Interview Question(s)	**Participant Response (Highlights)**	**Interviewer Notes**	**Reflection Notes**
Background: Children's services **(# 1)**			
Background: Underserved Communities **(# 2)**			
Background: Relationship with Math **(#3)**			
Adopter Categories: Type of Adopter **(#4)**			
Adopter Categories: Power **(#5)**			
Perceived Characteristics of the Innovation: Relative Advantage **(#6)**			
Perceived Characteristics of the Innovation: Compatibility **(#7)**			
Perceived Characteristics of the Innovation: Complexity **(#8)**			
Perceived Characteristics of the Innovation: Access (the needs of the Adopter) **(#9 & #10)**			
Perceived Characteristics of the Innovation: Access (the needs of the Constituents of the Adopter) **(#11)**			
Perceived Characteristics of the Innovation: Trialability **(#12 & #13)**			
Perceived Characteristics of the Innovation: Observability **(#14)**			
Adopter Categories: Type of Adopter **(#15 & #16)**			

Appendix E: Transcriber's Pledge of Confidentiality

Title of Study: *The Adoption of Children's Mathematics Education in Public Libraries for Underserved Communities: An Exploratory Qualitative Study from a Critical Perspective*

As a transcribing typist of this research project, I understand that I will be viewing and/or hearing video recorded confidential interviews or hearing tapes of confidential interviews. The information on these videos and/or tapes has been revealed by research participants who participated in this project on good faith that their interviews would remain strictly confidential. I understand that I have a responsibility to honor this confidentially agreement. I hereby agree not to share any information on these videos and/or tapes with anyone except the primary researcher of this project. Any violation of this agreement would constitute a serious breach of ethical standards, and I pledge not to do so.

_____ _____

Transcribing Typist Date

VITA

Frank Pancho Aviles was born in Bakersfield, California, to Fructuoso and Maria Guadalupe Aviles, migrant farmworkers who came to the US from Mexico. He attended Outside Creek School, Visalia, California, and graduated from Exeter Union High School, Exeter, California. He obtained a Bachelor of Arts in Mathematics with a minor in La Raza Studies from California State University, Fresno. He received a Certificate in Library Information Technology from City College of San Francisco. He further received A Master's degree in Information Resources and Library Sciences from University of Arizona, Tucson. Upon acceptance of this dissertation, he will complete his academic career at the University of Tennessee, Knoxville in December 2018 with a Doctor of Philosophy in Communication and Information degree.

Frank has worked as a farm laborer, journalist, counselor, health educator, and various roles in both public and academic libraries. Most recently Frank has taught *Information Seeking: Resources and Strategies*, *Technologies for Information Retrieval*, and *Race, Gender, and Information Technology* in the School of Information Sciences at University of Tennessee, Knoxville, as a graduate assistant. In addition, Frank worked as graduate assistant and Saturday supervisor for the Pendergrass Agriculture and Veterinary Medicine Library at the University of Tennessee, Knoxville.