ELEMENTARY EDUCATORS' SELF-EFFICACY, CURIOSITY, LEARNING ATTAINMENT, EXPERIENCE, AND THE NUMBER OF NEUROMYHTIC BELIEFS: A CORRELATIONAL STUDY

by

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Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

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ABSTRACT

The advancements in brain research have led to misconceptions in education. These misconceptions, known as neuromyths, can have impacts on the education system. The problem is educators could potentially waste resources on instructional practices or professional development due to neuroscience misconceptions. The purpose of this quantitative correlation study was to determine if there was a relationship between elementary educators' self-efficacy, curiosity, learning attainment, experience, and the number of neuromythic beliefs. The sample population (N = 67), collected through a convenience sample, included rural in-service elementary educators from one school district in Missouri. Participants took an online questionnaire that included the following instrumentation Generalized Self-efficacy scale, The Curiosity and Exploration Inventory-II, and the General Knowledge About the Brain Survey. Pearson's r and Spearman's rho correlation coefficients were used to determine if a relationship existed between the predictor and the criterion variables in four null hypotheses. After data analysis, the researcher failed to reject all four null hypotheses, meaning there was not sufficient evidence to conclude a relationship exists between the predictor and criterion variables. This study was significant in that it provided added information to researchers and the field of education concerning the relationship of elementary educators' motivation to learn and background information regarding their beliefs in neuromyths. Future research should involve quantitative studies including a more diverse population of elementary educators.

Keywords: neuromyths, neuroscience, curiosity, self-efficacy, learning attainment, teaching experience, brain, learning

Dedication

I would like to dedicate this manuscript to my best friend and the love of my life. Ray, you are my everything.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

The Curiosity and Exploration Inventory-II (CEI-II)

The General Knowledge About the Brain Survey (GKB)

The Generalized Self-efficacy scale (GSE)

Missouri Department of Elementary and Secondary Education (DESE)

National Center for Education Statistics (NCES)

Organization for Economic Cooperation and Development (OECD)

Social-cognitive theory (SCT)

CHAPTER ONE: INTRODUCTION

Overview

This chapter will provide a background on the topic of neuroscience and its relevance to education. An introduction to the problem will discuss potential wasted resources when educators believe in neuromyths. Next, the purpose of this quantitative study will introduce the intended population and variables in this study. A description of the contributions to researchers and educators provided support to the significance of this quantitative research. This chapter will conclude with the research questions and defined terms important to this study.

Background

Educators are experts in the field of learning and much of their practice is based upon learning theories that have been around for many ages. Recently, in the new age of technology, a new driving force for how learning happens has emerged (van Dijk & Lane, 2018). With the advances of technology, the studies of the brain have begun to shed light on the brain and its role in learning (Feiler & Stabio, 2018). Many scholars believe brain research has relevance in today’s classrooms (Grospietsch & Mayer, 2019); however, some scholars believe that the bridge is too far gone to be able to have a practical use (Bowers, 2016). The study of the brain, defined as neuroscience, is a complex field with complex terms for those who are outside of the science field to understand (Ferrero et al., 2016). Brain research findings are complex and require collaboration to interpret the results to practice (van Dijk & Lane, 2018). To understand where educators are in their knowledge of the brain and its role in learning, one must take a look at where and how brain research has evolved. The advancements in brain research have led to misconceptions and misunderstandings in education known as neuromyths (Grospietsch & Mayer, 2019). According to Organization for Economic Cooperation and Development [OECD]

(2002), a neuromyth is defined as a confusion, a misinterpretation, and in some cases, an intentional twisting of the scientifically proven fact to make a valid argument for education.

The study of the brain has generated enthusiasm in many disciplines since the 1990s, which was coined the Decade of the Brain (Dekker et al., 2012). This neuroscientific research has produced relevant information for education. An example includes the concept of plasticity. The synaptic connectors mold the brain and change due to a person's experiences. This plasticity of the brain has been shown to get stronger with repeated tasks and weaker with inactivity (Dubinsky et al., 2013). However, not all information about the brain has helped the education system.

Neuroscience, the study of the brain, has increased brain-related information in many fields. Research in neuroscience has provided information to the field of counseling. Brain studies have provided information about the long-lasting effects of the social environment during prenatal and early childhood development (Provençal & Binder, 2015). Neuroscience has been cited in connection to various areas of law and government, legal notions, and theories, including legal decision-making (Chandler et al., 2019). Many marketing tactics have adopted neuroscience research as a strategic approach. Commercial businesses have a vested interest in learning consumers' buying triggers in the brain (Brenninkmeijer et al., 2020), such as framing content with brain images or information (Im et al., 2017). This marketing approach has been coined *neuroframing* (Im et al., 2017). Neuroscience has reached the field of education too. Educational neuroscience relevance has been debated by scholars over the last few decades (Feiler & Stabio, 2018).

The realization of brain misconceptions began with the advancement of technology that has improved the general knowledge of how the brain functions and learns. Recent discoveries of brain development involving cognitive networks and frameworks fundamental for learning and motivation could potentially improve the education process around the world (Stafford-Brizard et al., 2017). Some of these findings have led to misconceptions about the brain due to misinterpretations of scientific findings. Commercial products have neuroframed their products creating false or unverified brain information (OECD, 2002). Today, the creation of many institutes and programs are a result of these brain advancements to conduct research and communicate accurate neuroscience information to educators, neuroscientists, psychologists, and policymakers (Feiler & Stabio, 2018) in efforts to understand and reduce the number of misconceptions about the brain and learning.

Neuroscience has its effects on the education system which affects society-at-large. The impacts of human brain research for learning are extensive (Feiler & Stabio, 2018). For example, there has been an increased acknowledgment of the importance, availability, and public investment in early childhood learning programs (U.S. Department of Education, 2015). Research on the use of phonological awareness on brain function has increased awareness and interventions for struggling readers (Washburn et al., 2017). Knowledge of the long-term brain effects of bullying (Vaillancourt et al., 2008) has assisted in the development of bullying prevention policies and anti-bullying programs (Espelage, 2016). For the education system, these and other neuroscience discoveries from brain research have increased legitimacy and significance to the education field.

Educators' exposure to brain information has increased due to the developments in the technology of brain imaging used in scientific research. There is an increased interest in using this brain research in the field of education to advance theory, practice, and policy (Feiler & Stabio, 2018); however, many misconceptions about the brain and its role in learning are a result of a motivation to learn and an interest in neuroscientific findings (Macdonald et al., 2017). These misconceptions have been branded as neuromyths (OECD, 2002). Educators' beliefs in neuromyths can have negative impacts on education through ineffective instructional practices or training which affects the society-at-large by way of lost time and money.

Howard-Jones (2014) discovered that teachers from the United Kingdom, the Netherlands, Turkey, Greece, and China were reasonably prone to neuromythic beliefs. Neuromythic beliefs have consequences. For example, one popular neuromyth is the Mozart effect. It was advertised and people believed that young children's intelligence would increase if they listened to classical music (Pasquinelli, 2012). Due to this neuromyth, Florida law required daycares to play classical music daily to their children (Pasquinelli, 2012). In 1998, the Governor of Georgia allotted millions of dollars of funding to purchase and deliver recordings of classical music to all newborn children within the state (Ruyter & Miedema, 2012). Neuromyths misinformed decision-makers to make poorly informed policies that cost millions of dollars.

The origin of neuromythic beliefs and persistence in education is unknown. Neuromyths in education can date to the early 1970s when an article by Maya Pines in the *New York Times Magazine* entitled "We are Left-Brained or Right-Brained" was published (Hardyck & Haapanen, 1979). The article oversimplified the use of brain research and left educators pleading school psychologist for assistance in teaching to the whole brain (Hardyck & Haapanen, 1979). In 1985, the popular term *neuroeducator* and technology advancement increased the interest in the role of the brain in education (Feiler & Stabio, 2018). Due to this increased interest, many misconceptions about the brain and its role in learning were formed.

The research on neuromyths is conflicting. A study conducted by Howard-Jones (2014) found that teachers with more brain knowledge helped reduce the belief of neuromyths. A contradicting study, conducted by Gleichgerrcht et al. (2015), found that educators with more brain knowledge had an increase in the beliefs of neuromyths. Macdonald et al. (2017) conducted a widespread study across the general public in the United States. Their results found that age and professional learning predicts more accurate general knowledge of the brain, and its role in learning. However, most of the groups in this study still believed in the two most popular neuromyths concerning dyslexia and learning styles (Macdonald et al., 2017). Learning characteristics related to the variables in Macdonald et al.'s study could help researchers better understand the proliferation of neuromythic beliefs.

In Macdonald et al.'s (2017) study, three variables were found to guard against neuromyth beliefs. These variables were having a graduate degree, experience with neuroscience coursework, and exposure to peer-reviewed research all related to professional learning attainment. Educators have a vast number of professional learning opportunities. Educators can learn from each other, attend district required professional development, or seek learning opportunities of interest to the educator. The social-cognitive theory (SCT) explains learning through the environment along with cognitive factors such as motivation and beliefs (i.e., self-efficacy or curiosity), and behaviors such as learning attainment and years of education experience. Personal cognitive, behaviors, and environmental factors influence elementary educators' professional learning attainment (Bandura, 2006). Educators consider their background, experience, and expertise when contemplating improving their teaching capacity. This reflection permits educators to gain knowledge about themselves and the social context around them (Bandura, 1991). Moderate challenges, such as struggling students, motivate educators to attain professional learning to develop their teaching capacity.

Elementary educators operate as active agents in their attainment of professional learning (Bandura, 1991). They examine and gather information from extensive social and environmental interactions (Bandura, 1991). These experiences strengthen educators' professional learning attainment. Educators' attainment of knowledge affects attitudes, emotional reactions, and behavioral tendencies toward situations that are connected to the learning experiences (Bandura, 1991). The professional learning experiences of educators range from observing neighboring classrooms or schools, reading educational media, or attending professional development workshops. These experiences allow educators to observe and attain what other people in the field of education are doing and to evaluate their knowledge following what they observe (Bandura, 2006), either educating or exposing elementary educators to neuroframing, neuromyths, or a misinterpretation of neuroscience information.

Self-efficacy influences learning (Vela et al., 2018). According to Bandura (1997), perceived self-efficacy is a mechanism of human agency as a motivator for learning. Several factors such as arousal by psychological stimuli, experiences, achievement strivings, curiosity, and career aspirations influence elementary educators to learn (Bandura, 1997). Educators' beliefs about capability and outcomes can have positive or negative effects on learning. Those who believe they can achieve an outcome with success, such as learning new ways to help struggling students, are more likely to engage and be satisfied with this learning task (Bandura, 1997). Those who find themselves with low levels of self-efficacy and negative outcome beliefs often fail to attempt the task and often experience high self-criticism. High self-efficacy enables educators to control their self-development (Bandura, 1997). This self-driven belief in themselves to have a successful outcome could potentially lead educators to attain professional learning or advanced degrees. Professional learning attainment such as obtaining advanced degrees have been known to reduce the number of neuromythic beliefs (Macdonald et al., 2017). Self-efficacy is a personal cognitive factor that helped further the understanding of elementary educators' neuromythic beliefs.

Curiosity is relevant to this study as a motivator to learning, influential in decision-making, and crucial for healthy development (Kidd & Hayden, 2015). According to Mussel (2013), curiosity is a significant variable for the prediction and clarification of work-related performance. Stumm et al. (2011) found that curiosity correlates to academic achievement to the same degree as intelligence. There are many definitions of curiosity. Berlyne (1954) separated perceptual curiosity from epistemic curiosity, explaining epistemic curiosity as learning of knowledge. Loewenstein (1994) defined curiosity as arising from a perceived lack of knowledge. Knowledge and its learning are key concepts related to epistemic curiosity are described repeatedly in the literature. Litman (2008) described epistemic curiosity as the longing to acquire new knowledge and is projected to stimulate intellectual interest or eliminate conditions of informational deprivation. Silvia (2008) considered curiosity as the emotion of interest that is relevant to new, complex, or uncertain situations to an individual. Mussel (2013) explained that thinking about individual learning differences, people with higher levels of epistemic curiosity are more likely to look for, investigate, and master novel, complicated, and uncertain situations. These people frequently have behaviors such as information seeking, learning, and thinking, all of which lead to higher levels of expertise (Mussel, 2013). One aspect of curiosity that most can agree on is that curiosity is a desire for information (Kidd & Hayden, 2015). Studies have found the curiosity trait positively correlates with learning success (Ainley et al., 2002; Grossnickle, 2016; Hidi, 2016; Mussel, 2013).

Interest is the emotion strongly tied to curiosity (Silvia, 2008). There has been a flood of interest in using neuroscience discoveries to expand the educational approaches of educators (Im et al., 2017). Being interested means that emotional reactions, perceived value, and cognitive functioning intertwine, and that attention and learning feel effortless (Dewey, 1913). Educators are interested in what neuroeducation can provide to the classroom (Serpati & Loughan, 2012). Interesting or seductive details of neuroscience are distractors to important details (Schneider & Preckel, 2017). Pickering and Howard-Jones (2007) expressed educators' high-interest in the application of neuroscience could potentially lead to neuroscience misconceptions or exposure to neuromyths. Multiple studies report educators' high interest in neuroscience (Dekker et al., 2012; Howard-Jones, 2014; Macdonald et al., 2017; Pasquinelli, 2012; Ruhaak & Cook, 2018). Given that curiosity leads to interest (Hidi & Renninger, 2006), curiosity is a personal cognitive factor that helped further the understanding of elementary educators' neuromythic beliefs.

Multiple studies have found a relationship between educators' beliefs about learning and their instructional practices (Lunn Brownlee et al., 2017; Nie et al., 2013; Stein & Wang, 1988). Dekker et al. (2012) stated that educators transfer misconceptions about neuroscience, known as neuromyths, into professional practice. A clear need exists to better understand how educators come to or continue to believe neuromyths to improve evidenced-based instructional practices. This understanding can come from studying different motivations to learn, such as self-efficacy (Zee & Koomen, 2016) and curiosity (Kidd & Hayden, 2015). Learning attainment is related to the number of neuromythic beliefs among different populations (Macdonald et al., 2017). These motivations to learn and learning experiences could potentially introduce or guard educators against neuromyths. Testing for a relationship between self-efficacy, curiosity, professional learning attainment, years of experience, and the number of neuromythic beliefs could further the understanding of educators' beliefs of the brain and its role in learning. This understanding could improve the education system by protecting instructional and professional learning with evidence-based practices along with the cost associated with ineffective materials or training.

Educators help shape the structure and functioning of students' brains through classroom instruction and environmental stimuli (Im et al., 2017). However, many educators have a low understanding of neuroscience literacy in comparison to educators' high interest in neuroscience (Im et al., 2017). Neuroscience literacy is important when evaluating neuroframed instructional practices and commercial products (Im et al., 2017). Without neuroscience literacy, educators are prone to believing neuromyths. A neuromyth is defined as a confusion, a misinterpretation, and in some cases, an intentional twisting of the scientifically proven fact to make a valid argument for education (OECD, 2002). Educators have been found to believe these neuromyths and base their instructional practices on these misconceptions (Dekker et al., 2012).

Problem Statement

A significant amount of research conducted in the area of neuromythic beliefs has been completed with preservice teachers regarding demographic characteristics (Im et al., 2017; Macdonald et al., 2017; Ruhaak & Cook, 2018). Results from studies have produced inconclusive findings to possible predictors from these misconceptions (Feiler & Stabio, 2018). Little research has been conducted to determine if motivators of learning such as educators' self-efficacy and curiosity with in-service elementary educators are related to educators' beliefs of neuromyths. Due to this, a gap exists in understanding whether elementary educators' self-efficacy, curiosity, learning attainment, and experience are related to the number of educators' neuromythic beliefs. Ruhaak and Cook (2018) reported that more investigation into the phenomena of neuromyths needed to take place with practicing educators.

Grospietsch and Mayer (2019) stated that educators have a great interest in transferring neuroscience topics into brain-based learning. However, no study had tested whether curiosity in neuroscience was related to neuromythic beliefs. Other studies have found the amount of learning attainment influences neuromythic beliefs (Macdonald et al., 2017), but few studies have tested for an association between learning attainment or years of experience of elementary educators with neuromythic beliefs. The growth of the neuroscience field and availability of information has provided many new learning opportunities, such as organizations, journals, and graduate coursework, on the brain and its role in learning (Thomas et al., 2019). Upon reviewing related literature, a gap was identified which indicated a lack of knowing if there is an association between the motivations to learn or the learning experiences of elementary educators and their neuromythic beliefs. The problem is that there is a lack of research in understanding how and why educators come to and continue to believe in neuromyths.

Purpose Statement

The purpose of this quantitative, correlational study was to determine if there was a relationship between the variables of self-efficacy beliefs, curiosity, learning attainment, years of experience, and the number of neuromythic beliefs. The study was comprised of collecting demographic data, self-reporting of curiosity and self-efficacy, and a survey on the brain concerning learning from a convivence sample of in-service elementary educators from one rural school district in south-central Missouri. This study's outcome adds more information to the literature about educators' beliefs in neuromyths.

The variables in this study include the criterion variable of the number of neuromythic beliefs, along with the predictor variables of self-efficacy, curiosity, professional learning attainment, and years of experience. The number of neuromythic beliefs is the number of misconceptions about the brain and its role in learning believed by educators. The OECD (2002) defined neuromyths as a confusion, a misinterpretation, and in some cases an intentional twisting of the scientifically proven fact to make a valid argument for education. Self-efficacy is a person's perception of his or her capability to regulate actions within his or her life (Bandura, 1997). Curiosity is a desire for information (Kidd & Hayden, 2015). Richter et al. (2011) described professional learning as "the uptake of formal and informal learning opportunities that deepen and extend teachers' professional competence, including knowledge, beliefs, motivation, and self-regulatory skills" (p. 116). Professional learning attainment is the "duration of time teachers reported spending in various learning activities" (Kose & Lim, 2011, 202). Law Insider (n.d.) defined years of experience as the number of years of full-time employment as a teacher in a public school, private school licensed or accredited by the State Board of Education, or institution of higher education (p. 1).

Significance of Study

This study was significant because educators must be mindful of their lack of knowledge to improve and to prevent spreading misconceptions to their students. Catalano et al. (2019) conducted a study involving 82 in-service and 27 pre-service elementary school teachers who are known to have low self-efficacy in science. Catalano et al. investigated whether teachers' knowledge of science content was related to their self-efficacy. The study found a negative relationship between one's belief that they could teach science effectively and their knowledge of science content. Efficacious teachers might not be cognizant that they need to expand their science content knowledge (Catalano et al., 2019). Like Catalano et al.'s study, the current study tested for a relationship between motivations to learn, such as self-efficacy and curiosity, and science misconceptions, specifically the number of neuromythic beliefs.

This study was important because it provided added information to researchers and the field of education concerning behaviors of elementary educators such as professional learning attainment and teaching experience regarding beliefs in neuromyths. Ferrero et al. (2016) conducted a meta-analysis on the literature available at that time and found that 98.5% of teachers were interested in the brain and its role in learning and 95.4% thought neuroscientific knowledge was very important to the teaching practice. In these studies, 96.1% of educators increased their professional learning involving education and the brain using sources such as web pages and blogs, books, or professional development courses (Ferrero et al., 2016). This meta-analysis also found that women are more likely to have an increased number of neuromythic beliefs than men (Ferrero et al., 2016). While Ferrero et al.'s research collected data on what types of professional learning educators reported, this study tested to see if the amount of professional learning had a role in the number of neuromythic beliefs. Ferrero et al.'s research also found cultural differences among different neuromythic beliefs. The current study's population was solely interested in elementary educators within one geographic area, unlike any study known to the researcher. A study investigating only elementary educators added to the empirical evidence about cultural differences and the number of neuromythic beliefs among various populations.

Neuromythic beliefs have been established as prevalent among the general public and K-12 teachers. Betts et al. (2019) conducted an international study that investigated an awareness and predictors of neuromyths among "higher education professionals across institutional types, course delivery modes, roles, and a variety of characteristics such as demographics, teaching experience, and level of education" (p. 1). Like many other studies, Betts et al. also studied neuroscientific interest among professional roles. Similar to Betts et al.'s investigation, this study tested for a relationship among teaching experience and the number of neuromythic beliefs. Due to the high interest in neuroscience, this study also investigated educators' self-reported curiosity level and its relationship to neuromythic beliefs.

This study focused on relationships between personal cognitive and behavioral factors along with the number of neuromythic beliefs of elementary educators. Many studies have been conducted across the world concerning the area of neuromyths (Macdonald et al., 2017). Ferrero et al., (2016) stated a better understanding of the educator would be useful in designing more effective interventions to tackle the issues of neuromythic beliefs. However, empirical data are lacking in individual learning differences of educators and neuromythic beliefs. This empirical data was important because it provided researchers with another piece of information in understanding why neuromyths exist and provided guidance to overcome these misconceptions.

Betts et al. (2019) stated that understanding the pedagogical beliefs of educators, and their neuromythic beliefs are important in regards to improving professional development on advancements in neuroscience. Along with improving professional learning and instructional learning time, the financial cost associated with misconceptions is of great concern (Ferrero et al., 2016). Neuromyths also influence decision making which can have substantial economic cost (Ferrero et al., 2016). Educators' misconceptions are worrisome due to the relationship between educators' beliefs about learning and their instructional practices (Lunn Brownlee et al., 2017).

While this study was focused on elementary educators, researchers could use the data to examine individual learning differences among other population groups within the discipline of education. According to Im et al. (2017), educators must make educated decisions about the implementation of new curricula and instructional practices, some of which are supported with an inaccurate appeal to neuroscience research. The results of this study could be used to help educators protect themselves against the seductive details of high interest found in the neuromarketing of education publications. The study was significant to the theory of self-efficacy and curiosity because it found no evidence for a relationship between self-efficacy or curiosity and the number of neuromythic beliefs. This added information was practical because it could help educators protect valuable resources such as instructional and learning time along with the financial cost (Ferrero et al., 2016), knowing that seeing is not always believing when presented with neuroframed information.

Research Questions

RQ1: Is there a relationship between elementary educators' self-efficacy and the number of neuromythic beliefs in a rural south-central Missouri school district?

RQ2: Is there a relationship between elementary educators' curiosity and the number of neuromythic beliefs in a rural south-central Missouri school district?

RQ3: Is there a relationship between elementary educators' professional learning attainment and the number of neuromythic beliefs in a rural south-central Missouri school district?

RQ4: Is there a relationship between elementary educators' teaching experience and the number of neuromythic beliefs in a rural south-central Missouri school district?

Definitions

The following are terms used with this dissertation and their definitions:

1. *Neuromyth* – A neuromyth is defined as a confusion, a misinterpretation, and in some cases, an intentional twisting of the scientifically proven fact to make a valid argument for education (OECD, 2002).

2. *Self-efficacy* – Self-efficacy is a person's perception of his or her capability to regulate actions within his or her life (Bandura, 1997).
3. *Curiosity* – Curiosity is a person's desire for information (Kidd & Hayden, 2015).
4. *Professional learning* – Professional learning is "The uptake of formal and informal learning opportunities that deepen and extend teachers' professional competence, including knowledge, beliefs, motivation, and self-regulatory skills" (Richter et al., 2011, p. 116).
5. *Professional learning attainment* – Professional learning attainment is the "duration of time teachers reported spending in various learning activities" (Kose & Lim, 2011, 202).
6. *Years of experience* – Experience is the number of years of full-time employment as a teacher in a public school, private school licensed or accredited by the State Board of Education, or institution of higher education (Law Insider, n.d., p.1).

CHAPTER TWO: LITERATURE REVIEW

Overview

This chapter provides a review of the SCT and current literature associated with neuroeducation. The first section is about the SCT and the role of personal cognitive, behavioral, and environmental factors concerning personal beliefs. Next, a synthesis of recent literature is reviewed regarding neuroscience, the allure of neuroscience, and neuroeducation, including misconceptions about the brain and its role in learning. Then literature surrounding the personal cognitive, behavioral, and environmental factors in regards to learning are discussed. To conclude, a gap in the literature was acknowledged, which showed a significant purpose for the present study.

Theoretical Framework

To measure for a relationship between educators' neuromythic beliefs and the variables of self-efficacy, curiosity, professional learning attainment, and teaching experience, the theoretical framework that guides this study must support the idea that multiple factors can influence beliefs. Bandura's (1989) SCT proposes that there are reciprocal relationships between beliefs, behavior, and environment. Neuromythic beliefs could be related to a motivation to learn, such as self-efficacy or curiosity. Neuromythic beliefs could be learned as a result of behaviors or the social context within environments such as professional learning and years of teaching experience. The environment, such as one school district, can influence what is learned by elementary educators. The environment can also pique curiosity when an educator feels deprived due to an information gap along with motivating them to acquire knowledge (Loewenstein, 1994). Neuromythic beliefs could have a relationship with other personal beliefs, behaviors, and the environment; therefore, the STC was the theoretical framework for this study.

SCT establishes a framework for educators and their potential neuromythic beliefs. SCT emphasizes the role of social contexts on motivation, learning, and self-regulation (Bandura, 1991). SCT theorizes an interrelated connection between personal cognitive, behavioral, and environmental factors (Bandura, 1989). According to Bandura (1989), personal cognitive factors include attitudes, beliefs, thoughts, emotions, experiences, and structures of the brain. Kunter et al. (2013) divided educators' beliefs into two categories: epistemological beliefs and beliefs about learning and practice. Neuromythic beliefs can be considered a personal belief derived from professional learning or experiences. SCT describes learning as a result of personal cognitive, behavioral, and environmental factors to motivate and self-regulate future actions (Bandura, 2006).

Personal cognitive, behavioral, and environmental factors can have a causal effect on peoples' behaviors and beliefs within different social contexts (Bandura, 1989). Bandura further explains how these three factors can influence individual beliefs and behaviors (Bandura, 1989). SCT does not report a relationship just between beliefs and behavior. It includes many interrelated factors in an ever-changing social environment. However, one could theorize that there is a relationship between behavior and beliefs. Besides neuromythic beliefs, the other variables investigated in this study aided in isolating other personal cognitive (self-efficacy and curiosity), behavior (professional learning attainment and teaching experience), and environmental factors (one local school district). Testing these factors could potentially identify a relationship to neuromythic beliefs. SCT theorizes that human capacity is the result of the power to visualize and examine behaviors before doing them (Bandura, 1989). People evaluate their actions and behaviors based on their beliefs, thoughts, and attitudes before completing the behavior (Bandura, 1989) such as professional learning or career persistence.

Bandura (1989) referenced the possibility of misinterpreting situations in ways that lead to erroneous and incorrect beliefs due to cognitive bias. Neuromyths could be one of those erroneous or incorrect beliefs that are a result of an individuals' cognitive bias. Bandura (1989) stated cognitive processes can affect individual beliefs and behaviors. Individual cognitive differences, such as self-efficacy or curiosity, are important when studying the role of personal factors and neuromythic beliefs.

The concept of self-efficacy signifies one central aspect of SCT (Bandura, 1997). According to Bandura (1997), perceived self-efficacy is a mechanism of human agency as a motivator for learning. Several factors such as arousal by psychological stimuli, experiences, achievement goals, curiosity, and career aspirations, drive elementary educators to learn (Bandura, 1997). Thinking is a strong sense of ability that enables mental processes and performance in diverse settings, including the quality of decision-making and academic achievement (Jerusalem & Schwarzer, 1992). When presented with a challenge, those who believe they can accomplish a positive outcome are more likely to engage and be satisfied with overcoming this challenge (Bandura, 1997). The belief in one's self to achieve a successful outcome can have positive or negative effects on educators. Self-efficacy plays a role in how people think, feel, and act (Jerusalem & Schwarzer, 1992).

Self-efficacy is a person's belief about his or her aptitudes and potential (Bandura, 1989). Bandura (1997) theorized that self-efficacy determines if actions will be taken, the amount of effort exerted, and sustainability when faced with failures. Self-efficacy influences actions because self-regulated thoughts are a key element in the motivation process (Jerusalem & Schwarzer, 1992). Self-efficacy levels can improve or hinder motivation. People with high self-efficacy choose to complete more difficult tasks (Bandura, 1997; Jerusalem & Schwarzer, 1992).

They set higher goals and are determined to achieve them. Behaviors are intentional, and people expect either positive or negative outcomes related to their level of self-efficacy (Jerusalem & Schwarzer, 1992).

Self-efficacy assumes a relationship between a person's belief in themselves and their potential, along with that person's behavior. Elementary educators with high self-efficacy are enabled to control their self-development (Bandura, 1997), which could lead to higher levels of professional learning attainment, such as advanced degrees. Dunn et al. (2013) found educators with high self-efficacy for data-driven decision making were more likely to collaborate with others, implying that efficacious educators collaborate and professionally learn with others. Eun and Heining-Boynton (2007) found efficacious educators to be more likely to use knowledge and skills attained from professional learning than educators with low self-efficacy. Efficacious educators typically use highly effective teaching strategies, have a higher dedication to teaching, and are less likely to burn out (Zee & Kooman, 2016).

In a related study about scientific knowledge, professional learning increased the self-efficacy beliefs of elementary science teachers. Results also found that teachers' self-efficacy and the amount of professional learning attainment positively related to student achievement (Lumpe et al., 2012). Educators' self-efficacy, as a personal belief factor, influenced student and teacher outcomes through behavior and practice (Guo et al., 2012; Zee & Kooman, 2016). However, Catalano et al. (2019) found efficacious elementary educators were prone to have lower content knowledge in science. These studies show that self-efficacy beliefs have a relationship with learning. This study tested for a relationship between perceived levels of self-efficacy of elementary educators and the number of neuromythic beliefs.

Albert Bandura's theory of human agency, a component of SCT, explains an educator's motivation to learn. Educators' learning is affected by personal cognitive, behavioral, and environmental factors (Bandura, 2006). Educators' cognitive factors operate as a driving force in their motivation to learn in the SCT (Bandura, 1991). Self-motivation involves cognitive comparison. This comparison involves educators differentiating between what they know and what they want to know (Bandura, 1991). Curiosity is a cognitive system involving intrinsic motivation that drives human agents to learn (Gottlieb et al., 2016). Loewenstein (1994) defined curiosity as "a cognitive induced deprivation that arises from the perception of a gap in knowledge and understanding" (p. 75). Curiosity is a cognitive system involving intrinsic motivation that drives human agents to learn (Gottlieb et al., 2016). In the act of thinking, the brain assesses the knowledge and emotions of cognitive operations and generates interest and intrinsic motivation that motivates learning (Gottlieb et al., 2016).

The personal cognitive factor of curiosity could help explain cognitive comparison. Loewenstein (1994) defined curiosity as an arising from a perceived lack of knowledge. Mussel (2013) explained that when thinking about individual learning differences, people with higher levels of epistemic curiosity are more likely to look for, investigate, and master novel, complicated, and uncertain situations. These people frequently have behaviors such as information seeking, learning, and thinking, all of which lead to higher levels of expertise (Mussel, 2013).

Curiosity is a positive emotion related to interest (Fredrickson, 1998). Perceptual and epistemic are the two types of curiosity. Perceptual curiosity is generally activated by circumstances involving the senses, such as hearing, seeing, tasting, and feeling (Altun, 2018). Epistemic curiosity varies with each individual and new information obtained by or delivered to that individual from social context within the environment and behaviors. Epistemic curiosity emerges primarily from information (Altun, 2018). Neuromyth studies have found educators who have been introduced to neuroscience information have a high interest in neuroscience (Betts et al., 2019; Dekker et al., 2012; Ferrero et al., 2016; Pickering & Howard-Jones, 2007; Serpati & Loughan, 2012). A motivation to learn could expose educators to information that piques epistemic curiosity in the area of the neuroscientific topics related to education.

A sense of curiosity and interest may motivate learning and make it meaningful. Interest in pursuing more knowledge has helped educators make sense of the environment (Mahmoodzadeh & Khajavy, 2019). Curiosity and interest can be a powerful motivator to learn (Arnone et al., 2011). This interest can initiate behaviors focused on investigating social and informational environments to clarify and discover. Curiosity is a basic instinct, that enables species to study and become experts in new concepts within their environments (Arnone et al., 2011). Silva (2008) stated that curious people tend to highly rate their ability to understand information. When educators have an interest, they are more likely to feel self-efficacious and be able to self-regulate their learning (Renninger et al., 2015). Driven by cognitive comparison, educators' curiosity level could help explain the number of neuromythic beliefs due to curiosity being a predictive factor in work-related performance (Mussel, 2013; Reio & Wiswell, 2000), academic achievement (Stumm et al., 2011), and learning success (Ainley et al., 2002; Grossnickle, 2016; Hidi, 2016; Mussel, 2013).

Moderately difficult experiences in educators' environments create a challenge that motivates educators to grow their knowledge base (Bandura, 1991). Educators are exposed to a wide variety of behavior experiences, such as professional learning and teaching experience, that expands their professional learning (Durksen et al., 2017). The experiences range from observing neighboring classrooms or schools and, reading educational media, to attending professional development workshops (Durksen et al., 2017). These experiences allow them to observe what other people in the field of education are doing and to evaluate their knowledge following their observation (Bandura, 2006). These behavior factors, professional learning, and experience have been studied in related literature concerning neuromythic beliefs with mixed results (Ferrero et al., 2016).

To summarize, the current study examined the relationship between the number of neuromythic beliefs with the variables of self-efficacy, curiosity, professional learning, and experience of elementary educators. The framework for this study was based on the SCT because of personal cognitive factors such as self-efficacy or curiosity influence educators' outcomes through behavior and practices (Guo et al., 2012; Zee & Kooman, 2016). These behaviors and practices include professional learning attainment or persistence in the education field, which could increase or reduce the number of neuromythic beliefs. Educators are more likely to feel efficacious and be able to self-regulate their learning when they are interested in the content (Renninger et al., 2015). Efficacious educators typically use highly effective teaching strategies, have a higher dedication to teaching, and are less likely to burn out (Zee & Kooman, 2016). However, higher self-efficacy has been found to have a negative relationship with elementary educators' science content knowledge (Catalano et al., 2019). Elementary educators are known to have lower self-efficacy in science-related content (Catalano et al., 2019). This study added information concerning SCT by finding no evidence supporting a relationship between the personal cognitive factors of self-efficacy and curiosity beliefs and the behavior factors of professional learning and persistence in education concerning the number of neuromythic beliefs.

Related Literature

This section will explore a review of related literature. It will cover the topic of neuroscience. Neuroscience is the study of the brain. Second, the application of neuroscience is discussed. Neuroscience has been used in many areas. Next, a review of neuroscience and education is discussed. This will lead into the topic of neuroeducation. Then, neuroeducation will be reviewed, and after that information about improving neuroeducation is discussed. Next, literature pertaining to the concept of neuromyths is reviewed. Last, cognitive factors and behaviors in relation to their role in learning are reviewed.

Neuroscience

Progressions in technology have had a significant effect on the enhanced investigation of and a comprehensive understanding of how the brain operates and acquires knowledge (Fuller & Glendening, 1985). Learning, at the fundamental and mechanistic level, is a neurological phenomena resulting from physical transformations in brain cells (Owens & Tanner, 2017). Technology has improved the rate of innovation, especially in neuroscience: the study of the brain (Fuller & Glendening, 1985). Nevertheless, understanding how to utilize these innovations and information has not exactly kept up with practical applications in classrooms (Ansari et al., 2011).

The study of the brain has generated enthusiasm in many disciplines since around 1990, which was coined the Decade of the Brain by Congress (Dekker et al., 2012). This time commenced the merging of science and education. Numerous buzz words emerged during this time, such as neuroeducation, neuromyths, mindfulness, and brain-based learning (Dekker et al., 2012). Feiler and Stabiob (2018) stated the potential for the application of neuroscience in classrooms includes language, numeracy, reading, attention and memory, stress, and the effects of emotion and sleep on neuroplasticity.

The spread of neuroscience misconceptions has taken place. Commercialized curriculum programs, professional development sessions, and literature have begun to integrate components of neuroscience as an authenticating source of evidence (Tardif et al., 2015). The label neuromyth developed as a product of the inadequate exchange of information between the disciplines of education and neuroscience (Feiler & Stabio, 2018). Commercialized products, stating their claims to be brain-based, assisted in distorting the facts of neuroscientific research by making distorted information widespread (Tardif et al., 2015). An educator's lack of knowledge in neuroscience also increases the misconceptions of neuroeducation.

Application of Neuroscience

Neuroscience has only been around for a few decades. Due to this infancy stage, the information provided to education regarding brain science has not advanced into real-world classroom practices (Ansari et al., 2011). Neuroscience research in the discipline areas of music, mathematics, and reading has been conducted (Düvel et al., 2017; Gabrieli, 2009; Grabner & De Smedt, 2011). Some of the findings verify what psychology had already theorized (Byrnes & Vu, 2015), such as educators making connections to other topics or using real-world situations to improve retention (Owens & Tanner, 2017). Neuroscience has provided significant brain discoveries regarding education include emotions, attention, the effects of sleep and instruction, and a better understanding of some learning disabilities (Cronin-Golomb, 2016; Mackes et al., 2018; Rubia, 2018; Rykhlevskaia et al., 2009). Much of the information discovered has only been in the form of neurounderstandings.

Recent brain research can be sorted into three categories for classroom use: neurounderstanding, neuroprediction, and neurointervention (De Smedt & Grabner, 2016). Neurounderstanding consists of knowledge involving the functioning of the brain and processes involved with learning. Neuropredictions offer information about difficulties that might occur due to development delays and predict the outcomes of particular interventions (De Smedt & Grabner, 2016). Neurointerventions are suggestions from neuroscience research merged with sound instructional practices (De Smedt & Grabner, 2016). Brain imaging has improved the understanding of learning disabilities, which has led to a greater understanding of disabilities (Fletcher, 2017). As neuroscience research and collaboration among the experts of neuroscience, psychology, and education continues, it is hoped that research will provide an increase in neuroscience applications in all three categories, especially in the category of neurointerventions (De Smedt & Grabner, 2016).

Neuroscience and Education

With technology developments, new areas of research emerged to assist in the integration of neuroscience findings in established fields of information, including therapy, education, sociology, and other related disciplines (Goldstein, 1994). Brain imaging has captured how the brain is continuously changing (Carey, 2018). As one learns new concepts, the networks among neurons transform or build new connections (Carey, 2018). These exchanges, along with environmental surroundings, help shape the brain. Learning happens because of the changes in the strength and number of connections between existing neurons (Carey, 2018). The changes happen in such a way that regularly used connections among neurons are changed the most (Owens & Tanner, 2017). Neuroscientists call this plasticity (Carey, 2018).

Plasticity supports rationalizations of discoveries from intervention studies, which theorized increased results are associated with prompter intervention (Fletcher, 2017). Supekar et al. (2013) found evidence that individual brain differences are strong predictors of receptiveness to children receiving math tutoring. Supekar et al. conducted a study involving 24 students in third grade who were given structural and resting-state $N = 90$ scans before receiving eight weeks of one-on-one mathematics tutoring. Supekar et al. wanted to study whether brain measures could predict differences in mathematical achievement among children who receive tutoring. Students made gains during the tutoring sessions; however, not all gains were the same. Supekar et al. found that before tutoring the hippocampal volume, a brain region that controls motivation, emotion, learning, and memory, predicted performance improvements. The study also found other parts of the brain known for higher cognitive functions, such as switching attention, working memory, maintaining abstract rules, and inhibiting inappropriate responses, also predicted performance improvements (Supekar et al., 2013). These findings could provide future neuropredictions or neurointerventions to help identify and address learning needs earlier in a child's development (De Smedt & Grabner, 2016). Neuroscience is generating a hopeful future for appropriate exploration and could have an encouraging impact on student achievement (Busso & Pollack, 2015).

Neuroeducation Research

The National Center for Education Statistics [NCES] (2019) reported approximately only one-third of United States fourth-graders scored at or above a proficient reading level according to the National Assessment of Educational Progress report. This left 63% of students reading below grade level (NCES, 2019). With these underperforming students in mind, neuroscience might provide an understanding of how we learn and how to effectively use this information to improve teaching practices, curricula, and educational policy. Neuroscience has provided some information to different subject areas. Erol and Karaduman's (2018) found that students working in brain-based learning settings made significant improvements in the areas of academic achievement and retention. Reading instruction can be improved by understanding how the brain works (Kweldju, 2015). Carew and Magsamen (2010) stated that students deserve the opportunity to be instructed with accurate information learned through neuroscience.

Neuroscience has provided images of the complex reading process (Kweldju, 2015). The images demonstrated how the whole brain is involved in the reading process. Research studies have studied brain images of on-grade-level readers during different developmental stages (Kweldju, 2015). The studies have shown that reading happens in every brain region as well as the neuropathway connectors (Kweldju, 2015). Neuroscience has discovered significant reading findings that establish how vocabulary, decoding components, spelling, and phonological awareness activate different brain regions (Bailey et al., 2016). This established a neurounderstanding that quality reading instruction should contain these reading elements (Bailey et al., 2016).

Martin et al. (2015) conducted a meta-analysis to test for age-related commonalities and differences in brain activation patterns. The meta-analysis studied 40 fMRI reading studies in children and adults (Martin et al., 2015). The fMRIs were separated into two sets, children and adults. After analysis, the two sets found commonalities and differences in patterns of reading related to brain activation in both children and adults (Martin et al., 2015). While this research currently has no practical use in classrooms, it does provide a neurounderstanding about the brain activation differences in children and adults.

Neuroscience has provided information to the field of mathematics too. Unlike reading, only specific regions of the brain emphasize the learning associated with mathematics. Due to neuroscience's infancy stage (Owens & Tanner, 2017), most neuroscientific findings for mathematics have only illustrated where math skills such as number sense, procedures, and automaticity take place in the brain (Ansari et al., 2012). Like the reading research, mathematics researchers have discovered differences in the brain images between on-grade-level and below-grade-level math students (Supekar et al., 2013).

Price et al. (2016) conducted a longitudinal study that investigated the relationship between grey matter volume in the brain and mathematic achievement. The study comprised of 50 elementary school children. Results found that grey matter volume in a particular region of the brain at the conclusion of 1st grade related to mathematics achievement one year later (Price et al., 2016). While this grey matter volume did not change within a year, the volume was associated with mathematics achievement at the conclusion of 2nd grade. Price et al. found support regarding the gray matter in particular regions of the brain is a critical foundation for mathematical acquisition.

Neuroscience may one day help teachers predict the need for intense academic support. Supekar et al. (2013) examined the actions and neural functioning of third-grade students receiving one-on-one tutoring. Participants received fMRI scans pre- and post-tutoring. The images found from the fMRI scans showed students experienced different growth rates during the tutoring timeframe (Supekar et al., 2013). Patterns of growth from the achievement groups were created during the tutoring timeline (Supekar et al., 2013). With future studies, neuroscience could use these patterns to provide neuropredictors involving growth rate for mathematical achievement.

Research involving the brain and socioeconomic status (SES) has been conducted. Demir-Lira et al. (2016) studied the relationship of SES as a neuropredictor to mathematical achievement with the operation of subtraction. This three-year longitudinal study involving a behavioral math skill evaluation, fMRI imaging, and SES status found imaging evidence relating mathematics achievement to SES (Demir-Lira et al., 2016). The outcomes of the study offered further evidence to the body of information that a student's SES has an effect on the brain and influences learning (Demir-Lira et al., 2016).

Neuroscience has provided research findings that could improve the knowledge of educators (Carew & Magsamen, 2010). Biological evidence, provided by neuroscience, has patterned typical brain development (Herting et al., 2018). Neuroscience can offer neurounderstandings, neuropredictions, and neurointerventions (De Smedt & Grabner, 2016). Neuroscience has the capacity to deliver data that could advance the methods of teaching to assist learning (Carew & Magsamen, 2010).

Improving Neuroeducation

Neuroscience is a field with many complex studies and vocabulary. This makes understanding neuroscience difficult. Bridging the disciplines between neuroscience and education is an obstacle that needs attention to improve developments in education (Feiler & Stabiob, 2018). Feiler and Stabiob (2018) revealed three areas to bridge the disciplines of neuroscience and education: relevance in the classroom, interdisciplinary, and common academic vocabulary. Professional development in these areas is essential to precise and useful applications in classroom procedures (Dubinsky et al., 2013).

Neuroscience is more than brain images and data from research. It has the potential to improve teachers' classroom practice (Clement & Lovat, 2012). Pickering and Howard-Jones

(2007) stated that procedures such as neuroimaging can assist with improving teaching methods in the classroom, but should be evaluated grounded on the effectiveness in behavioral situations (Clement & Lovat, 2012). Educators have science misconceptions that negatively influence their teaching (Catalano et al., 2019). Sarrasin et al. (2019) stated teachers would benefit from professional development in the research and the practical application of using neuroscience research in the classroom. Their study found that teachers use their knowledge about the brain, factual or not when designing and implementing classroom practices (Sarrasin et al., 2019).

Neuroeducation is when collaboration takes place among the fields of neuroscience, psychology, and education. The contributors share their knowledge base and together creating a new framework of knowledge (Byrnes & Vu, 2015). The Neuro-Education Leadership Coalition is an interdisciplinary team hoping to improve pedagogy and education policy, incorporating neuroscience, psychology, cognitive science, and education (Carew & Magsamen, 2010). Endorsing interdisciplinary collaboration between neuroscience and education permits educators to seek the answers to neuroscientific questions and allows neuroscientists the opportunity to ask educationally-relevant questions (Ansari et al., 2012). McMahon et al. (2019) conducted a study that reduced student teachers' neuromythic beliefs and a change in basic assumptions in the acceptance of scientific information. Their study was based on professional learning through an intervention of interdisciplinary collaboration to improve educators' knowledge of neuroscientific findings.

Neuroscience takes a biological approach to learning while much of education uses environmental and behavioral outcomes as a framework for learning (Varma et al., 2008). Neuroscience uses scientific vocabulary and complicated methods that are frequently misunderstood by others beyond the scientific community (Feiler & Stabio, 2018). Making the vocabulary comprehensible and collective between the disciplines will assist in preventing misconceptions and creating neuromyths (Feiler & Stabio, 2018). This improvement in neuroeducation can happen through an interdisciplinary collaboration between the fields.

Neuromythic Beliefs

A variable in the current study is the number of neuromythic beliefs. This study investigated the variables of self-efficacy, curiosity, professional learning attainment, and teaching experience concerning the number of neuromythic beliefs. Personal cognitive factors such as self-efficacy and curiosity have not been studied in the role of neuromythic beliefs. However, behaviors such as formal and informal types of professional learning and years of experience have been researched in neuromythic studies. This section will explore the various studies of neuromythic beliefs and what the existing research has found.

Accurate content and pedagogic knowledge are important when assessing, teaching, and supporting student learning. However, multiple studies have found teachers have content and pedagogical misconceptions. In the discipline of reading, teacher misconceptions include readability measures are the only way to determine a text's difficulty (Hiebert & Pearson, 2014), reading easier texts improves comprehension (Lupo et al., 2019), and misconceptions about the characteristics of dyslexia (Washburn et al., 2017). Mathematics has its misconceptions among educators too. These misconceptions include young children are not ready for math, and mathematics should be learned through free exploration (Lee & Ginsburg, 2009). It is important to note that many content misconceptions start in classrooms (Stein et al., 2008; Tompo et al., 2016). Educators possibly teach misconceptions to their students (Burgoon et al., 2011; Stein et al., 2008; Tompo et al., 2016;). Researchers claim that misconceptions are hard to change, making learning new material difficult for a person who believes the misconception (Burgoon et al., 2011; Erdas Kartal et al., 2018; Moodley & Gaigher, 2019).

Misconceptions are found in the discipline of neuroeducation too. Neuromyths are misunderstandings about the brain (Tardif et al., 2015). Macdonald et al. (2017) operated a nine-month investigation in the United States using an Internet survey involving neuromythic beliefs with various populations in the United States. The study intended to deliver empirical guidance for preservice educators and in-service training programs for educators. The investigation was designed to expose neuromythic beliefs between various categories of people, such as neuroinformed people, educators, and the general public (Macdonald et al., 2017). Their research found that younger people with a graduate degree who were exposed to neuroscience concepts were more capable of recognizing fact from fiction. This research found the existence of neuromyths within various groups of people; however, the number of misunderstandings can be minimized with training in education and neuroscience (Macdonald et al., 2017).

Educators from many regions, such as Latin America, Europe, and North America, have been found to have neuromythic beliefs (van Dijk & Lane, 2018). Widespread misunderstandings about neuroscience among educators include learning styles, left and right brain, reversed letters as a diagnosis of dyslexia (Knight, 2018; Wadlington & Wadlington, 2005; Wnuk, 2018), and people only use 10% of their brainpower (van Dijk & Lane, 2018). Neuromyths can have consequences for education. Dekker et al. (2012) expressed that educators could be wasting valuable resources, such as time, on misinformed neuroeducation strategies.

Ferrero et al. (2016) conducted a meta-analysis of the neuromythic belief studies. The prevalence of each neuromyth in 10 different countries was presented. Educators believed the idea that people learn better when taught in their preferred learning style (85.8 to 97.1%) and the idea that stimulating environments improve the brains of pre-school children (86.7 to 98.5%) were extraordinarily popular in most countries (Ferrero et al., 2016). Cross-cultural neuromythic beliefs were found through the analysis such as a split in countries believing the myth of critical periods for learning (Ferrero et al., 2016).

The universal spread of neuromyths among educators is troubling because several of the neuromyths are associated with learning and development, and misunderstandings among educators might create negative student outcomes (Macdonald et al., 2017). Take, for instance, an educator who believes the neuromyth that letter reversals are an indicator of dyslexia, this educator may not consider dyslexia for those students who do not demonstrate letter reversals (Wadlington & Wadlington, 2005). Additionally, some neuroframed commercial education curricula are built on these neuromyths and have inadequate empirical backing (Macdonald et al., 2017). School districts that are not aware of neuromyths could dedicate valuable time and resources to such curricula, which could have been used for empirically-validated programs. It is vital to learn more about the prevalence and predictors of neuromyths to propose useful methods for offsetting the myths (Macdonald et al., 2017). According to Papadatou-Pastou et al. (2017), "The proliferation of neuromyths amongst teachers is worrisome, as the adoption of such myths wastes money, time, and energy resources that could be spent on evidence-based practices" (p. 2). There are many brain misconceptions; eight are considered prevalent neuromyths (OECD, 2002).

Neuromyth One

The first common neuromyth is that the first years of human life are critical periods that can determine later development and future success (Betts et al., 2019; Dekker et al., 2012; Macdonald et al., 2017; OECD, 2002). This misconception has its roots in the findings of many neuroscientific studies on animals (OECD, 2002). Lorenz (1970) found critical periods for imprinting in birds. Imprinting in birds happens after a chick hatches and makes a connection with the principal moving object in their environment. Critical periods for puppies have been found. Scott (1958) found the first three to seven weeks of a puppy's life are when primary socialization takes place. This critical time is ideal for dog owners to build relationships with their puppies (Scott, 1958). However, the human brain does not have periods of critical development. The human brain does have sensitive periods for learning certain skills; however, these periods are not critical due to brain plasticity (OECD, 2002). Plasticity is when the brain changes due to new experience and repetition. The human brain has the potential to learn and change throughout a person's life (Carey, 2018).

Neuromyth Two

The second common neuromyth is that enriched environments during critical periods of life improve the capacity for learning (Betts et al., 2019; Dekker et al., 2012; Macdonald et al., 2017; OECD, 2002). This myth means that for optimal learning to occur, diversity and early experiences are imperative (Goswami, 2004). The idea of this enriched learning may have originated from early learning in rats (Goswami, 2004). Research showed that rats, which were raised in an enhanced and stimulating environment, displayed improved ability to solve and learn complex maze obstacles compared to rats that were raised in destitute environments (Goswami, 2004). The brains of these rodents that were raised in an enhanced and stimulating environment had formed more synapses and more proteins connected with the conservation of synaptic contacts (Lindefors et al., 1992). However, research is necessary to be able to transfer these insights from animal research to human learning (Goswami, 2004). The human brain has the potential to learn and change throughout a person's life due to plasticity (Carey, 2018).

Neuromyth Three

Another prevalent neuromyth is that improved learning happens when people learn information in their preferred learning styles (e.g., auditory, visual, kinesthetic) (Betts et al., 2019; Dekker et al., 2012; Macdonald et al., 2017; OECD, 2002; Pashler et al., 2008). According to Pashler et al. (2008) this is a prevalent neuromyth in education. The human brain pursues learning through auditory, visual, and kinesthetic modalities to understand and to make decisions (Kidd & Hayden, 2015). Information on learning styles is enormous, and few studies have used an experimental methodology able to test the legitimacy of learning styles applied to the learning process (Pashler et al., 2008). The few experimental design methods found results that contradict the popular neuromyth (Pashler et al., 2008). The use of learning style assessments in instructional practice has no empirical basis and time should be spent on instructional practices with a strong evidence base (Pashler et al., 2008).

Neuromyth Four

The fourth common neuromyth is that humans only use 10% of their brains (Betts et al., 2019; Dekker et al., 2012; Macdonald et al., 2017; OECD, 2002). This is the most widely known neuromyth (OECD, 2002). This myth can be traced back to the 1800s (Betts et al., 2019) through the research of neuroanatomy by Marie-Jean Pierre Flourens (Yildirim & Sarikcioglu, 2007) and continues today as a result of neuromarketing. Dr. Flourens practiced experimental brain investigations on rabbits, pigeons, and other mammals (Yildirim & Sarikcioglu, 2007). Commercial products claiming to tap into the potential of the human brain to provide self-help such as popular books by Daniel Carnegie and Uri Geller (OECD, 2002) have assisted in the proliferation of this myth. Innovative technology has debunked this myth through neuroimaging methods that measure the chemical, electrical, and structural parts of the brain; resulting in supporting evidence that humans use their whole brain (Betts et al., 2019).

Neuromyth Five

Neuromyth number five is the belief that language acquisition should happen one language at a time (Betts et al., 2019; Dekker et al., 2012; Macdonald et al., 2017; OECD, 2002). This myth has roots in politics and misinterpretations of prior research (OECD, 2002). In the United States, the early 1900s began a historical time for immigration and World War I (Brisk, 1981). Large numbers of immigrants led to hostile situations for those who spoke other languages. During World War I, people who spoke German were treated as inferiors due to their language (Brisk, 1981). By 1923, these factors led to 34 states requiring classrooms to strictly use English during instruction (Brisk, 1981). In Wales, a multilanguage area, students were given intelligence testing in one language. The results produced poor scores for students who spoke a language other than the assessment given. This gave the impression that these students had a reduced intellect (Pinsent, 1960). On the contrary, research links bilingualism to advanced levels of attention and control in brain functioning and to defend against the decline of brain functioning in aging (Quinteros & Billick, 2018). Research does suggest that bilinguals may have reduced vocabulary and slower vocabulary retrieval (Quinteros & Billick, 2018). There is no evidence that people need to stop speaking their native language since this will not result in better language acquisition when learning a new language (Quinteros & Billick, 2018).

Neuromyth Six

The sixth prevalent neuromyth is people learn due to being either left- or right-brain dominant (Betts et al., 2019; Dekker et al., 2012; Macdonald et al., 2017; OECD, 2002). This myth found its roots in Arthur Ladbroke Wigan’s book *A New View of Insanity: Duality of the*

Mind (OECD, 2002). Wigans (1844) described the two brain hemispheres as separate parts with independent motivation and reasoning. However, Konstantin M. Bykov, a Russian psychologist, conducted experiments that showed how the corpus callosum was important for communication between the two brain hemispheres (Kanne & Finger, 1999). Nielsen et al. (2013) conducted brain imaging on 1,010 people between the ages of seven and 29 and divided areas of the brain into 7,000 regions to study if one side of the brain was more active than the other side. Their study found no evidence for left- or right-brain dominance (Nielsen et al., 2013).

Neuromyth Seven

The seventh prevalent neuromyth is that your brain shuts down during sleep (Betts et al., 2019; Dekker et al., 2012; Macdonald et al., 2017; OECD, 2002). According to Cirelli and Tononi (2017), brain plasticity is the reason people need sleep. Brain plasticity is when the brain changes due to experiences. This process needs energy and cellular support. Sleep restores the body’s cells, clears unnecessary information from the brain, and aids in learning and memory (Cirelli & Tononi, 2017). Some brain processes increase during sleep (About sleep, 2009). Examples of these processes include the secretion of some hormones and the brain's pathways for learning and memory. There is no empirical evidence to support that any major organ shuts down during sleep (About sleep, 2009).

Neuromyth Eight

The eighth common neuromyth is the belief that a common characteristic of dyslexia is seeing letters backward (Betts et al., 2019; Macdonald et al., 2017; OECD, 2002). According to Wnuk (2018), this myth dates back to the 1920s when neuropathologist Samuel Orton detected that struggling readers often read words from right to left and had a hard time distinguishing between similarly-shaped letters. Many children reverse letters when they learn to read and write

(Wnuk, 2018). Dyslexia is an unexpected struggle in learning to read despite normal intelligence, vision, and access to good instruction. Wnuk stated people with dyslexia struggle to read because they have trouble linking the shapes of printed letters with the sounds of spoken language. This is not due to problems with visual perception or memory (Knight, 2018; Wadlington & Wadlington, 2005; Wnuk, 2018).

Self-efficacy's Role in Learning

This study investigated the relationship between self-efficacy and the number of neuromythic beliefs. While self-efficacy has not been studied in prior neuromythic studies, it has been known as a predictor of self-directed learning, science content knowledge, and academic achievement. As a motivator to learn, self-efficacy as a predictor for self-directed learning could expose elementary educators to environments that have been neuroframed with complex or misinformation about the brain. It is also possible, that self-efficacy as a predictor of science content knowledge or academic achievement could provide accurate information that protects educators from neuromythic beliefs. The following will explore the role of self-efficacy and its motivation to learn.

Self-efficacy is a person's belief in themselves about the ability to accomplish difficult tasks to achieve certain goals (Bandura, 1997). Self-efficacy is important for adults' lifelong decision-making (Bath & Smith, 2009; Hammond & Feinstein, 2005). This assessment of self-confidence affects an individual's actions, effort, and time allocated to a task (Bandura, 1997; Jerusalem & Schwarzer, 1992). Self-efficacy has been found as a predictor in adult's participation in self-directed learning (Bath & Smith, 2009; Hammond & Feinstein, 2005). This type of learning process can promote a learner's reflection on their beliefs and knowledge and the exploration of new knowledge (Sandlin et al., 2013).

This study tested for a relationship between self-efficacy and the neuromythic beliefs among in-service elementary educators. Educators have varying efficacy beliefs about their abilities as teachers, which can affect their instruction (Catalano et al., 2019). Many factors can influence an educator's self-efficacy such as professional learning and years of experience (Catalano et al., 2019). The research on science teaching self-efficacy involving elementary teachers is extensive (Catalano et al., 2019).

A person's self-efficacy has been found as a predictor of scientific knowledge. Tsai and Huang (2018) investigated the relationship between adult self-efficacy and proficiency in science. The study included Taiwanese citizens between the ages of 18 and 70. The study results found that self-efficacy was predictive of proficiency in science (Tsai & Huang, 2018). The study also found that females' self-efficacy was a stronger predictor of proficiency in science versus males' self-efficacy (Tsai & Huang, 2018).

Catalano et al. (2019) found efficacious elementary educators were prone to have lower science content knowledge. Efficacious educators could be resistant to altering instructional practices because they have confidence in their instructional practices (Cordova et al., 2013; Tschannen-Moran et al., 1998). Settlage et al. (2009) found efficacious pre-serve teachers were not willing to grow their knowledge to improve their instructional practices. Brighton (2003) found teachers' self-efficacy may affect their willingness to change. Efficacious educators report being more open to trying new instructional practices compared to less efficacious colleagues (Guskey, 1988). Jameson and Fusco (2014) found self-efficacy helps to improve and sustain cognitive skills in adults which influences their learning. Self-efficacy improvement has a role in assisting adult learners, such as educators, in succeeding and continuing in their learning (Tsai & Huang, 2018).

Curiosity's Role in Learning

As another motivator to learn, this study investigated the role of trait curiosity concerning the number of neuromythic beliefs. Educators' cognitive factors like curiosity influence their behaviors and beliefs such as acquiring information (Reio & Wiswell, 2000). While the trait curiosity has not been studied with neuromythic beliefs, many educators have expressed a high interest in the study of neuroscience (Betts et al., 2019; Macdonald et al., 2017). The curiosity trait has been a known predictor of academic performance (Stumm et al., 2011), problem-solving (Reio & Wiswell, 2000), and recall of information (Marvin & Shohamy, 2016; Silvia, 2007). The preceding will synthesize literature concerning the trait of curiosity as a motivator for learning.

The topic of the role of interest in learning has been discussed in literature since John Dewey (Gutek, 2011) wrote his book *Interest and Efforts in Education*. Research relevant to interest has been conducted under the label of curiosity, such as the research on the curiosity trait (Silvia, 2007). According to Silvia, only theoretical and speculative statements have been made about the differences between interest and curiosity which have not been supported with research. Silvia (2007) stated the possibility of "the interest–curiosity distinction may be based on the different uses of interest and curiosity in everyday speech" (p. 191).

The curiosity trait has been studied concerning its role in learning. Learning orientated people regard themselves as curious and interested in difficult tasks to develop their competencies (Harrison et al., 2011). Highly curious individuals have increased learning experiences and improved information retention due to being engaged in their learning (Silvia, 2007). Individuals with high levels of trait curiosity have a desire to explore and discover opportunities to gain new information and learn new things (Hulme et al., 2013; Reio & Wiswell, 2000). Studies have found an association between curiosity and learning engagement (Eren &

Coskun, 2016; Litman, 2010; Reio & Wiswell, 2000; Rotgans & Schmidt, 2014) including research on the role of science interest and the decision to participate in science learning (Ballantyne & Packer, 2009; Falk et al., 2007).

A study on the differences in children's curiosity levels concerning learning was conducted by van Schijndel et al. (2018). van Schijndel et al. investigated how individual differences in children's curiosity relate to inquiry-based learning and outcomes in different environments. The role of curiosity as an individual trait variable was selected due to the significance of curiosity in science education (van Schijndel et al., 2018). The study by van Schijndel et al. found that children's curiosity trait was positively related to their knowledge acquisition.

Marvin and Shohamy (2016) described curiosity as the motivation to obtain a reward. In the case of curiosity, the reward is information. The participants in this study were 84 adults who answered trivia questions and were asked to rate their curiosity and confidence (Marvin & Shohamy, 2016). Participants were more likely to wait for the information they were more curious about (Marvin & Shohamy, 2016). Participants' curiosity predicted who remembered the correct answers (Marvin & Shohamy, 2016). These results support the concept that information works as a reward for selecting choices and learning (Marvin & Shohamy, 2016).

Many fields are interested in the information provided by neuroscience. Due to this interest, the marketing field has coined the term *neuromarketing* (Plassmann et al., 2012). It was estimated that in 2012, over 100 companies were utilizing neuroscience marketing techniques (Plassmann et al., 2012). Interesting and scientific-looking brain images serve as a controlling instrument of persuasion (Spence, 2019). Brain images have been shown to inflate the creditability of information, even with people who are perceived to be authorities on the subject matter (McCabe & Castel, 2008). This interest in neuroscience has had its effects on education (Ansari et al., 2011). According to Im et al. (2017), popular media reporting occasionally links false educational information with colorful brain images.

Im et al. (2017) conducted a study to determine if adding neuroinformation to educational articles increased the reader's creditability rating of the information. The researchers used different types of neuroframing in their study. Neuroframing includes adding written neuroinformation or textual features, such as graphics or brain images, to educational information (Im et al., 2017). The findings of the study showed that educational information with brain images and neuroscientific data received the highest creditability ratings (Im et al., 2017).

Previous research has found a positive relationship between curiosity and self-efficacy (Jeraj & Marič, 2013; Karwowski, 2012; Li et al., 2019; Kim & Choi, 2019; Robayo-Tamayo et al., 2020; Zhao et al., 2011). Self-efficacy plays a significant role in influencing an individual's curiosity trait (Li et al., 2019). Self-efficacy predicts important job performance results such as work-related attitudes, professional development, and performance (Jeraj & Marič, 2013). Efficacious individuals are more likely to have a positive perception of their social environment (Consiglio et al., 2016). People with reported high curiosity have more positive emotions (Wang & Li, 2015). Curious individuals are highly engaged in settings that provide opportunities for professional development, experience, and motivation (Kashdan & Silvia, 2009). Individuals with high curiosity tend to be more efficacious in making, attempting, and completing job-related tasks (Kim & Choi, 2019). Curiosity and self-efficacy as personal cognitive factors influence "individuals' intrinsic motivation, well-being, learning, and performance in the academic context" (Robayo-Tamayo, 2020, p. 9).

Educators are interested in what neuroeducation can provide to the classroom (Betts et al., 2019; Dekker et al., 2012; Pickering & Howard-Jones, 2007; Serpati & Loughan, 2012). Pickering and Howard-Jones expressed educators' interest in the application of neuroscience in education from a group of educators after the completion of neuroeducation professional development sessions; however, there is a disconnect between educators' interest and their ability to apply neuroscientific findings to the teaching practice (Rato et al., 2013). Educators who have received professional development on neuroscience expressed interest in understanding how the brain processes and learns and felt this knowledge would be important (Dekker et al., 2012; Pickering & Howard-Jones, 2007). This environment could have piqued the educators' curiosity due to feeling deprived of information along with motivating them to acquire knowledge (Loewenstein, 1994; Reio & Wiswell, 2000) about neuroscience. However, studies have found educators misinterpret research findings when images of the brain or neuroscientific information are added (McCabe & Castel, 2008; Lindell & Kidd, 2013). International studies have found educators with interest and high neuroscience knowledge have been found to believe in neuromyths (Dekker et al., 2012; Düvel et al., 2017; Ferrero et al., 2016; Gleichgerrcht et al., 2015; Rato et al., 2013;); however, no study has tested a relationship between in-service elementary educators' curiosity and the neuromythic beliefs as this study investigated.

Professional Learning and Its Role in Beliefs

The variable of professional learning attainment concerning neuromythic beliefs of elementary educators was included in the study. Professional learning attainment is the "duration of time teachers report spending in various learning activities" (Kose & Lim, 2011, p. 202). The behaviors of elementary educators along with other factors influence their beliefs. Various types of formal and informal professional learning have been studied concerning the number of neuromythic beliefs of educators. Some studies have used professional learning as an intervention and other studies have tested types of professional learning as a predictor of neuromythic beliefs. No study has addressed the amount of professional learning reported by educators and its role in neuromythic beliefs. The following will explore studies concerning the role of professional learning attainment concerning the beliefs and behaviors of elementary educators.

Educators are required to grow professionally during their careers, due to continual changes in teachers' daily contexts, reform policies, and advances in the field of education (Knight, 2002). Professional learning influences instructional practices that affect student achievement. Professional development is the term often used when learning opportunities are arranged for teachers, whereas the phrase professional learning is learning opportunities based on the motivation of the educator and their needs (Durksen et al., 2017). Avalos (2011) defined professional learning as a multifaceted development, that involves an educator's cognitive and emotional involvement. It involves the willingness of the educator to reflect on personal knowledge capacity to consider values and beliefs (Avalos, 2011). This reflection drives improvement or change based on educational environments or cultures (Avalos, 2011). Richter et al. (2011) described professional learning as "the uptake of formal and informal learning opportunities that deepen and extend teachers' professional competence, including knowledge, beliefs, motivation, and self-regulatory skills" (p. 116).

The purpose of professional learning is to develop the professional knowledge, skills, and attitudes of educators to improve students' academic achievement. According to Miller and Kastens (2018), effective educator learning is central to student achievement. Professional learning is an ongoing process that has been associated with improved teacher knowledge and skills (Avalos, 2011; Fischer et al., 2018; Richter et al., 2011) and encourages educators to evaluate their beliefs and educational practices (Charland, 2006). Professional learning connects current research to classroom applications (Fischer et al., 2018). Educators' professional learning has a strong impact on instructional practices and behavior (Dunn et al., 2019).

Instructional practices are an important factor in academic achievement in the classroom. Studies have found links between instructional practices and student achievement (Fischer et al., 2018; Lara-Alecio et al., 2012; Lyon & Weiser, 2009). The improvement of instructional practice in the classroom is the key to improving education. Teachers are presented with challenges and reforms that motivate educators to gain additional knowledge and skills (Dunn et al., 2019). Professional learning attainment is a factor affecting teachers' instructional practices.

In particular, this study examined if professional learning is related to the neuromythic beliefs of elementary educators from one school district. In related studies, professional learning has been a key factor in neuroscientific knowledge (Betts et al., 2019, Dekker & Jolles, 2015). Betts et al. found professional learning to be a predictor of neuromythic awareness among higher education faculty. In particular, faculty who self-reported reading journal articles or who reported attending training on the topics related to the science of learning were able to detect more neuromyths (Betts et al., 2019). Another study conducted by Dekker and Jolles (2015) investigated whether an intervention learning module about the brain and learning increased high school biology students' and teachers' neuroscientific knowledge. The results found that after professional learning, participants had increased neuroscientific knowledge (Dekker & Jolles, 2015). However, the studies involving professional learning have provided mixed results, some have found educators to be at an increased risk of neuromythic beliefs, while others have found professional learning to be a predictor of reducing neuromythic beliefs.

Im et al. (2018) investigated whether taking an educational psychology course was related to improved neuroscience literacy and a reduction in neuromythic beliefs. The educational psychology course was designed as a bridge between the disciplines of neuroscience and education (Im et al., 2018). The participants in this study were pre-service teachers from South Korea who took measures of neuroscience literacy pre- and post-course. The results found that taking an educational psychology course was related to improved neuroscience literacy, but neuromythic beliefs were not reduced (Im et al., 2018).

A similar study conducted by Grospietsch and Mayer (2019) investigated whether an intervention could reduce the number of neuromythic beliefs among pre-service biology teachers. The study also wanted to test the extent of a reduction in the amount of neuromythic beliefs. A university course was developed as an intervention in this study (Grospietsch & Mayer, 2019). The sample consisted of 57 university students who were asked about their knowledge, beliefs, neuromyths, and thoughts about the developed university course pre- and post-intervention (Grospietsch & Mayer, 2019). Unlike Im et al. (2018), the results of this study found that explicitly refuting misconceptions about learning and the brain helped to reduce the number of neuromythic beliefs, but it did not eliminate them (Grospietsch & Mayer, 2019).

Dekker et al. (2012) conducted a study that investigated the predictors and the amount of neuromythic beliefs from teachers in the area of the United Kingdom and the Netherlands. The sample included 242 K-12 teachers who reported being interested in neuroscience (Dekker et al., 2012). The teachers who participated in the study completed a survey to assess knowledge of the brain and neuromyths. The results found that teachers believed 49% of the neuromyths, mostly neuromyths connected to commercialized programs (Dekker et al., 2012). Teachers answered about 70% of the knowledge statements correctly. Teachers who reported professional learning by reading popular science magazines achieved higher scores on knowledge questions (Dekker et al., 2012). However, more general knowledge predicted an increased belief in neuromyths. Dekker et al. found that teachers who are interested in the application of neuroscience find it hard to discriminate fact from fiction (Dekker et al., 2012). Having more information about the brain was not a predictor of believing in neuromyths (Dekker et al., 2012).

Ferrero et al. (2016) conducted a neuromyth study from a sample of Spanish teachers and meta-analyzed evidence on other neuromyth studies. Ferrero et al. found some of the most prevalent neuromyths were also believed by Spanish teachers. Concerning the role of professional learning, the results show that reading scientific journals reduced neuromythic beliefs, but reading educational magazines increased neuromythic beliefs (Ferrero et al., 2016). This study also identified other sources of information educators used to learn about the brain, such as books or web sites (Ferrero et al., 2016). Their findings show that favorite sources of information for self-directed learning reported by teachers conflicted with the ones that predicted knowledge about the brain (Ferrero et al., 2016). More than half of the teachers in this study also reported taking a course about the brain and learning provided by their local school district (Ferrero et al., 2016).

Betts et al. (2019) conducted an international study that tested awareness of neuromyths and general knowledge about the brain, evidence-based practices, and predictors of awareness of neuromyths, general knowledge about the brain, evidence-based practices, and neuroscientific interest among the various professional roles. The population for this study included higher education professionals. Altogether a total of 1,290 surveys were completed, with 929 surveys meeting the inclusion criteria (Betts et al., 2019). The results found that all roles were aware of evidenced-based practices, but were prone to neuromythic beliefs. Results found that self-directed learning and professional development emerged as predictors in the awareness of neuromyths, knowledge about the brain, and evidence-based practices (Betts et al., 2019). Respondents who read journals related to learning sciences had higher percent correct responses for neuromyths. Also, professional development associated with learning sciences was found to be a predictor of awareness of neuromyths and general knowledge about the brain, and evidence-based practices (Betts et al., 2019).

Educators' Experience and Its Role in Learning

The last relationship test in this study involved the variable of years of experience associated with the number of neuromythic beliefs. This variable was included in this study because of the likelihood of similar vicarious learning experiences from educators within one school district. Research has found that educators have various stages of learning throughout their careers. These stages influence the type of professional learning that educators engage in during their careers. Research states that mid-career educators and beyond practice professional learning differently than early career teachers (Day & Sachs, 2007; Louws et al., 2017). The variable of years of experience has been tested in some neuromythic belief studies. The following is the synthesis of the literature concerning educators' experience and its role in beliefs and behaviors.

Although every educator's career is different, researchers have found common characteristics of an educator's development such as knowledge, skills, and goals (Richter et al., 2011). Studies have found that as knowledge and skills grow with years of teaching experience, involvement in professional learning or the motivation for learning declines as educators become more experienced (Day & Sachs, 2007; Richter et al., 2011). Educators develop in stages from novice to advanced beginner, and towards expert teacher (Day & Sachs, 2007). With each stage, learning structures vary, starting with rule-driven, to an integrated, instinctive, and situated learning (Berliner, 2001). Novice and expert teachers should be expected to differ in what they know (Louws et al., 2017).

Teachers vary in learning throughout their career (Louws et al., 2017). Day and Sachs (2007) stated that every stage in an educator’s career can be sorted into learning phases. During the induction phase, 0–7 years of experience, educators learn about the profession and the socialization within the school community. Feiman-Nemser (2001) claimed, on the educators' learning continuum, early career learning attainment is mostly associated with content knowledge, students’ traits, classroom management, and professional identity. Once established, 8–15 years of experience, educators in the mid-career become settled and commit themselves to the profession along with trying to improve their effectiveness. Later in their careers, educators concentrate on improving content knowledge, instructional practices, and increased responsibilities within the school (Feiman-Nemser, 2001). In the final stage, 16 or more years of experience, late-career educators are categorized as being less committed to the profession (Rolls & Plauborg, 2009).

Louws et al. (2017) found that after approximately 7 years of teaching, educators learning goals extended beyond the classroom as educators sought new challenges. Richter et al. (2011) found mid-career educators to be the highest participants of learning opportunities provided by in-service training. Many learning goals important for mid-career educators were related to learning about curriculum and instruction and differentiation based on students’ needs (Louws et al., 2017). During this mid-career stage, according to Day and Sachs (2007), educators search for more effective ways to improve the impact on their students; however, Rolls and Plauborg (2009) found that research interest in midcareer teachers is extremely low.

The literature on educators’ work-related learning demonstrates that participation in formally organized learning activities declines with age (Kyndt et al., 2016; Richter et al., 2011). Richter et al. stated that more experienced educators invest the same time in professional development but through individualized learning activities. Cameron et al. (2013) found that more experienced teachers are selective in the learning activities in which they participate. Educators’ learning activities involving professional literature increased with experience (Richter et al., 2011). Many neuromyth researchers have found that reading professional literature, such as peer-reviewed journal articles, to be a predictor of accurate brain information (Betts et al., 2019; Ferrero et al., 2016; Macdonald et al., 2017). Educators with more experience are more focused on learning about improved teaching practices (Kyndt et al., 2016).

This study examined whether educators’ experience has a relationship with the number of neuromythic beliefs. The literature concerning educators’ years of experience established that educators have different learning goals during different stages of their careers. Previous studies (Betts et al., 2019; Ferrero et al., 2016; Gleichgerrcht et al., 2015) have examined years of experience and the number of neuromythic beliefs among educators. These studies did not find a significant relationship between the two variables; however, these studies focused on a wide range of educator roles and social contexts. This variable was added to test the environmental factor of the participants. The learning outcomes of educators can be inherently related to the social context of the educators (Eraut, 2004), such as one school district. Bandura (2006) describes the reciprocal effect between the three factors of personal cognitive, behaviors, and environment. This study focused solely on elementary educators from one specific environment, whereas the other studies looked at years of experience within multiple organizations.

In conclusion, research has found the benefits and obstacles of neuroeducation. Studies have shown that students working in brain-based learning settings have made significant improvements in the areas of academic achievement and retention (Erol & Karaduman, 2018). Educators are curious and interested in what neuroeducation can provide to the classroom (Serpati & Loughan, 2012). Macdonald et al. (2017) found the existence of neuromyths within various populations in the United States; however, the number of misunderstandings were minimized with training in education and neuroscience.

A clear need exists to better understand how educators come to or continue to believe neuromyths. Science misconceptions have been found to negatively influence teaching (Catalano et al., 2019). What was not known is how learning processes, beliefs, and behaviors within the population of elementary educators relate to the number of neuromythic beliefs. Self-efficacy and curiosity influence the motivation to learn (Reio & Wiswell, 2000). Both self-efficacy and curiosity can affect professional learning attainment (Reio & Wiswell, 2000). Elementary educators have a variety of backgrounds (Durksen et al., 2017). These backgrounds include different levels of professional learning attainment and elementary education experience (Durksen et al., 2017).

Personal cognitive factors and behaviors could potentially introduce or protect educators from neuromyths. Testing for a relationship between each predictor variable of self-efficacy, curiosity, professional learning, and experience with the criterion variable of the number of neuromythic beliefs furthered the understanding of educators' beliefs of the brain, and its role in learning. Related studies have found efficacious educators to be more likely to use knowledge and skills attained from professional learning than educators with low self-efficacy (Eun & Heining-Boynton, 2007; Lumpe et al., 2012). Significantly, educators who are aware of their brain knowledge can learn, and aid in the prevention of sharing misconceptions with their students or colleagues (Catalano et al., 2019). This understanding could improve the education system by protecting instructional and professional learning time, along with the cost associated with ineffective materials or training.

Summary

Educators' professional learning is influenced by personal cognitive, behavioral, and environmental factors (Bandura, 2006). Moderate challenges, such as struggling students, motivate educators to learn more to improve their teaching practice. Educators act as active agents in their learning (Bandura, 1991). They observe and attain information from a wide variety of experiences (Bandura, 1991). These experiences increase their professional learning attainment.

Experts have given higher credit ratings to erroneous information due to the allure of neuroscience. Teachers are experts in the field of education; however, they need collaboration opportunities and common vocabulary to understand neuroscientific educational studies (Feiler & Stabio, 2018). Due to learning being complex and the advancement of scientific knowledge, the risk of premature neuroapplications to education exists (Thomas et al., 2019). Motivations for learning, such as self-efficacy and curiosity, may influence the exposure of neuromyths to educators. A curiosity in brain research may also play a role in the beliefs of neuromyths. An educator who is curious about a certain topic may have a higher chance of experiencing neuroframed information that has been shown to increase creditability among its readers (McCabe & Castel, 2008). To the knowledge of the author, there has been no study examining elementary educators' motivation to learn through the lens of self-efficacy, curiosity, and the behaviors of professional learning attainment and years of experience related to the number of neuromythic beliefs; thus, creating a gap in the current literature.

CHAPTER THREE: METHODS

Overview

This chapter contains a description of a nonexperimental quantitative design. The design methods, along with the research questions, null hypotheses, participants, and setting, instrumentation, procedures, and data analysis will be explained. This quantitative correlational study was designed to investigate the relationship between elementary educators' general self-efficacy, curiosity, professional learning attainment, educational experience, and the number of neuromythic beliefs. This investigation required statistical analysis to determine if a significant relationship existed among the variables.

Design

This research used a quantitative, correlational design to study the research questions and hypotheses in the sample population. The purpose of this nonexperimental study was to determine if there was a significant relationship between each of the predictor variables of elementary educators' self-efficacy, curiosity, professional learning attainment, and educational experience, with the criterion variable of neuromythic beliefs. This design was selected because numerical data was collected and analyzed to describe a relationship (Gall et al., 2007) among the variables. This method was appropriate because the researcher wanted to evaluate the degree of linearity between the variables in this study (Green & Salkind, 2011). The predictor variables in this study were elementary educators' self-reported self-efficacy, curiosity, professional learning attainment, and teaching experience. The criterion variable was the number of neuromythic beliefs of elementary educators. There was no suggestion of a causal relationship; therefore, there was no distinction between the variables as being independent or dependent.

This study examined different aspects of learning and the relationship to neuromythic beliefs. The predictor variables of professional learning attainment and teaching experience of educators, along with the criterion variable of the number of neuromythic beliefs in this study have been researched in prior studies (Dekker et al., 2012; Howard-Jones, 2014; Macdonald et al., 2017; Pasquinelli, 2012; Ruhaak & Cook, 2018). Neuromyths are defined as a confusion, a misinterpretation, and in some cases an intentional manipulation of the scientifically proven fact to make a valid argument for education (OECD, 2002). Richter et al. (2011) described professional learning as “the uptake of formal and informal learning opportunities that deepen and extend teachers’ professional competence, including knowledge, beliefs, motivation, and self-regulatory skills” (p. 116). Years of experience is “the number of years of full-time employment as a teacher in a public school, private school licensed or accredited by the State Board of Education, or institution of higher education” (Law Insider, n.d.).

The additional predictor variables of educators’ self-efficacy beliefs and curiosity were included in this study because of their role in learning. Self-efficacy is a person’s perception of his or her capability to regulate actions within his or her life (Bandura, 1997). Loewenstein (1994) described curiosity “as a form of cognitively induced deprivation that results from the perception of a gap in one’s knowledge” (p. 76). Studying these learning variables about educators’ misconceptions added information to the issue of neuromythic beliefs.

Research Questions

The research questions for this study were:

RQ1: Is there a relationship between elementary educators’ self-efficacy and the number of neuromythic beliefs from a rural south-central Missouri school district?

RQ2: Is there a relationship between elementary educators' curiosity and the number of neuromythic beliefs from a rural south-central Missouri school district?

RQ3: Is there a relationship between elementary educators' professional learning attainment and the number of neuromythic beliefs from a rural south-central Missouri school district?

RQ4: Is there a relationship between elementary educators' teaching experience and the number of neuromythic beliefs from a rural south-central Missouri school district?

Null Hypotheses

The null hypotheses for this study were:

$H_0$1: There is no relationship between elementary educators' self-efficacy and the number of neuromythic beliefs from a rural south-central Missouri school district, as shown by the Generalized Self-Efficacy Scale (GSE) and the survey on General Knowledge About the Brain (GKB).

$H_0$2: There is no relationship between elementary educators' curiosity and the number of neuromythic beliefs from a rural south-central Missouri school district, as shown by the Curiosity and Exploration Inventory-II (CEI-II) and survey on GKB.

$H_0$3: There is no relationship between elementary educators' professional learning attainment and the number of neuromythic beliefs from a rural south-central Missouri school district, as shown by the survey on GKB.

$H_0$4: There is no relationship between elementary educators' teaching experience and the number of neuromythic beliefs, from a rural south-central Missouri school district as shown by the survey on GKB.

Participants and Setting

The target population in this study were rural-elementary educators from south-central Missouri. A nonprobability sample was selected based on participants’ availability through convenience sampling (Creswell, 2018). This common method of sampling was selected because the population was readily available to the researcher (Gall et al., 2007). All elementary educators within the district were invited to participate in the study.

The school district, which is approximately 111 square miles (Lehmen, 2014), is in a low socioeconomic area in rural Missouri. The district had an average expenditure of $9,672 per student in 2019 (Department of Elementary and Secondary Education [DESE], 2020). The free and reduced percentages were 54.5% for school A and 50.4% for school B for the 2018-2019 school year (DESE, 2020). Demographics of students within the school district include 95% white, 1% African-American, 1% Hispanic or Latino, 1% American Indian or Alaskan Native, and 2% are two or more races with a mean household income of $46,086 (NCES, n.d.).

The target population included in-service elementary educators with varying Missouri elementary education certifications, years of experiences, and varying professional learning attainments. These educators included all certified faculty members who work with elementary students at the two schools. Certified faculty members are educators who have at least a bachelor’s degree and have a valid educators’ certificate issued by the DESE of Missouri. The population sample was drawn from a convenience sample taken from one point in time. All certified elementary educators were asked to participate on a volunteer basis.

The makeup of the target population consisted of various roles forming naturally occurring groups. A review of the district’s website revealed most of the elementary educators were self-contained general education teachers. The two campuses had a combined total of 48 self-contained teachers working in preschool through fifth-grade for the 2020-2021 school year. The second-largest group of educators was special education teachers. This group contained 17 teachers. The next largest group of educators included those from specialized programs, including art, music, physical education, library media, and counseling containing a total of 10 teachers. The final group included in the target population was the administration group consisting of six administrators. The combined total population of elementary education educators included 79 educators for the 2020-2021 school year.

A priori power analysis was conducted to determine the number of participants needed for this study. A suitable sample size for the study was estimated using GPower analysis. The results of the GPower analysis specified a sample of 65 with an alpha of .05 would be sufficient to achieve a medium effect size with a power of .7 (Faul et al., 2009). However, Gall et al. (2007) recommended a minimum of 66 for a medium effect size with a statistical power of 0.7 and an alpha of 0.05. Gall et al. (2007) specified that the statistical power of research rises automatically, the larger the sample size.

The total sample contained 67 elementary educators out of the total population of 79 with 61 being female and 6 being male elementary educators. The breakdown of the convenience sample group contained 34 self-contained teachers, 14 special education teachers, 8 special area teachers, and 5 administrators. The sample population included 63 Caucasian, 1 African American, 1 Asian, and 1 Hispanic educator. The sample contained 34 participants in the 35-44 age group, 18 participants in the 25 to 34 age group, 11 participants in the 45 to 54 years age group, and 7 participants in the 55 to 64 years age group, respectively.

Instrumentation

Three instruments were used in this study: GSE, CEI-II, and the GKB which included a demographic and professional information section. The approximate time to complete the three instruments and demographic and background questions was about 22 minutes. Item responses included multiple-choice and Likert-type items and were delivered using the digital platform Google Forms.

Generalized Self-Efficacy Scale

The GSE is a self-report scale designed for adolescents and adults (Jerusalem & Schwarzer, 1995). The scale was developed to measure an overall sense of perceived self-efficacy with the goal in mind to predict managing everyday hassles as well as adaptation after experiencing all kinds of life events. The scale has been used in multiple studies (Bath & Smith, 2009; Luszczynska et al., 2005; Minshall et al., 2020; Rose et al., 2019; Scholz et al., 2002) including studies involving teachers (Schwarzer, 1999). The German version of this scale was initially created by Jerusalem and Schwarzer in 1981, beginning with 20-items and later reduced to 10-items (Jerusalem & Schwarzer, 1992). The construct validity of the GSE has been found to have a single factor (Jerusalem & Schwarzer, 1995) of self-efficacy.

To answer the research question about whether there is a relationship between elementary educators' self-efficacy beliefs and the number of neuromythic beliefs, a valid and reliable scale was needed to measure the variable of self-efficacy. The GSE was selected as the instrument of choice due to its reliable results across universal contexts. The GSE consists of 10 items and takes approximately 4 minutes to complete. Example statements on the scale include, "I can always manage to solve difficult problems if I try hard enough" and "When I am confronted with a problem, I can usually find several solutions" (Jerusalem & Schwarzer, 1995).

The GSE uses a four-point Likert scale. The GSE is a self-administered measurement. Participant read the directions and self-rated their perceived self-efficacy on a scale of one-to-four; *Not true at all* = 1, *Barely true* = 2, *Moderately true* = 3, and *Exactly true* = 4. Upon completion, a composite score ranging from 10 to 40 could be attained with greater self-efficacy aligning with higher scores (Jerusalem & Schwarzer, 1995). A score of 10 points meaning the person has low perceived self-efficacy and a score of 40 points meaning a high perception of self-efficacy or efficacious. The scale is available in multiple languages and reports reliability with a Cronbach's alpha range of 0.76 to 0.90 in samples across 14 nations (Schwarzer, 1999). The author grants permission for non-commercial research use on his website (see Appendix A). The participants took the GSE on a Google Form which automatically collected the participants' responses of perceived self-efficacy. The data were converted to an Excel spreadsheet by the researcher.

The Curiosity and Exploration Inventory-II

The CEI-II is a self-report scale designed for adult participants (Kashdan et al., 2009). The purpose of this instrument is to measure individual differences in broad dimensions of the curiosity trait (Kashdan et al., 2009). The CEI was revised and expanded slightly in the 10-item CEI-II (Kashdan et al., 2009). One main reason for developing the CEI-II was that:

> The authors of the CEI failed to address individual differences in the willingness to manage (even embrace) the tension that often arises when confronting novelty and uncertainty. This includes tolerance for ambiguity, distress, and uncertainty, and viewing difficulties as challenges more often than threats. (Kashdan et al., 2009, p. 3)

The CEI-II was developed to measure the curiosity trait through individual differences in the detection, search, and integration of novel and stimulating experiences and information

(Kashdan et al., 2009). The CEI-II is a 10-item scale with the two factors of stretching and embracing. Stretching (five items) is the motivation to seek out knowledge and new experiences and embracing (five items) is the willingness to embrace the innovative, ambiguous, or unpredictability events of everyday life (Kashdan et al., 2009). This scale has been used in multiple studies to measure the curiosity trait (Kashdan et al., 2009; Puente-Díaz & Cavazos-Arroyo, 2017; Vela et al., 2018). Sample items include: “I actively seek as much information as I can in new situations” and “I am the type of person who really enjoys the uncertainty of everyday life” (Kashdan et al., 2009). Kashdan et al. reported the CEI-II contains two subscales. Items 1, 3, 5, 7, and 9, measure the factor of curiosity defined as "stretching," whereas items 2, 4, 6, 8, and 10 measure "embracing." Kashdan et al. used traditional test methods and applied advanced procedures to evaluate and define the CEI-II’s psychometric properties. The use of confirmatory factor analysis procedures to assess the latent structure of curiosity across multiple samples offered evidence for the proposed two-factor theory of curiosity (Kashdan et al., 2009). The results propose that the CEI-II is a valid assessment in exploring the trait of curiosity.

Participants read the directions and self-rate the items based on a five-point Likert scale: *Very slightly or not at all* = 1, *A little* = 2, *Moderately* = 3, *Quite a bit* = 4, and *Extremely* = 5. Upon completion, a composite score ranging from 10 to 50 could be attained with greater curiosity aligning with higher scores (Kashdan et al., 2009). A score of 10 points meaning the person has a low perceived curiosity trait and a score of 50 points meaning a high perception of the curiosity trait. Scores for each of the two subscales (stretching and embracing) range from five to 25 points. For this study, the total curiosity trait was examined.

The CEI-II is a self-administered measurement. Participants read the directions and rated their curiosity level. The administration of the CEI-II is approximately 2 minutes. Participants took the CEI-II on a Google Form. The Google Form automatically collected participants' responses. Participants' responses were converted to an Excel spreadsheet by the researcher.

Kashdan et al. (2009) used many samples and comparisons to other instruments to test reliability and validity. The CEI-II reports reliability with a Cronbach's alpha within the range of .76 to .86 across two separate studies. As specified by the item response theory discrimination values of each item, findings showed moderate to very-high validity regarding each of the ten items (Kashdan et al., 2009). The author grants permission to use the CEI-II on his website. The scale was selected for this study due to the multiple studies reporting educators' high interest in neuroscience (Dekker et al., 2012; Howard-Jones, 2014; Macdonald et al., 2017; Pasquinelli, 2012; Ruhaak & Cook, 2018).

General Knowledge About the Brain Survey

The GKB survey, created by Betts et al. (2019), was used to measure the variable of the number of neuromythic beliefs. The demographic and professional information section collected data for the variables of professional learning attainment and experience. The GKB survey contains three sections: neuromyths and statements about the brain, evidence-based practice statements, and background and professional information. Participants took the entire survey. The current study was interested in the number of neuromythic beliefs of elementary educators; therefore, section one and a modified demographic section of the GKB was scored.

Section One: Neuromyths and General Knowledge about the Brain

The item statements in section one have been used in multiple studies (Dekker et al., 2012; Herculano-Houzel, 2002; Im et al., 2018; Macdonald et al., 2017) and were appropriate for this study because they accurately measure the number of neuromythic beliefs. Section one contains 23 multiple-choice statements about the brain; eight of those statements are considered prevalent neuromyths (OECD, 2002). The subscale measures percentages per selected answer choice. The current study was interested in the number of neuromythic beliefs; therefore, only the incorrect percentages were used. “A higher percentage on incorrect responses reflects more neuromyth beliefs” and lower percentage on incorrect responses reflects more accurate brain knowledge (Dekker et al., 2012, p. 3). Participants completed the GKB on a Google Form which automatically collected data for the answer choices. The data was converted from Google Forms to an Excel spreadsheet and uploaded to IBM Statistical Package for the Social Sciences software package version 25 (SPSS).

The GKB was delivered digitally to participants in a multiple-choice format. Participants read the directions and took the GKB independently. Example items included “Individuals learn better when they receive information in their preferred learning style (e.g., auditory, visual, kinesthetic)” and “Listening to classical music increases reasoning ability” (Betts et al., 2019). Participants had the option of selecting only one choice “correct”, “incorrect”, or “I don’t know”. Participants who selected either “the correct answer” or “I don’t know” were not considered to have a misconception about that statement. Betts et al. (2019) selected this answer format because it reflected the same format of previous neuromyth studies by Dekker et al. (2012), Macdonald et al. (2017), and Herculano-Houzel (2002). The approximate time to complete the GKB is about 15 minutes.

Most of the items in section one of the GKB can trace their roots back to Dekker et al.’s (2012) research. According to Betts et al. (2019), items from section one came from prior studies on neuromyths from Dekker et al. (2012), Herculano-Houzel (2002), and Macdonald et al. (2017). Items one to eight were original items from Dekker et al. (2012). Items 9-15 were from Macdonald et al.’s (2017) neuromyth survey. Six of these items were modified by Macdonald et al. (2017) from Dekker et al.'s (2012) original survey, with the addition of one original statement concerning dyslexia. This item was added by Macdonald et al. (2017) because it is a popular neuromyth in the United States. Items 16-22 were modified by Betts et al. (2019) from Dekker et al. (2012) and Macdonald et al. (2017). The last item was an original item from Herculano-Houzel (2002). Of the 23 items in section one, 21 were original or modified versions of Dekker et al.'s (2012) study. Dekker et al.'s (2012) original and modified neuromyth survey has been used with the target population of in-service educators (Bailey et al., 2018; Ferrero et al., 2016; Gleichgerrcht et al., 2015; Macdonald et al., 2017).

To ensure the survey measured neuromyths, documentation was provided for all 23 statements and the evidence-based answer choices. Every item statement was described in detail and supported with research. Eight of the 23 statements are widely accepted neuromyths (OECD, 2002). The validation of the questions and accuracy of the information was reviewed by experts on the topic of neuroscience (Betts et al., 2019). To measure reliability, Cronbach's alpha was used to measure consistency across survey items for section one of the GKB: neuromyths and general statements about the brain. The alpha coefficient for section one was 0.76. The authors of this survey gave their permission to use the GKB for this study (see Appendix B).

Section Three: Demographics and Professional Information

The last section contained demographic and professional background information. This section measured the variables of professional learning attainment and teaching experience. Missouri educators are required to attain and track the number of professional learning hours each year as part of their certification (DESE, n.d.). Participants selected the range of professional learning hours attained within the prior 12 months. Participants self-reported their teaching experience by selecting the answer choice that contained the appropriate years of experience. The professional and background section contained a question to screen for elementary educators to ensure data was only collected from certified elementary educators. This section also collected information for descriptive purposes of educators' neuroscientific interest, role, age, gender, and ethnicity.

Procedures

The procedures for this research study were carefully planned. Permission from the superintendent for conducting a research study within the district was granted (see Appendix C). After the superintendent granted permission, an Institutional Review Board (IRB) application was submitted for the approval of this study (see Appendix D). Data collection took place after IRB approval. A face-to-face question and answer conversation transpired with the principals of the two elementary campuses to alleviate any concerns about the cost and inconvenience of the research study to the campus (Gall et al., 2007). Given the principals were elementary educators who were members of the target population, only information about the procedures and timelines were discussed. No discussion about the research topic took place with the principals.

Interaction to gain collaboration from participants took place before, during, and after the three-week data collection timeframe. To encourage participation, participants were given the option to provide their email address to be entered into a drawing for a cash prize of $50 along with the researcher donating $5 to the United Way for each participant. The cash prize drawing and donation were presented after the study at a faculty meeting of the Principal's choice. The procedures followed the appropriate processes of conducting a comprehensive research study.

To obtain willing participants for this quantitative study, the researcher planned positive human interactions with the potential participants (Gall et al., 2007). To establish this positive relationship, with both principals' knowledge and approval, email addresses were obtained from the school district's website and an email letter was sent to all possible participants two weeks before data collection (see Appendix E). The email letter included an introduction to the research process and the importance of their participation. Both principals were asked to attach the letter to their weekly faculty meeting agenda one week before the initial data collection day.

The two principals were asked to give the researcher permission to attend their weekly faculty meeting one week before data collection. At this faculty meeting, the researcher introduced the study and the importance of the participants' participation. The researcher personally emailed the letter, the consent form (see Appendix F), and data collection instruments to faculty members with the principals' permission. A reminder email was sent to participants one week before the data collection window closed. After a three-week data collection window, another thank you email was sent to the two principals along with a request for an appropriate time and date to draw for the cash prize and present a donation to the United Way.

Participants used Google Forms to complete the questionnaire. Google Forms automatically collects and organizes data into spreadsheets. No personal identifying information was collected during data collection. The option to collect participants' email in Google Forms was disabled to protect participants' privacy. Email addresses were requested for the $50 cash drawing; however, they were pulled and separated from responses to maintain anonymity. At data completion, the researcher converted the information collected from the Google Form into an Excel spreadsheet.

SPSS software was used to analyze the data to establish acceptance or rejection of the four null hypotheses. Email addresses were requested for the drawing purpose; however, the addresses were pulled and separated from participants' responses to maintain anonymity. The $50 cash prize drawing and a $335 donation to the United Way were presented at a faculty meeting after the data collection window. Information was sorted using an Excel spreadsheet to begin the data analyzing procedure. Participants contributed to the research study willingly and participated in the same process.

Data Analysis

A Pearson product-moment correlation coefficient (Pearson's *r*) was used to test the strength of the relationship between the two quantitative variables (Warner, 2013) found in null hypotheses one and two. To conduct this analysis, every case must have scores on two continuous variables. Pearson's *r* assesses if there is a linear relationship between the two continuous variables in the sample (Green & Salkind, 2011). This was an appropriate test for hypotheses one and two because it is commonly used in correlational techniques with measures that have continuous scores and Pearson's *r* has a small standard error (Gall et al., 2007). Pearson product-moment correlations were appropriate because null hypotheses one and two paired two continuous variables. The sample size was greater than 50; therefore, the Kolmogorov-Smirnov test was used to assess normality. A test for normality was needed to determine how to continue with the statistical analysis. If the data were normally distributed, then a Pearson's *r* correlation would be run to test for a correlation and correlation strength of each of the null hypotheses. For data with distributions that significantly differ from normality based on an alpha of 0.05 a non-parametric tool, such as Spearman's correlation coefficient, would be necessary.

Spearman's correlation coefficient (Spearman's rho) was used to test the relationship between the two variables in null hypotheses three and four. Spearman rank correlation is a non-parametric test used to measure the degree of association between two variables. This was an appropriate test for null hypotheses three and four because each hypothesis contained one ordinal and one scale variable. A Spearman rank correlation is the appropriate analysis when one or both variables are ordinal, but it can be used with scale variables. The Spearman rank correlation assumes that the variables have a monotonic relationship with each other (Conover & Iman, 1981). A monotonic association shows that the variables' relationship does not change direction. This assumption is violated if the relationship between the variables changes from positive to negative or vice versa.

To test the predictor variables of self-efficacy, curiosity, professional learning attainment, and educational experience concerning the criterion variable of the number of neuromythic beliefs, a correlational analysis was conducted for each null hypothesis. The four null hypotheses were tested at a 95% confidence level and an alpha level of .05. To check for inconsistencies and missing data, all data were screened. The assumptions of bivariate outliers, linearity, and bivariate normal distribution were analyzed. First, the sample size was considered. Then, a visual inspection of the raw data and a scatterplot for extreme bivariate outliers took place for each null hypothesis. Once the outliers were considered, the assumption of linearity was analyzed by a visual inspection of a scatterplot and implementing a line of best fit to determine if there was a linear relationship between the predictor and criterion variable in each null hypothesis. Next, the assumption of bivariate normal distribution was analyzed by a visual inspection of a scatterplot. The visual inspection of the scatterplot should be similar to a "cigar" shape to meet the assumption of bivariate normal distribution.

Since this study had four null hypotheses and ran multiple significance tests, the Bonferroni correction was used to limit Type I errors (Warner, 2013). The Bonferroni correction divides the alpha by the number of significance tests being performed (Warner, 2013) making the Bonferroni correction for each hypothesis at $\alpha = 0.05/4 = 0.0125$. Pearson's *r* coefficient was computed to assess the relationship between the variables of self-efficacy, curiosity, and the number of neuromythic beliefs. Spearman's rho coefficient was computed to assess the relationship between the variables of professional learning attainment, teacher experience, and the number of neuromythic beliefs.

The effect size was determined using SPSS, where the index ranges from -1 to +1 (Warner, 2013). Green and Salkind (2011) reported that a positive value implies that as the first variable increases, the second variable also increases. A value of zero indicates that as the first variable increases, the second variable neither increases nor decreases (Green & Salkind, 2011). A negative value indicates that as the first variable increases, the second variable decreases. Stronger linear relationships are implied when values are closer to -1 or +1. Correlation coefficients of 0.10, 0.30, and 0.50, regardless of positive or negative, are translated as small, medium, and large coefficients (Green & Salkind, 2011), using an alpha of .05 (Warner, 2013). Descriptive statistics, number, degrees of freedom, *r*-value, r_s-value, significance level, and power were reported for each null hypothesis. Data were analyzed using SPSS.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this correlation study was to test for a relationship between the predictor variables of self-efficacy beliefs, curiosity, professional learning attainment, and teaching experience with the criterion variable of the number of neuromythic beliefs of in-service elementary educators. Pearson's *r* was used to generate a correlation coefficient to quantify the relationship between the predictor and criterion variables in null hypotheses one and two. Spearman's rho was used to generate a correlation coefficient to quantify the relationship between the predictor and criterion variable in null hypotheses three and four. Elementary educators (N = 67) in this study were from one school district located in rural south-central Missouri. The study took place during a three-week data collection window. This chapter reviews the research questions and null hypotheses. Descriptive statistics, bivariate assumptions, and analyses for each null hypothesis are reported.

Research Questions

The research questions for this study were:

RQ1: Is there a relationship between elementary educators' self-efficacy and the number of neuromythic beliefs from a rural south-central Missouri school district?

RQ2: Is there a relationship between elementary educators' curiosity and the number of neuromythic beliefs from a rural south-central Missouri school district?

RQ3: Is there a relationship between elementary educators' professional learning attainment and the number of neuromythic beliefs from a rural south-central Missouri school district?

RQ4: Is there a relationship between elementary educators' teaching experience and the number of neuromythic beliefs from a rural south-central Missouri school district?

Null Hypotheses

The null hypotheses for this study were:

$H_0$1: There is no relationship between elementary educators' self-efficacy and the number of neuromythic beliefs from a rural south-central Missouri school district, as shown by the GSE and the survey on GKB.

$H_0$2: There is no relationship between elementary educators' curiosity and the number of neuromythic beliefs from a rural south-central Missouri school district, as shown by the CEI-II and survey on GKB.

$H_0$3: There is no relationship between elementary educators' professional learning attainment and the number of neuromythic beliefs from a rural south-central Missouri school district, as shown by the survey on GKB.

$H_0$4: There is no relationship between elementary educators' teaching experience and the number of neuromythic beliefs, from a rural south-central Missouri school district as shown by the survey on GKB.

Descriptive Statistics

The target population was elementary educators from one school district in south-central Missouri. Through convenience sampling, participants were invited to participate in the study based on current employment with the district, working in an elementary setting, along with having a Missouri elementary educator certificate. All elementary educators (N = 67) who volunteered for the study signed an informed consent letter, met the requirements for the study, and completed the online questionnaire measuring self-efficacy, curiosity, professional learning attainment, teacher experience, and the number of neuromythic beliefs. All participants' (N = 67) surveys qualified for the study. Frequencies and percentages were calculated for each nominal or ordinal variable. Summary statistics were calculated for each interval and ratio variable.

Demographic Frequencies and Percentages

Participants answered a screening question and demographic questions related to ethnicity, the highest level of completed education, gender, and age range on section three of the GKB. On the screening question, all participants reported being a certified Missouri elementary educator (n = 67, 100%). The most frequently reported ethnicity category was Caucasian (n = 63, 94%). Participants most frequently reported the category of master's degree (n = 39, 58%) as the highest level of education completed. The most frequently observed category of gender was female (n = 61, 91%) and the most frequently reported age range was 35 to 44 years (n = 31, 46%). Frequencies and percentages are presented in Table 1 below.

Table 1

Demographics Frequency Table

Demographics	*n*	%
Missouri certified elementary educator		
Yes	67	100.00
Educator Role		
General Education classroom teacher	34	50.75
Special Education or Gifted & Talented teacher	14	20.90
Art, Music, P.E., or Media Specialist	8	10.45
Reading teacher	5	7.46
Administrator or Councilor	5	7.46
Physical or Speech Therapist	2	2.99
Ethnicity		
Caucasian	63	94.03
Asian	1	1.49
Native American	1	1.49
Caucasian, Native American	1	1.49
Highest Level of Education		
Master's Degree	39	58.21
Bachelor's Degree	16	23.88
Completed some postgraduate	11	16.42
Doctoral Degree	1	1.49
Gender		
Female	61	91.04
Male	6	8.96
Age Range (years)		
35 to 44	31	46.27
25 to 34	18	26.87
45 to 54	11	16.42
55 to 64	7	10.45

Note. Due to rounding errors, percentages may not equal 100%.

Summary Statistics for Interval and Ratio Variables

The GSE, CEI-II, and section one of the GKB instruments measured the variables of self-efficacy, curiosity, and the number of neuromythic beliefs. The predictor variables of self-efficacy beliefs and curiosity along with the criterion variable of the number of neuromythic beliefs in this study involved interval and ratio variables. The predictor variable of self-efficacy had an average total of 32.70 (*SD* = 3.70, SE_M = 0.45, Min = 26.00, Max = 39.00, Skewness =

0.06, Kurtosis = -1.16). The highest score possible on the GSE was a total of 40 points. The predictor variable of curiosity had an average total score of 33.46 (*SD* = 6.53, SE_M = 0.80, Min = 17.00, Max = 47.00, Skewness = -0.13, Kurtosis = -0.49). The highest score possible on the CEI-II was a total of 50 points. The criterion variable of the number of neuromythic beliefs had an average of 5.34 (*SD* = 1.82, SE_M = 0.22, Min = 1.00, Max = 9.00, Skewness = -0.15, Kurtosis = -0.30). The highest score possible on the GKB was a total of 23 neuromyths. The summary statistics can be found in Table 2.

Table 2

Summary Statistics Table for Interval and Ratio Variables

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
Self-Efficacy Total	32.70	3.70	67	0.45	26.00	39.00	0.06	-1.16
Curiosity Trait Total	33.46	6.53	67	0.80	17.00	47.00	-0.13	-0.49
Number of Neuromyths	5.34	1.82	67	0.22	1.00	9.00	-0.15	-0.30

Frequencies and Percentages for Ordinal Variables

The predictor variables of professional learning attainment and teaching experience in this study were ordinal variables. The variables were measured by section three of the GKB. The most frequently observed category of professional learning attainment was 21 - 40 hours (*n* = 20, 30%). The most frequently observed category of teaching experience was 10 - 19 years (*n* = 27, 40%). Frequencies and percentages are presented in Table 3 below.

Table 3

Frequency Table for Ordinal Variables

Variable	*n*	%
Professional Learning Attainment (hours)		
0	2	2.99
3 - 5	3	4.48
6 - 10	8	11.94
11 - 20	10	14.93
21 - 40	20	29.85
41 - 60	16	23.88
61 - 80	5	7.46
> 80	3	4.48
Teaching Experience (years)		
Less than 1	1	1.49
1 -4	8	11.94
5 - 9	16	23.88
10 - 19	27	40.30
20+	15	22.39

Note. Due to rounding errors, percentages may not equal 100%.

Results

This study had four null hypotheses. Data was screened for each null hypothesis. Assumption testing for null hypotheses one and two included checking for bivariate outliers, linearity, and bivariate normal distribution due to testing with Pearson's r. Assumption testing for null hypotheses three and four included checking for a monotonic relationship due to testing with Spearman's rho. The following explains the assumption and significant testing in more detail.

Null Hypothesis One

Data screening was conducted on the predictor variable of self-efficacy and the criterion variable of the number of neuromythic beliefs regarding data inconsistencies and outliers. The data was sorted for each variable and a visual scan was conducted for inconsistencies. No data errors or inconsistencies were identified. The sample size was greater than 50; therefore, a

Kolmogorov-Smirnov test was used to assess normality. A test for normality was needed to determine how to continue with the statistical analysis. The following variables had distributions which did not significantly differ from normality: Self-efficacy Total (D = 0.15, p = .081) and Number of Neuromyths (D = 0.16, p = .057). See Table 4 below for the normality test results.

Table 4

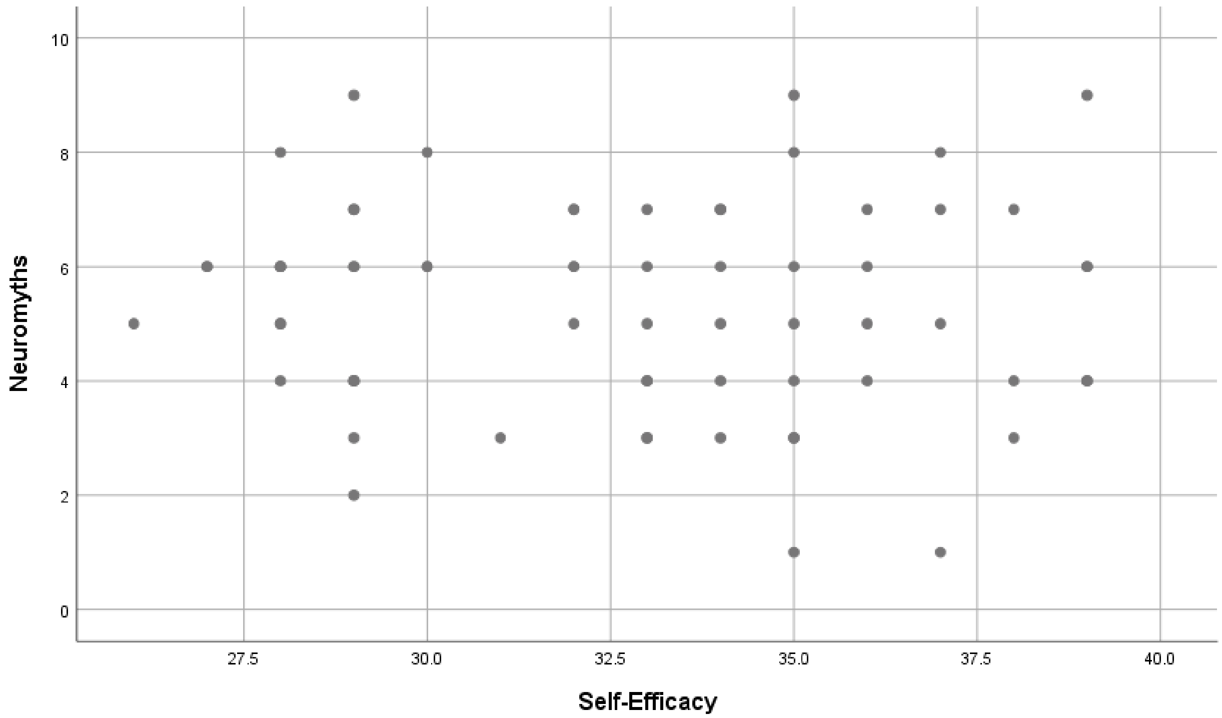
$H_0$1 Kolmogorov-Smirnov Test Results

Variable	*D*	*p*
Self-efficacy Total	0.15	.081
Number of Neuromyths	0.16	.057

A scatter plot was used to detect outliers on each variable. No outliers were identified. To overcome misleading results in reporting, preliminary data screening was conducted on each variable in the attempt to reduce inconsistencies, missing data, and outliers (Warner, 2013). The assumption of bivariate outliers was tenable and the assumption was met. See Figure 1 for the scatter plot.

Figure 1

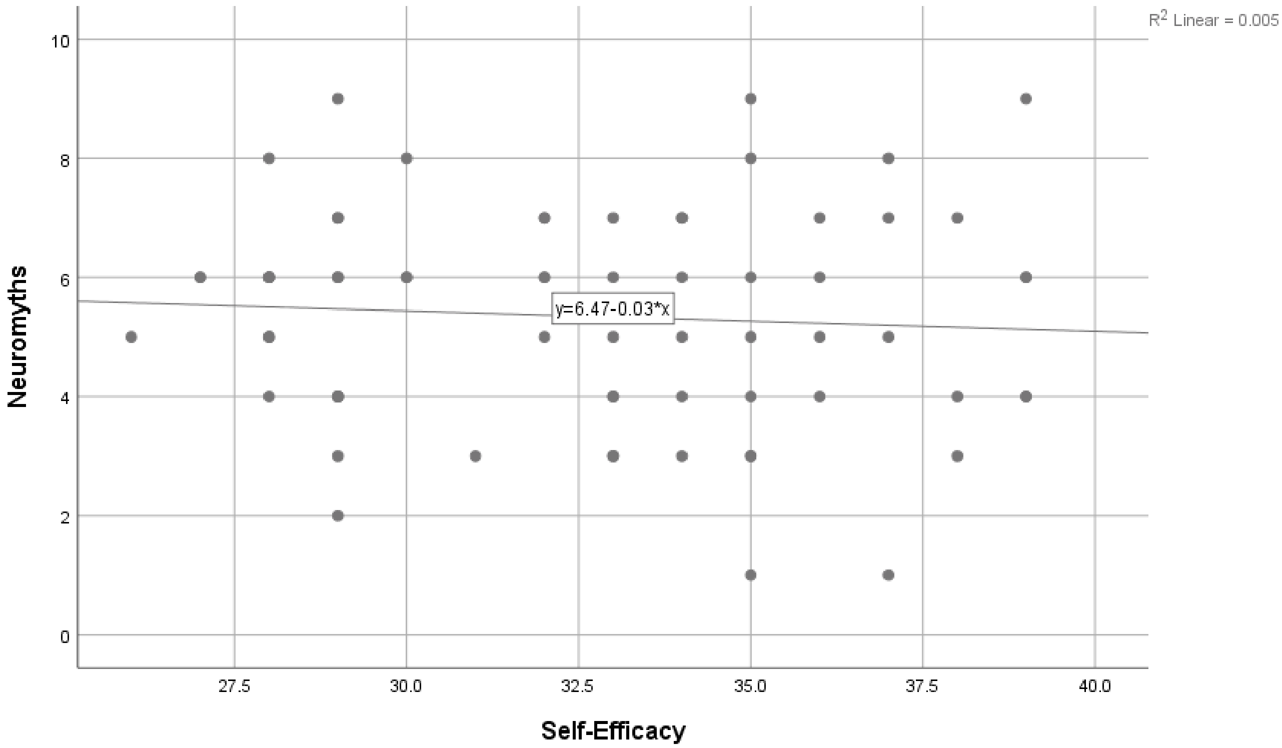
$H_0$1 Scatter Plot for Potential Outliers



The remaining assumptions tested for linearity and bivariate normal distribution, respectively. Pearson's *r* requires that the relationship between each pair of variables is linear (Conover & Iman, 1981). This assumption is violated if there is curvature among the points on the scatterplot between any pair of variables. The scatterplot in Figure 2 below did not exhibit any curvature between the variables; therefore, the assumption was met.

Figure 2

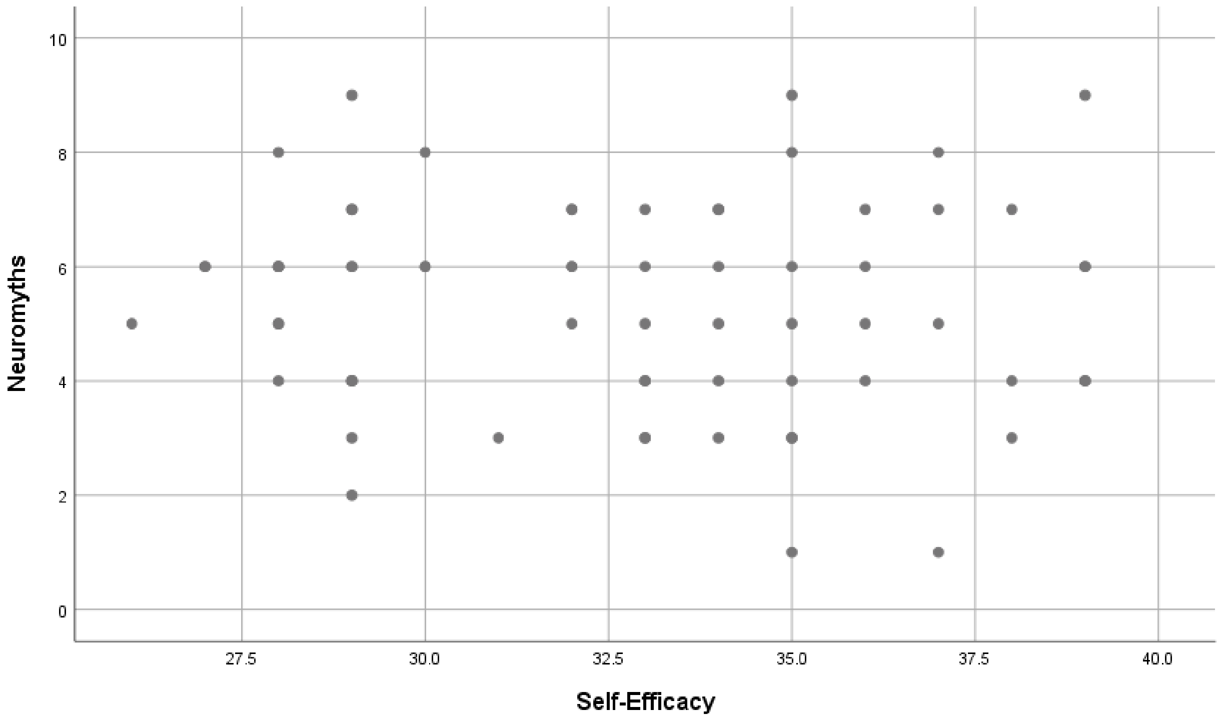
$H_0$1 Scatter Plot for Assumption of Linearity



The assumption of bivariate normal distribution was analyzed by visual inspection of a scatterplot. The assumption was met because the shape of the plot was consistent with a "cigar" shape. See Figure 3 below for the Assumption of Bivariate Distribution scatterplot. All assumptions were met and allowed for the correlation to run with a 95% confidence level.

Figure 3

$H_0$1 Scatter Plot for Assumption of Bivariate Normal Distribution



A Pearson product-moment correlation analysis was conducted between elementary educators' self-efficacy beliefs and the number of neuromythic beliefs. This study had 67 participants, which allowed for a medium effect size with a statistical power of 0.7 and an alpha of 0.05 (Gall et al., 2007). The effect size was determined using SPSS, where the index ranges from -1 to +1 (Warner, 2013). Green and Salkind (2011) reported that a positive value implies that as the first variable increases, the second variable also increases. A value of zero indicates that as the first variable increases, the second variable neither increases nor decreases (Green & Salkind, 2011). A negative value indicates that as the first variable increases, the second variable decreases. Stronger linear relationships are implied when values are closer to -1 or +1. Cohen's standard was used to evaluate the strength of the relationship, where coefficients between .10 and

.29 represent a small effect size, coefficients between .30 and .49 represent a moderate effect size, and coefficients above .50 indicate a large effect size (Cohen, 1988). Since this study had four null hypotheses and ran multiple significance tests, the Bonferroni correction was used to limit Type I errors (Warner, 2013). The Bonferroni correction divides the alpha by the number of significance tests being performed (Warner, 2013) making the Bonferroni correction for each hypothesis at $\alpha = 0.05/4 = 0.0125$.

The correlation coefficient between self-efficacy scores and the number of neuromythic beliefs resulted in a negative weak effect (r = -.07). The results of Pearson's r test indicated no predictive relationship between the total self-efficacy score and the number of neuromythic beliefs of elementary educators. The results of the test, shown in Table 5 below, $r(65) = -.07$, p = .574 at the 95% confidence level. This resulted in failing to reject the null hypothesis ($H_0 1$) because the alpha was greater than .0125 and determined that there was not enough evidence to determine a relationship between elementary educator's self-efficacy beliefs and neuromythic beliefs.

Table 5

$H_0 1$ Pearson Correlation between Self-efficacy and Neuromythic Beliefs

Variables	Variables	
	Self-efficacy	Neuromyths
Self-efficacy		
Pearson Correlation	1	-.070
Sig. (2-tailed)		.574
N	67	67
Neuromyths		
Pearson Correlation	-.070	1
Sig. (2-tailed)	.574	
N	67	67

Null Hypothesis Two

Data screening was conducted on the predictor variable of curiosity and the criterion variable of the number of neuromythic beliefs regarding data inconsistencies and outliers. The data was sorted for each variable and a visual scan was conducted for inconsistencies. No data errors or inconsistencies were identified. The sample size was greater than 50; therefore, the Kolmogorov-Smirnov test was used to assess normality. A test for normality was needed to determine how to continue with the statistical analysis. The following variables had distributions which did not significantly differ from normality: Curiosity Trait Total (D = 0.08, p = .721) and Number of Neuromyths (D = 0.16, p = .057). See Table 6 below for normality test results.

Table 6

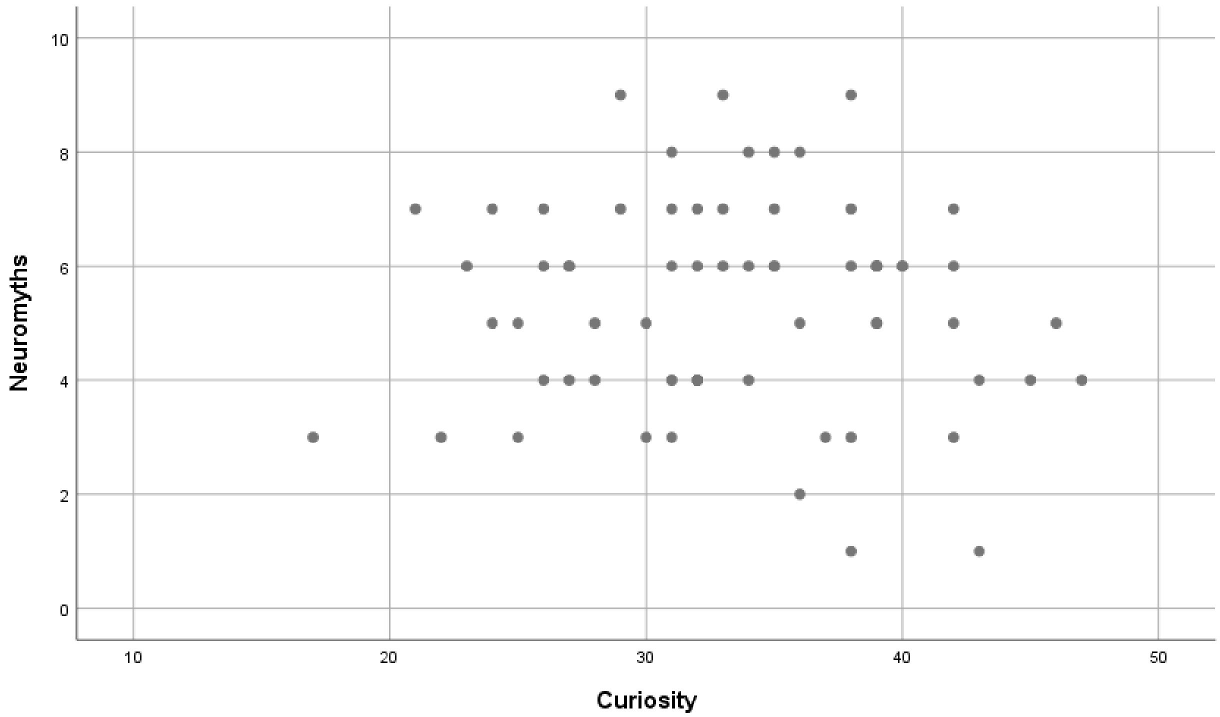
$H_0$2 Kolmogorov-Smirnov Test Results

Variable	D	p
Curiosity Trait Total	0.08	.721
Number of Neuromyths	0.16	.057

A scatter plot was used to detect outliers on each variable. No outliers were identified. To overcome misleading results in reporting, preliminary data screening was conducted on each variable in the attempt to reduce inconsistencies, missing data, and outliers (Warner, 2013). The assumption of bivariate outliers was tenable and the assumption was met. See Figure 4 for the scatter plot.

Figure 4

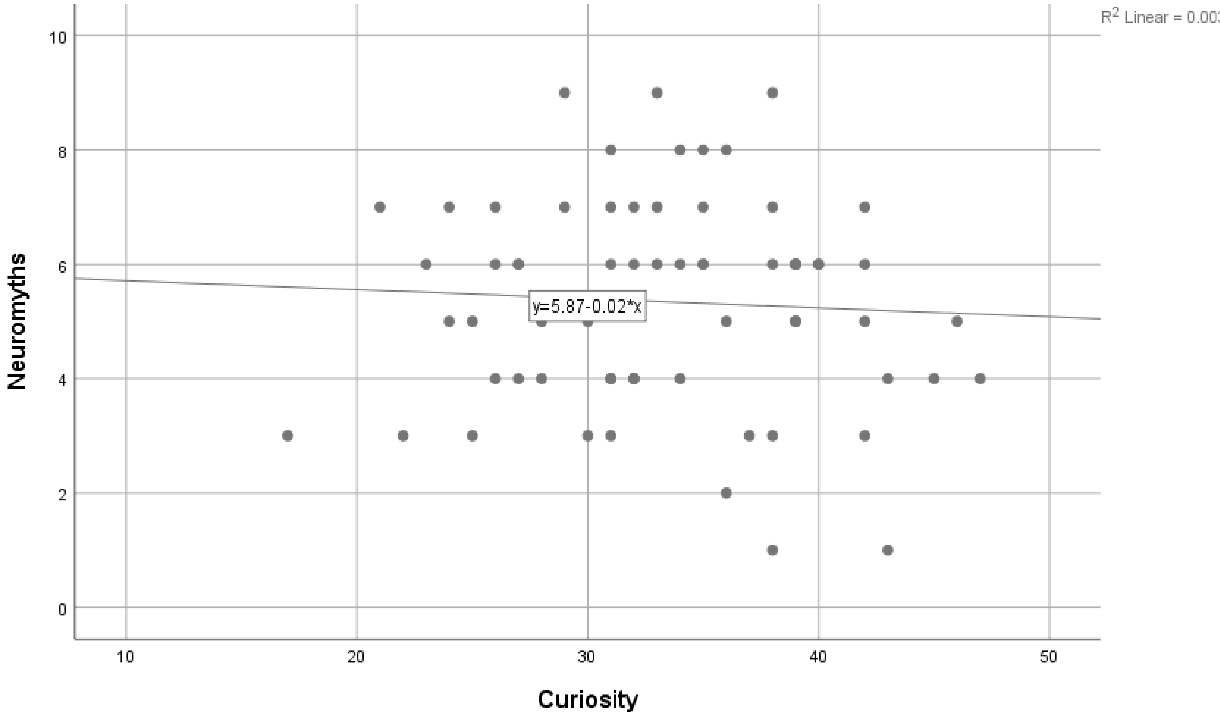
$H_0$2 Scatter Plot for Potential Outliers



The remaining assumptions tested for linearity and bivariate normal distribution, respectively. Pearson's *r* requires that the relationship between each pair of variables is linear (Conover & Iman, 1981). This assumption is violated if there is curvature among the points on the scatterplot between any pair of variables. The scatterplot in Figure 5 below did not exhibit any curvature between the variables; therefore, the assumption was met.

Figure 5

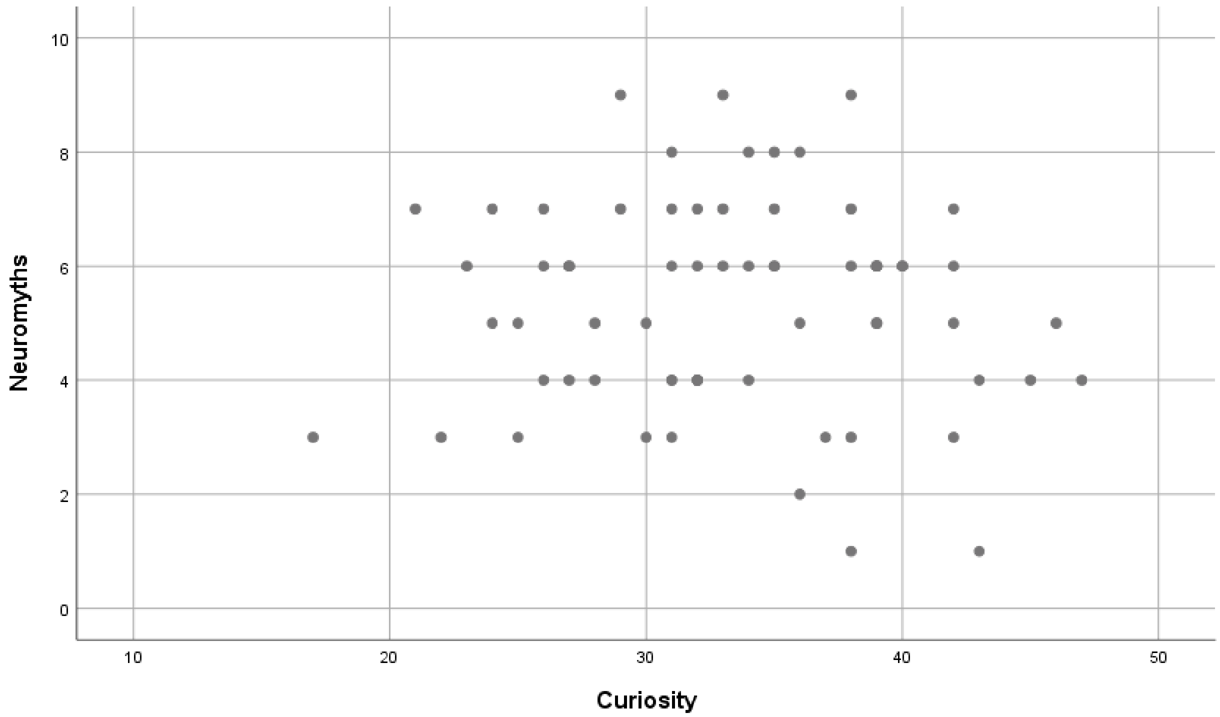
$H_0$2 Scatter Plot for Assumption of Linearity



The assumption of bivariate normal distribution was analyzed by visual inspection of a scatterplot. The assumption was met because the shape of the plot was consistent with a “cigar” shape. See Figure 6 below for the Assumption of Bivariate Distribution scatterplot. All assumptions were met and allowed for the correlation to run with a 95% confidence level.

Figure 6

$H_0$2 Scatter Plot for Assumption of Bivariate Normal Distribution



A Pearson product-moment correlation analysis was conducted between elementary educators' curiosity scores and the number of neuromythic beliefs. Cohen's standard was used to evaluate the strength of the relationship, where coefficients between .10 and .29 represent a small effect size, coefficients between .30 and .49 represent a moderate effect size, and coefficients above .50 indicate a large effect size (Cohen, 1988). Since this study had four null hypotheses and ran multiple significance tests, the Bonferroni correction was used to limit Type I errors (Warner, 2013). The Bonferroni correction divides the alpha by the number of significance tests being performed (Warner, 2013) making the Bonferroni correction for each hypothesis at α = 0.05/4 = 0.0125.

The correlation coefficient between curiosity and the number of neuromythic beliefs resulted in a negative weak effect (r = -.06). The results of Pearson's r test indicated no predictive relationship between the total curiosity score and the number of neuromythic beliefs of elementary educators. The results of the test, shown in Table 7 below, *r*(65) = -.06, *p* = .648 at the 95% confidence level. This resulted in failing to reject the null hypothesis ($H_0 2$) because the alpha was greater than .0125 and determined that there was not enough evidence to determine a relationship between the elementary educators' curiosity and neuromythic beliefs.

Table 7

$H_0$2 Pearson Correlation between Curiosity and Neuromythic Beliefs

	Variables	
Variables	Curiosity	Neuromyths
Neuromyths		
Pearson Correlation	-.057	1
Sig. (2-tailed)	.648	
N	67	67
Curiosity		
Pearson Correlation	1	-.057
Sig. (2-tailed)		.648
N	67	67

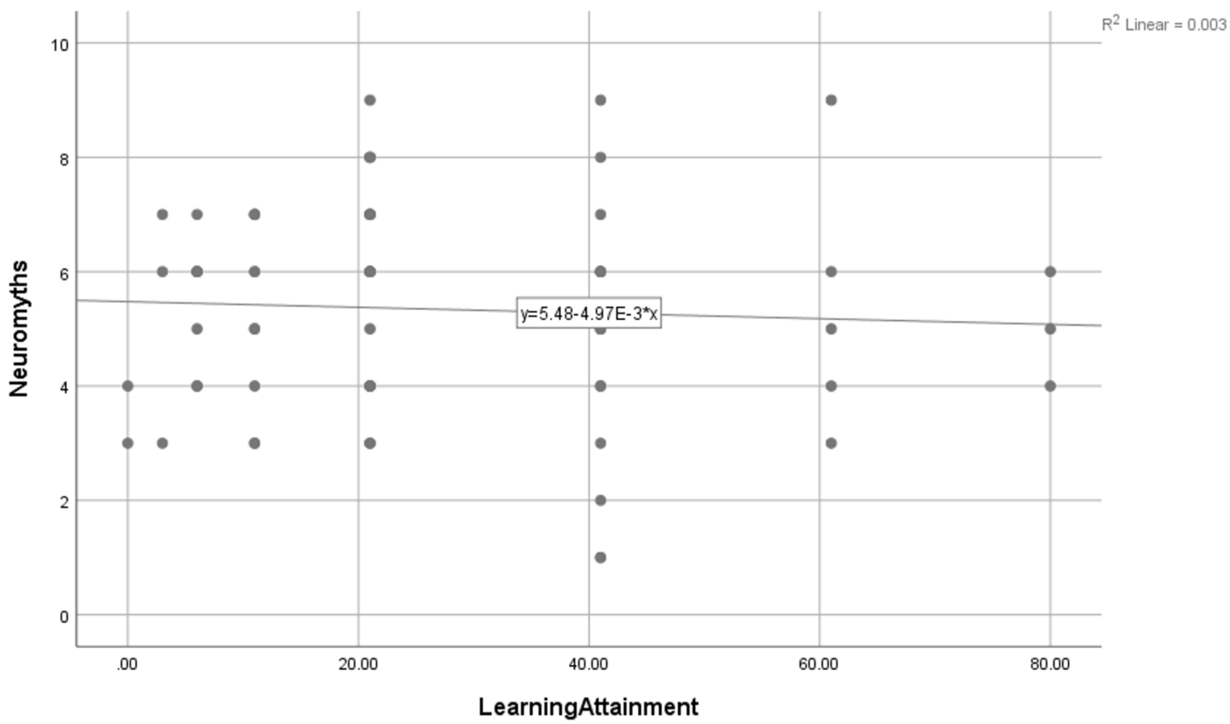
Null Hypothesis Three

Data screening was conducted on the predictor variable of professional learning attainment and the outcome variable of the number of neuromythic beliefs regarding data inconsistencies. The data was sorted for each variable and a visual scan was conducted for inconsistencies. No data inconsistencies were identified.

A Spearman correlation requires that the relationship between each pair of variables does not change direction (Conover & Iman, 1981). This assumption is violated if the points on the scatterplot between any pair of variables appear to shift from a positive to negative or negative to positive relationship. The assumption was met and allowed for the correlation to run with a 95% confidence level. See Figure 7 below.

Figure 7

$H_0$3 Scatter Plot for Assumption of Monotonic Relationship



A Spearman correlation analysis was conducted between elementary educators' self-reported professional learning attainment hours and the number of neuromythic beliefs. Since this study had four null hypotheses and ran multiple significance tests, the Bonferroni correction was used to limit Type I errors (Warner, 2013). The Bonferroni correction divides the alpha by the number of significance tests being performed (Warner, 2013) making the Bonferroni correction for each hypothesis at $\alpha = 0.05/4 = 0.0125$.

The correlation coefficient between professional learning and the number of neuromythic beliefs resulted in a negative weak effect (r_s = -.04). The results of the Spearman correlation test indicated no predictive relationship between the professional learning attainment and number of neuromythic beliefs of elementary educators. The results of the test, shown in Table 8 below, r_s (65) = -0.04, p = 0.781 at the 95% confidence level. This resulted in failing to reject the null hypothesis ($H_0$3) because the alpha was greater than .0125 and concluded there was not enough evidence to determine a relationship between elementary educators' professional learning attainment and neuromythic beliefs.

Table 8

$H_0$3 Spearman's rho Correlation between Professional Learning Attainment and Neuromythic Beliefs

	Variables	
Variables	Neuromyths	Learning Attainment
Neuromyths		
Correlation Coefficient	1	-.035
Sig. (2-tailed)		.781
N	67	67
Learning Attainment		
Correlation Coefficient	-.035	1
Sig. (2-tailed)	.781	
N	67	67

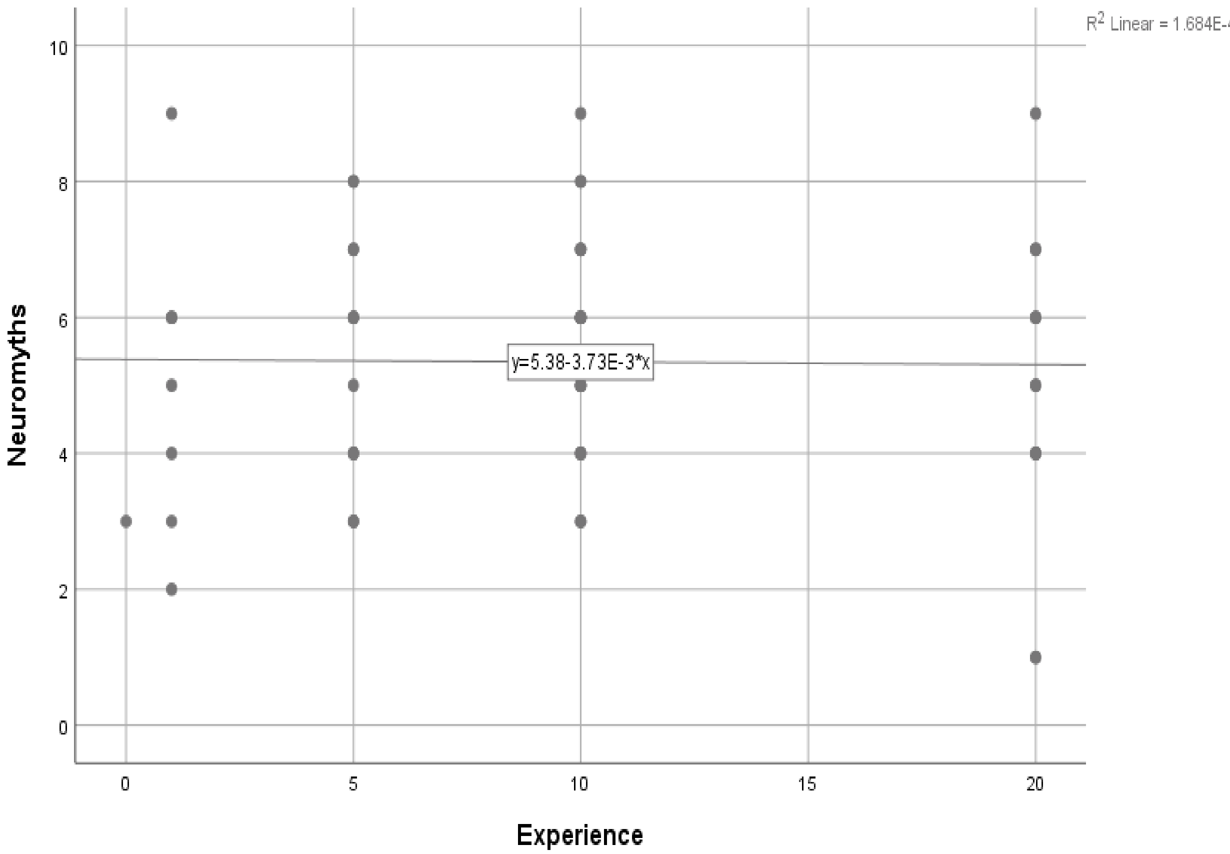
Null Hypothesis Four

Data screening was conducted on the predictor variable of professional learning attainment and the outcome variable of the number of neuromythic beliefs regarding data inconsistencies. The data was sorted for each variable and a visual scan was conducted for inconsistencies. No data inconsistencies were identified.

A Spearman correlation requires that the relationship between each pair of variables does not change direction (Conover & Iman, 1981). This assumption is violated if the points on the scatterplot between any pair of variables appear to shift from a positive to negative or negative to a positive relationship. The assumption was met and allowed for the correlation to run with a 95% confidence level. See Figure 8 below.

Figure 8

$H_0$4 Scatter Plot for Assumption of Monotonic Relationship



A Spearman correlation analysis was conducted between elementary educators' self-reported teaching experience and the number of neuromythic beliefs. Since this study had four null hypotheses and ran multiple significance tests, the Bonferroni correction was used to limit Type I errors (Warner, 2013). The Bonferroni correction divides the alpha by the number of significance tests being performed (Warner, 2013) making the Bonferroni correction for each hypothesis at $\alpha = 0.05/4 = 0.0125$.

The correlation coefficient between teaching experience and the number of neuromythic beliefs resulted in a positive weak effect (r_s = .04). The results of the Spearman correlation test indicated no predictive relationship between teaching experience and the number of neuromythic beliefs of elementary educators. The results of the test, shown in Table 9 below, r_s (65) = .04, p = .732 at the 95% confidence level. This resulted in failing to reject null hypothesis four ($H_0$4) because the alpha was greater than .0125 and concluded there was not enough evidence to determine a relationship between elementary educator's teaching experience and neuromythic beliefs.

Table 9

$H_0$4 Spearman's rho Correlation between Experience and Neuromythic Beliefs

	Variables	
Variables	Neuromyths	Experience
Neuromyths		
Correlation Coefficient	1	.043
Sig. (2-tailed)		.732
N	67	67
Experience		
Correlation Coefficient	.043	1
Sig. (2-tailed)	.732	
N	67	67

Summary

Chapter four explains the statistical results for the current study including the descriptive statistics to address the four null hypotheses. The purpose of this quantitative, correlational study was to determine if there was a relationship between the variables of self-efficacy beliefs, curiosity, learning attainment, years of experience, and the number of neuromythic beliefs. Pearson's *r* and Spearman's rho were used to generate a correlation coefficient to quantify the relationship between the predictor and criterion variables. Based on the results, the researcher failed to reject all four null hypotheses.

CHAPTER FIVE: CONCLUSIONS

Overview

This chapter provides a discussion of the study including the problem statement, a review of the methodology, and a summary of the results. Along with the discussion, this chapter will include implications, limitations, and recommendations for further research. The conclusions discussed will help add to the existing body of literature regarding rural elementary educators' beliefs about learning and the brain.

Discussion

The purpose of this quantitative, correlational study was to determine if there was a relationship between the predictor variables of self-efficacy beliefs, curiosity, learning attainment, years of experience and the criterion variable of the number of neuromythic beliefs among elementary educators. The target population included in-service elementary educators from one school district in south-central Missouri. The goal of this study was to address a gap in the literature concerning a lack of understanding if there is an association between different motivations to learn (self-efficacy or curiosity) or the learning experiences (professional learning and education experience) of elementary educators and their neuromythic beliefs. The predictor variables were measured by the GSE (self-efficacy total score), CEI-II (curiosity trait total score), and section three of the GKB (self-reported professional learning attainment and teaching experience). The criterion variable was measured using section one of the GKB (total number of neuromyths). Pearson's *r* coefficient was used to test the strength of the relationship between the scale variables (Warner, 2013) in null hypotheses one and two. Spearman's rho coefficient was used to test the strength of the relationship between the ordinal and scale variables in null hypotheses three and four.

Null Hypothesis One

The first research question in this study was "Is there a relationship between elementary educators' self-efficacy and the number of neuromythic beliefs in a rural south-central Missouri school district?" The first null hypothesis of this study stated there would be no statistically significant correlation between elementary educators' self-efficacy beliefs and their number of neuromythic beliefs. A correlational analysis was performed to test the first null hypothesis. The analysis indicated no predictive relationship between the total self-efficacy score and the number of neuromythic beliefs of elementary educators, $r(65) = -.07$, $p = .574$. Therefore, it was concluded this study did not collect evidence to reject the first null hypothesis.

This study was framed on the SCT. SCT describes learning as a result of personal cognitive, behavioral, and environmental factors to motivate and self-regulate future actions (Bandura, 2006). The current study tested for a relationship between the personal cognitive factor of self-efficacy and educators' neuromythic beliefs. Personal cognitive factors can have a causal effect on peoples' behaviors and beliefs (Bandura, 1989). Bandura (1989) referenced the possibility of misinterpreting situations in ways that lead to erroneous and incorrect beliefs due to cognitive bias.

The participants in this study were elementary educators. Like other studies, the elementary educators in this study rated themselves on the higher end ($M = 33$) of the self-efficacy scale (Catalano et al., 2019). Self-efficacy has not been studied in prior neuromythic studies, however; it is a predictor of self-directed learning, science content knowledge, and academic achievement. Self-efficacy has been found as a predictor in adult's participation in self-directed learning (Bath & Smith, 2009; Hammond & Feinstein, 2005). Self-efficacy can promote a learner's reflection on their beliefs, knowledge, and the exploration of new knowledge

(Sandlin et al., 2013). Self-efficacy influences learning (Vela et al., 2018). In theory, one could assume the more efficacious the educator, the more accurate knowledge of the brain and its role in learning. The results of this study did not provide evidence to support this theory. While self-efficacy is a predictor of self-directed learning, science content knowledge, and academic achievement, it was not found to be a predictor of neuromythic beliefs. The data analysis results in this study found no significant relationship between elementary educators' self-efficacy beliefs and their number of neuromythic beliefs.

Null Hypothesis Two

The second research question in this study was "Is there a relationship between elementary educators' curiosity and the number of neuromythic beliefs in a rural south-central Missouri school district?" The second null hypothesis of this study stated there would be no statistically significant correlation between elementary educators' curiosity trait score and the number of neuromythic beliefs. A correlational analysis was performed to test the second null hypothesis. The analysis indicated no predictive relationship between the total curiosity trait score and the number of neuromythic beliefs of elementary educators, $r(65) = -.06$, $p = .648$. Therefore, it was concluded this study did not collect evidence to reject the second null hypothesis.

This study was framed on the SCT. SCT describes learning as a result of personal cognitive, behavioral, and environmental factors to motivate and self-regulate future actions (Bandura, 2006). The current study tested for a relationship between the personal cognitive factor of curiosity and educators' neuromythic beliefs. Personal cognitive factors can have a causal effect on peoples' behaviors and beliefs (Bandura, 1989). Bandura (1989) referenced the possibility of misinterpreting situations in ways that lead to erroneous and incorrect beliefs such as neuromyths due to cognitive bias.

Highly curious individuals have increased learning experiences and improved information retention due to being engaged in their learning (Silvia, 2007). Individuals with high levels of trait curiosity have a desire to explore and discover opportunities to gain new information and learn new things (Hulme et al., 2013; Reio & Wiswell, 2000). The curiosity trait has been studied concerning its role in learning. Learning orientated people regard themselves as curious and interested in difficult tasks to develop their competencies (Harrison et al., 2011). In theory, one could assume the more curiosity an educator has, the more accurate knowledge of the brain, and its role in learning. While the curiosity trait has not been studied with neuromythic beliefs, many educators have expressed a high interest in the study of neuroscience (Betts et al., 2019; Macdonald et al., 2017). The results of this study do not provide evidence to support this theory. The data analysis results in this study found no significant relationship between elementary educators' curiosity and their number of neuromythic beliefs.

Null Hypothesis Three

The third research question in this study was "Is there a relationship between elementary educators' professional learning attainment and the number of neuromythic beliefs in a rural south-central Missouri school district?" The third null hypothesis of this study stated there would be no statistically significant correlation between elementary educators' learning attainment and the number of neuromythic beliefs. A correlational analysis was performed to test the third null hypothesis. The analysis indicated no predictive relationship between the self-reported learning attainment and the number of neuromythic beliefs of elementary educators, r_s

(65) = -0.04, *p* = .781. Therefore, it was concluded this study did not collect evidence to reject the third null hypothesis.

This study was framed on the SCT. SCT describes learning as a result of personal cognitive, behavioral, and environmental factors to motivate and self-regulate future actions (Bandura, 2006). The current study tested for a relationship between the behavior factor of professional learning and educators' neuromythic beliefs. Behavior factors can have a causal effect on peoples' beliefs (Bandura, 1989). People evaluate their actions and behaviors based on their beliefs, thoughts, and attitudes before completing the behavior (Bandura, 1989) such as professional learning.

Professional development associated with learning sciences is a predictor of awareness of neuromyths and general knowledge about the brain, and evidence-based practices (Betts et al., 2019). In theory, one could assume the more professional learning attainment an educator has the more accurate knowledge of the brain, and its role in learning. The results of this study do not provide evidence to support this theory. The current study was interested in discovering whether the amount of professional learning attainment had a relationship with the number of neuromythic beliefs. The data analysis results in this study found no significant relationship between elementary educators' learning attainment and their number of neuromythic beliefs.

Null Hypothesis Four

The last research question in this study was "Is there a relationship between elementary educators' teaching experience and the number of neuromythic beliefs in a rural south-central Missouri school district?" The last null hypothesis of this study stated there would be no statistically significant correlation between elementary educators' teaching experience and the number of neuromythic beliefs. A correlational analysis was performed to test the last null hypothesis. The analysis indicated no predictive relationship between the self-reported teaching experience and the number of neuromythic beliefs of elementary educators, r_s (65) = .04, p = .732. Therefore, it was concluded this study did not collect evidence to reject the last null hypothesis. The study results found no significant relationship between elementary educators' teaching experience and their number of neuromythic beliefs.

This study was framed on the SCT. SCT describes learning as a result of personal cognitive, behavioral, and environmental factors to motivate and self-regulate future actions (Bandura, 2006). The current study tested for a relationship between the behavior factor of teaching experience and educators' neuromythic beliefs. Behavior factors can have a causal effect on peoples' beliefs (Bandura, 1989). People evaluate their actions and behaviors based on their beliefs, thoughts, and attitudes before completing the behavior (Bandura, 1989) such as career persistence.

This result is similar to other studies involving teaching experience and its relationship to neuromythic beliefs. Previous studies (Betts et al., 2019; Ferrero et al., 2016; Gleichgerrcht et al., 2015) have examined years of experience and the number of neuromythic beliefs among educators. These studies did not find a significant relationship between the two variables. These studies focused on a wide range of educator roles and social contexts.

This variable was included in the current study to test the environmental and social context factor of the participants. The environment can influence what is learned by elementary educators. The environment can also pique curiosity when an educator feels deprived due to an information gap along with motivating them to acquire knowledge (Loewenstein, 1994). The learning outcomes of educators can be inherently related to the social context of the educators (Eraut, 2004), such as one school district. This study was focused solely on elementary educators from one specific environment, whereas the other studies looked at years of experience within multiple organizations. However, the results of this study did not find evidence to support the environment theory involving education experience and its relationship to the number of neuromythic beliefs.

Implications

Neuromythic beliefs have been established as prevalent among the general public and K-12 teachers. Ferrero et al. (2016) stated a better understanding of the educator would be useful in designing more effective interventions to tackle the issues of neuromythic beliefs. However, empirical data was lacking in individual learning differences of educators and neuromythic beliefs. The findings of this study aided in reducing the gap in the literature by offering research on elementary educators' personal cognitive and behavioral factors along with the number of neuromythic beliefs within one environment. This study was significant because educators must be mindful of their lack of knowledge to improve and to prevent spreading misconceptions to their students. Efficacious teachers might not be cognizant that they need to expand their science content knowledge (Catalano et al., 2019). Studies have found an association between curiosity and learning engagement (Eren & Coskun, 2016; Litman, 2010; Reio & Wiswell, 2000; Rotgans & Schmidt, 2014) including research on the role of science interest and the decision to participate in science learning (Ballantyne & Packer, 2009; Falk et al., 2007). The results of this research did not find supporting evidence that personal cognitive factors such as self-efficacy and curiosity have a predictive relationship with the number of neuromythic beliefs of elementary educators. With further research on the predictor variables in this study, researchers could eliminate the personal cognitive factors of self-efficacy and curiosity as predictors of neuromythic beliefs.

Also, according to Im et al. (2017), educators must make educated decisions about the implementation of new curricula and instructional practices, some of which are supported with an inaccurate appeal to neuroscience research. This study was important in that it provided added information to researchers and the field of education concerning behaviors of elementary educators such as professional learning attainment and teaching experience regarding beliefs in neuromyths. Ferrero et al., 2016 found that 96.1% of educators increased their professional learning about neuroeducation using sources such as web pages and blogs, books, or professional development courses. This study could be used to help educators protect themselves against the seductive details of high interest found in the neuromarketing of education publications. Betts et al. (2019) stated that understanding the pedagogical beliefs of educators, and their neuromythic beliefs are important in regards to improving professional development on advancements in neuroscience. This empirical data is important because it could provide researchers with another piece of information in understanding why neuromyths exist and provide guidance to overcome these misconceptions. This added information is practical because it could help educators protect valuable resources such as instructional and professional learning time along with the financial cost (Ferrero et al., 2016) of ineffective practices.

Limitations

This study met the minimum requirements to achieve satisfactory results. However, some limitations in terms of internal and external validity should be noted. This study included but was not limited to the following limitations.

The sample population in this study limited the generalization of the study results. This research was specific to elementary educators from one school district in Missouri. This limited the opportunity for participation recruitment from elementary educators from other rural and urban districts. The population demographic groups also varied in size. Increasing the number of participants would assist with increasing the range of self-efficacy ratings since most participants scored on the upper end of the self-efficacy scale.

The premise of this study concerning elementary educators from one geographic location also limited the generalization of the findings. The participants were from one rural school district which limited the diversity of participants' demographic information, such as age, gender, and ethnicity. It also limited the information from elementary teachers who teach in urban areas. Expanding the setting would help with the generalization of the results of this study. The correlation design of the research also had limitations. The researcher chose to study elementary educators as one group versus studying elementary educators in naturally occurring groups such as groups involving career roles, degrees earned, age, and gender. For example, Tsai and Huang (2018) found females' self-efficacy was a stronger predictor of proficiency in science versus males' self-efficacy. A comparative study using an analysis of variance could have helped differentiate the correlation coefficients, which produces a more robust quantitative analysis of the results.

Recommendations for Future Research

The following are recommendations for future research. First, the results were obtained from one school district located in rural south-central Missouri. Therefore, replicating this study in other rural school districts with similar cultural contexts is suggested to improve the generalization of the findings. Replicating the study in similar school districts would assist in increasing the sample size. Gall et al. (2007) specified that the statistical power of research rises automatically, the larger the sample size. It is further recommended to conduct the research to include urban and rural elementary educators. A large-scale study of elementary educators would allow for a better analysis, within and across settings.

Additionally, future research should involve a longitudinal comparative study of preservice elementary teachers who take or do not take neuroscience courses during teacher preparation programs. A study of this nature could provide information regarding neuroscience training and its effects on instructional practices in elementary classrooms. Longitudinal data could also provide information about elementary teachers' neuromythic beliefs and student achievement. This additional data could provide information about the effects of neuroscience training, especially during teacher preparation programs.

Finally, studying how elementary educators' neuromythic beliefs influence their teaching practice could add valuable insight into the importance of dispelling neuromythic beliefs. A research study of this nature would require observing, surveying, and interviewing teachers about their beliefs and practices. Quantifying instructional practices might be difficult; therefore, a qualitative study might provide additional insight into how neuromythic beliefs influence instructional practice. A quantitative research study could help fill the gaps in the literature concerning the associated costs of neuromythic beliefs in elementary education.

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Appendix A

Freie Universität Berlin

Fachbereich Erziehungs-
wissenschaft und Psychologie
- Gesundheitspsychologie -

Freie Universität Berlin, Gesundheitspsychologie (PF 10),
Habelschwerdter Allee 45, 14195 Berlin, Germany

Professor Dr. Ralf Schwarzer
Habelschwerdter Allee 45
14195 Berlin, Germany

Fax +49 30 838 55634
health@zedat.fu-berlin.de
www.fu-berlin.de/gesund

Permission granted

to use the General Self-Efficacy Scale for non-commercial reseach and development purposes. The scale may be shortened and/or modified to meet the particular requirements of the research context.

http://userpage.fu-berlin.de/~health/selfscal.htm

You may print an unlimited number of copies on paper for distribution to research participants. Or the scale may be used in online survey research if the user group is limited to certified users who enter the website with a password.

There is no permission to publish the scale in the Internet, or to print it in publications (except 1 sample item).

The source needs to be cited, the URL mentioned above as well as the book publication:

Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston, *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp.35-37). Windsor, UK: NFER-NELSON.

Professor Dr. Ralf Schwarzer
www.ralfschwarzer.de

Appendix B

[redacted]

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

Angela,

Thank you for your email. We are happy to provide you with permission to use the survey instruments for your study. The only thing that we would ask is that you cite our study in your research.

We wish you the best with your study!

Sincerely,

Kristen Betts

PA

[redacted]

International Report: Neuromyths and Evidence-Based Practices in Higher Education

Hello Dr. Betts,

My name is Angela Posey and I am a doctoral student at Liberty University in Virginia. I am investigating elementary educators' self-efficacy and its relationship to the beliefs of neuromyths. I am in search of a valid and reliable instrument to measure elementary educator's number of neuromyth beliefs. I read your report and was in hopes of gaining permission to use your survey with proper citing. I have seen the items on your survey in multiple studies and feel this survey would be appropriate for elementary educators. Let me know your thoughts!

Thank you for your consideration,

Angela RaNae Posey

Appendix C

October 3, 2020

Dr. [redacted]
Superintendent
[redacted]

Dear [redacted]

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree. The title of my research project is The Brain and Its Role in Learning and the purpose of my research is gain knowledge on elementary educators' personal characteristics in relation to knowledge about the brain.

I am writing to request your permission to conduct my research at [redacted] and [redacted]

Participants will be asked to go to this link and complete the attached survey. Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time. Participants will be given the option to provide their email address to be entered into a drawing for a cash prize of $50 along with the researcher donating $5 to the United Way for each participant.

Thank you for considering my request. If you choose to grant permission, respond by email to [redacted]. A permission letter document is attached for your convenience.

Sincerely,

Angela RaNae Posey
Doctoral Candidate, LU

[redacted]rg>
Mon 10/5/2020 5:02 PM

To: Posey, Angela

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

Angela RaNae Posey
Doctoral Candidate
Liberty University

Dear Angela RaNae Posey:

After careful review of your research proposal entitled The Brain and Its Role in Learning, I have decided to grant you permission to contact our faculty and invite them to participate in your study. Please keep the school district and participants anonymous.

Highlight the following statement, as applicable:

I am requesting a copy of the results upon study completion and/or publication.

Sincerely,

[redacted]

Appendix D

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

November 6, 2020

Angela Posey
Rebecca Lunde

Re: IRB Exemption - IRB-FY20-21-239 The Brain and Its Role in Learning

Dear Angela Posey, Rebecca Lunde:

The Liberty University Institutional Review Board (IRB) has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under the following exemption category, which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

Category 2.(i). Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording).
The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects.

Your stamped consent form can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. This form should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document should be made available without alteration.

Please note that this exemption only applies to your current research application, and any modifications to your protocol must be reported to the Liberty University IRB for verification of continued exemption status. You may report these changes by completing a modification submission through your Cayuse IRB account.

If you have any questions about this exemption or need assistance in determining whether possible modifications to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,
G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

Appendix E

Email letter to participants

Dear

As a student in the School of Education at Liberty University, I am conducting research as part of the requirements for a doctoral degree. The purpose of my research is to gain a better understanding of educators' beliefs about the brain and its role in learning, and I am writing to invite eligible participants to join my study.

Participants must be in-service educators who are 18 years of age or older and have a current Missouri teaching certificate. Participants, if willing, will be asked to complete a survey including self-rating levels of self-efficacy and curiosity, along with answering multiple choice items about learning and the brain. It should take approximately 22 minutes to complete the procedures listed. Participation will be completely anonymous, and no personal, identifying information will be collected. Participants will be given the option to provide their email address to be entered into a drawing for a cash prize of $50 along with the researcher donating $5 to the United Way for each participant. Email addresses will be requested for compensation purposes; however, they will be pulled and separated from your responses to maintain your anonymity.

In order to participate, please click here to access the online survey. Please contact me at aposey4@liberty.edu for more information.

A consent document is provided as the first page of the survey. The consent document contains additional information about my research. After you have read the consent form, please click the "I agree" button to proceed to the survey. Doing so will indicate that you have read the consent information and would like to take part in the survey.

Sincerely,

Angela RaNae Posey
Doctoral Candidate
aposey4@liberty.edu

Appendix F

Consent Form

Title of the Project: The Brain and Its Role in Learning
Principal Investigator: Angela RaNae Posey, Doctoral Candidate, Liberty University

Invitation to be Part of a Research Study

You are invited to participate in a research study. In order to participate, you must be an in-service educator who is 18 years of age or older, currently working in an elementary setting, and have a current Missouri educator certificate. Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to take part in this research project.

What is the study about and why is it being done?

The purpose of this study is to examine the relationship between self-efficacy, curiosity, professional learning, and experience to the number neuromythic beliefs of elementary educators. Demographics and job-related factors include: gender, age, ethnicity, level of education, credentials, experience, and interest in the role of the brain in learning. I am interested in answering the following questions: Is there a relationship between elementary educators' self-efficacy and the number of neuromythic beliefs in a rural south-central Missouri school district?, Is there a relationship between elementary educators' curiosity and the number of neuromythic beliefs in a rural south-central Missouri school district?, Is there a relationship between elementary educators' professional learning attainment and the number of neuromythic beliefs in a rural south-central Missouri school district?, and Is there a relationship between elementary educators' teaching experience and the number of neuromythic beliefs in a rural south-central Missouri school district?

What will happen if you take part in this study?

If you agree to be in this study, I would ask you to do the following things:

1. Complete the 86-item questionnaire, consisting of 10 curiosity, 10 efficacy, 53 brain and learning, and 13 demographic and job-related questions. No questions are asked that require you to give confidential or identifying information. Completion of the questionnaire in its entirety is expected to take only 20-25 minutes.

How could you or others benefit from this study?

Participants should not expect to receive a direct benefit from taking part in this study. Benefits to society include providing added information to researchers and the field of education concerning the relationship of self-efficacy, curiosity, and background information such as professional learning attainment and teaching experience regarding educators' beliefs. This information could help protect valuable resources such as learning and instructional time along with protecting against purchasing misleading or inaccurate curricula or professional development.

What risks might you experience from being in this study?

The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Liberty University
IRB-FY20-21-239
Approved on 11-6-2020

How will personal information be protected?

The records of this study will be kept private. Research records will be stored securely, and only the researcher and dissertation chair will have access to the records.

- Participant responses will be anonymous.
- Data will be stored on a password-locked computer and may be used in future presentations. After three years, all electronic records will be deleted.

How will you be compensated for being part of the study?

Participants will be given the option to provide their email address to be entered into a drawing for a cash prize of $50 along with the researcher donating $5 to the United Way for each participant. The $50 cash prize drawing and donation will be presented at the conclusion of the study at a faculty meeting of the Principal's choice. Email addresses will be requested for compensation purposes; however, they will be pulled and separated from your responses to maintain your anonymity.

Does the researcher have any conflicts of interest?

The researcher serves as supervisor at [redacted]t. To limit potential or perceived conflicts the study will be an[redacted]ill not be able to link responses to individuals. This disclosure is made so that you can decide if this relationship will affect your willingness to participate in this study. No action will be taken against an individual based on his or her decision to participate in this study.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty University [redacted]rict. If you decide to participate, you are free to not answer any question or withdraw at any time prior to submitting the survey.

What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please exit the survey and close your internet browser. Your responses will not be recorded or included in the study.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Angela RaNae Posey. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at aposey4@liberty.edu. You may also contact the researcher's faculty sponsor, Dr. Rebecca Lunde, at [redacted]

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA 24515 or email at irb@liberty.edu

Your Consent

Before agreeing to be part of the research, please be sure that you understand what the study is about. You can print a copy of the document for your records. If you have any questions about the study later, you can contact the researcher using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

If you give consent to participation, please select the "I agree" button to continue.