COGNITIVE CONFLICT LEVELS BETWEEN MIDDLE SCHOOL STUDENTS WITH LEARNING DISABILITIES AND STUDENTS WITHOUT LEARNING DISABILITIES

by

Stephanie Elizabeth Randall

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

Liberty University

2022

COGNITIVE CONFLICT LEVELS BETWEEN MIDDLE SCHOOL STUDENTS WITH LEARNING DISABILITIES AND STUDENTS WITHOUT LEARNING DISABILITIES

Stephanie Elizabeth Randall

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

Liberty University, Lynchburg, VA

2022

APPROVED BY:

Dr. Angela Ford, Committee Chair

Dr. Jeffrey Savage, Committee Member

ABSTRACT

The purpose of this quantitative, causal comparative study was to measure differences in the level of cognitive conflict among middle school science students utilizing independent *t*-tests. This study supports increasing knowledge for middle school science educators and potentially contributes to improved curriculum design and delivery. This quantitative study examined levels of cognitive conflict within a sample size of 28 middle school science students with learning disabilities, with an individual education plan (IEP) or a 504 Plan, compared to a sample size of 28 students without learning disabilities, without an IEP or 504 Plan. This study related social cognitive learning among middle school science students with regard to varying levels of cognitive conflict. Middle school science students were separated into two groups, students with learning disabilities (have an IEP or 504 Plan) and students without learning disabilities (do not have an IEP or 504 Plan), to compare differences in cognitive conflict scores among four subsets of cognitive conflict, recognition of a contradiction, interest, anxiety, and cognitive reappraisal. Data used for analysis was obtained from 56 upstate New York middle public school science students using the Cognitive Conflict Levels Test (CCLT) research instrument. Expected results will demonstrate a difference or no difference in cognitive conflict levels between middle school students with learning disabilities and middle school science students without learning disabilities. Further study should include the impact of social conflict, value of self-efficacy, motivational conflict, interest conflict, and relevance conflict among students with learning disabilities compared to students without learning disabilities.

Keywords: cognitive conflict, Individual Education Plan, learning disabilities, Science Technology Engineering and Math, social cognitive theory

Dedication

First and foremost, this work is dedicated to my Creator and Lord of my life, Jesus Christ, for providing the perseverance, guidance, and strength beyond myself necessary to complete this journey. All glory goes to God alone, for only through the Holy Spirit was it possible for me to accomplish a feat such as this. This work is also dedicated in memory of my maternal grandmother, Dorothy Montross, and paternal grandfather, George Janke, for modeling and teaching me how to have grit. I also dedicate this work to my second-grade teacher, Miss Breeze, whose tenderness, encouragements, and loving, uplifting spirit endowed me with a sense of value when I needed it most.

Secondly, this dissertation is dedicated to all those late bloomers, like me, who dare to dream and then muster up the gumption to put those dreams into actionable, productive energy.

Acknowledgments

My journey of completing this doctoral degree was inspired and fueled by a multitude of Liberty University professors, teaching colleagues, friends, and family members. My deepest appreciation is given to my dissertation chair, Dr. Angela Ford, whose prayers, patience, productive feedback, and encouragement always fed me at the right moment, thank you. With deepest gratitude, I thank Dr. Jeffrey Savage, my committee member, for his quick responses, in-depth reviews, constructive feedback, and insider info on new formatting, thank you. Thank you Dr. Michelle Jones Barthlow for your tireless guidance and coursework instructions at Liberty University, and especially for introducing me to Dr. Ford and encouraging her to take me on.

Special acknowledgements go to Dr. Cori Van Buren, one of my Liberty University professors, who inspired me toward creative writing. It was pure joy to have you as a professor. What a wonderful role model you are!

To my teaching colleagues and church family, thank you for your countless prayers, God heard you, divine intervention occurred, and this finished work resulted. This endeavor would not have been possible without my prayer warriors feeding inspiration into my heart and soul.

To my family, son Seth, daughter in law Janis, and granddaughter Jillian, you are the balance in my life and have been dearly missed as I worked evenings, weekends, and holidays to complete this longer than expected doctoral journey. I am forever indebted and profoundly grateful. I rejoice in anticipation of reconnecting. And I would be remiss if I did not acknowledge my constant four-legged companions who have spent many, many hours in my office, under my desk (or walking across it), as I worked, and they listened.

I am so blessed, so grateful, so amazed, that God would choose me to serve others, through His Holy Spirit. *Soli Deo Gloria*

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Cognitive Conflict Levels Test (CCLT)

Individuals with Disabilities Act (IDEA)

Individualized Education Plan (IEP)

Institutional Review Board (IRB)

Learning Disabilities (LD)

Multiple Intelligences (MI)

National Academy of Engineering (NAE)

National Research Council (NRC)

National Science Foundation (NSF)

Nature of Science (NOS)

Problem Based Learning (PBL)

Science, Technology, Engineering, and Mathematics (STEM)

Science, Technology, Engineering, and Mathematics Integration (iSTEM)

Science-Technology-Society (STS)

Science Writing Heuristic (SWH)

Students with Learning Disabilities (SWLD)

Universal Design for Learning (UDL)

CHAPTER ONE: INTRODUCTION

Overview

The purpose of this study was to discover if there is a difference of cognitive conflict in middle school science students with learning disabilities and middle school science students without learning disabilities. The objective of this study was to provide information that would contribute to middle school science curriculum development. Middle school science curriculum designed to identify and teach through cognitive conflict may improve middle school students' interest in science. Chapter One provides a background for the topics of cognitive conflict toward learning science and the endeavors to reverse the limited interest in science, technology, engineering, and mathematical (STEM) academics. Included in the background is an overview of the theoretical framework for this study. The problem statement examines the scope of recent literature on this topic. The purpose of this study is followed by the significance of the current study included in the following discourse. Definitions of applicable terms are provided, and the research questions are introduced.

Background

The developing minds of middle school science students can promote misperceptions, misunderstandings, and prior incorrect beliefs about scientific principles that contribute to cognitive conflict among students with learning disabilities (SWLD) and students without learning disabilities (LD). The interconnected chain of events that have resulted in a demand for highly-trained and effective technicians, scientists, engineers, and mathematicians began with the development of the age of technological advances. Twenty-first century science curriculum begins in elementary school and progressively expands in the middle school years to prepare students for high school science with the intention of filling the call toward STEM careers

(Alemdar et al., 2018; Badri, 2019; Bircan & Sungur, 2016; Ellerbrock et al., 2018; Winarti et al., 2019). Middle school science students learning may be compromised by cognitive conflict that interferes with the synergistic academic sequence of instruction attempting to increase an interest in pursuing the study of STEM courses (Aligaen & Capaciete, 2016; Horsley & Moeed, 2018; Schulze & van Heerden, 2015; Yang, 2016).

Historical Overview

Education in elementary and middle school has focused on the basics of learning to read, write, and solve age-appropriate mathematical problems before the introduction of technology into the daily part of most students' lives, shifting focus, shifting conflicts (Alverson et al., 2019; Hacieminoglu, 2016; Kalatskaya et al., 2016; Labonte & Smith, 2019). Many different psychological and learning theories include cognitive conflict within their foundational substrates. Notwithstanding shifting of importance among many theories, the Piagetian discussion of development of cognitive conflict, as an internal experience of opposing contradictions, was considered the central concept of cognitive development (Lee et al., 2003). Piaget further expanded discussion into an equilibrium model that supported self-regulation (Lee et al., 2003; Schunk, 2016).

Historically, Piaget's theory states that when a child is in disequlibrium (cognitive conflict), the child is motivated to attempt to resolve the conflict and maintain equilibrium. Piaget referred to equilibrium as the process of self-regulation to maintain a balance between "assimilation" and "accommodation" (Lee et al., 2003; Schunk, 2016). Application of learning theories has improved educational practices; however, graduation rates and students choosing careers in STEM are not yet at a level that can support a technological future (Ascione, 2020;

Bao et al, 2013; US Department of Educatio, n. d.; National Center for Education Statistics, 2019).

In 1940 less than 10% of high school graduates attended college and 50 years later, in 1990, less than 30% attended college (Snyder, 1993). In 2016, comparatively, 70% of high school graduates began college (Thompson, 2018), however, only 20% of those going to college chose a STEM major (National Center for Education Statistics, 2019). Approximately one-third of STEM majors changed their major to a field outside of STEM, furthering the decline in trained scientists, engineers, and mathematicians (National Center for Education Statistics, 2019). Society's needs have shifted toward technologically literate populations that can supply the demand for an increase in scientists, computer specialists, programmers, engineers, and mathematicians (Cook & Artino, 2016; Thoutenhoofd & Pirrie, 2015; Urbani et al., 2017). Efforts to increase interest in STEM from middle school into high school continue to challenge educators to provide viable graduates choosing a career in the sciences that could benefit society locally, nationally, and globally (Ellerbrock et al., 2018; Karacam, 2016; Saw et al., 2019). Today's middle school science students experience different stressors and cognitive conflicts than middle school science students of 25 years ago (Aligaen & Capaciete, 2016; Yang, 2016).

Society at Large

The demands of societal advances in the 21st century have influenced what scientific knowledge students need to acquire. The methodology of curricula delivery for today's students influences knowledge acquisition in middle school and high school science classes within the context of how learning occurs (Akcay & Akcay, 2015; Alismail & McGuire, 2015; Booth et al., 2018; Cook & Artino, 2016; Schulze & van Heerden, 2015; Wallace & Bodzin, 2017; Yang, 2016). Identifying cognitive conflict that may deter early interest in science learning could provide insight, improving curriculum lesson methods toward the desired outcome of increasing interest in STEM courses and ultimately STEM careers (Bircan & Sungur, 2016; Khalil & Elkhider, 2015; Saw et al., 2019). Middle school science students with high levels of cognitive conflict tend to hold a negative attitude toward science and perceive learning science as a futile effort based on beliefs that science content material is too difficult to learn (Akcay & Akcay, 2015; Aligaen & Capaciete, 2016; Hacieminoglu, 2016, Lee, 2017; Tatar et al., 2016; Wallace & Bodzin, 2017; Yang, 2016; Yüksel & Geban, 2016). Global economies are increasing the demand for well-trained and educated scientists, engineers, and mathematicians, however, these demands are going unanswered as middle school students become discouraged to pursue science studies and do not complete a STEM major in college (Schulz & van Heerden, 2015; Smith & Darvas, 2017).

Theoretical Background

Engaging middle school science students through the context of social cognitive theory and providing an educational environment that stimulates an increased interest in science could provide a foundation for curriculum that supports an outcome toward STEM achievement (Lotter et al., 2018; Taylor, 2016). Albert Bandura expanded learning and performance behaviors into social cognitive theory (Bandura, 1986; Schunk, 2016). Social cognitive theory inolves self-regulation which motivates and regulates behavior from internal standards and self-evaulated reactions to personal actions (Bandura, 1986; Schunk, 2016). Studies based upon social cognitive theory have shown the importance of providing a conceptual framework for learning, modeling processes, and the instructional applications of these concepts to grasping academic concepts (Cook et al., 2016; Morris et al., 2017; Schunk, 2016; Thoutenhoofd & Pirrie, 2015). Bandura’s (1977, 1986) research found that a person could learn new actions by observing others performing the actions (Bandura & Walters, 1963; Schunk, 2016). These findings were in dispute of the central assumptions of conditioning theories. Bandura's (1986) social cognitive theory focuses on the idea that learning takes place in social environments through observing others (Schunk, 2016).

Middle school science students that develop self-efficacy, self-regulation, academic motivation, and acquire a sense of relevance of science content, could minimize cognitive conflict and create an increased interest in learning science to achieve improved academic outcomes (Booth et al., 2018; Cook et al., 2016; Dorrenbacher & Perels, 2015; du Tolt-Brits, 2019; Knight, 2017; Schunk, 2016; Thoutenhoofd & Pirrie, 2015). Social cognitive theory provides the basis of understanding how cognitive skill learning, through observational modeling, expands the learning process and will guide this study's research questions toward collecting effective data (Schunk, 2016). Use of the Cognitive Conflict Levels Test (CCLT) instrument in this study will measure cognitive conflict levels between two groups of science students in a middle school setting, students with learning disabilities with an Independent Educational Plan (IEP) or 504 Plan and students without learning disabilities who do not have an IEP or 504 Plan.

Problem Statement

Scholarly studies regarding conflicts in learning are limited in the area of cognitive conflict of middle school science students (Booth et al., 2018; Cook & Artino, 2016; Dorrenbacher & Perels, 2015; Hacieminoglu, 2016; Morris et al., 2017; Thoutenhoofd & Pirrie, 2015). Middle school students influenced by cognitive conflict can become uninterested in learning science and perceive science as too challenging to understand (Cook & Artino, 2016; Khalil & Elkhider, 2016; Lee, 2017; Panadero, 2017; Schulze & van Heerden, 2015;

Thoutenhoofd & Pirrie, 2015). Studying how to increase interest in learning science for middle school students is an important element to finding solutions toward the challenges of 21st-century living, careers and relating to STEM globally (Alemdar et al., 2018; Aligaen & Capaciete, 2016; National Center for Education Statistics, 2019; Urbani et al., 2017).

Research to understand levels of cognitive conflict in learning science have been generalized to a broad band of educational levels (Bao et al., 2013; Lee, 2017; Permatasari & Suyono, 2016). Research literature is limited in the area of cognitive conflict studies for middle school science students. Permatasari and Suyono (2016) studied the level of cognitive conflict among chemistry college students. Research by Bao et al. (2013) focused on how cognitive conflict could impact anxiety as well as learning STEM materials. The Bao et al. (2013) study informed educators on how to identify the existance and features of cognitive conflict. However, there is evidence for interest in understanding why students experience cognitive conflict and how to improve interest in learning science (Alemdar et al., 2018; Badri, 2019; Bircan & Sungur, 2016; Ellerbrock et al., 2018; Permatasari & Suyono, 2016). The problem is that the literature has not fully addressed how to mitigate the lack of interest in learning science and has not provided adequate studies to determine the level of cognitive conflict among middle school students, which may have an effect on future science content comprehension, minimizing an interest in science courses.

Purpose Statement

The purpose of this quantitative, causal comparative study is to measure the level of cognitive conflict among middle school science students. The independent variable is the type of student. There are two groups of students in this study, middle school students with learning disabilities (SWLD) and middle school students without learning disabilities (LD). Students with learning disabilities are provided specific accommodations in their learning through an established Independent Education Plan (IEP) or 504 Plan with curriculum designed to meet the diverse needs of each individual student, (Mahoney, 2020). Students without learning disabilities do not receive specialized learning accommodations and receive curriculum and teaching methodologies holistically, irrespective of students' learning skills (Mahoney, 2020). The dependent variable is the level of cognitive conflict. Cognitive conflict is the internal experience of rival contradictions that create mental uneasiness, produced when a person receives new information that is not in alignment with prior beliefs or ideas (Lee et al., 2003; Schunk, 2016). Middle school science students' cognitive conflict was measured in an inclusion classroom that integrates SWLD and students without LD. Controls were established for grade level and socioeconomic status within a questionnaire, preceding the CCLT test items. Socioeconomic status was determined through whether or not a student takes part in the free breakfast/lunch program. The CCLT instrument (Lee et al., 2003) measured the dependent variable, cognitive conflict.

Significance of the Study

This study has significance regarding the issue of student cognitive conflict in learning science at middle school levels (Deksissa et al., 2014; Lee et al., 2003). Cognitive conflicts inhibit science students' ability to problem solve with an approach to manage perceptions about learning science (Aligaen & Capaciete, 2016; Booth et al., 2018; Libao et al., 2016; Schulze & van Heerden, 2015; Smith & Darvas, 2017). Analyzed data from this study will validate that cognitive conflict is present in the participating middle school science classes and potentially contribute to science instructional strategies to minimize misconceptions and correct students' prior incorrect science concept beliefs within the participating school district (Cook et al., 2016;

Lee et al., 2003). The researcher and participating educators involved with this study will gain experiential knowledge of identifying cognitive conflict levels and be able to consider addressing learning challenges for future curriculum development within the participating school district.

Development of cognitive skills through curriculum design creates foundational thinking, opportunities to address cognitive conflict, and shifting incorrect scientific preconceived ideas toward correct scientific knowledge. Addressing cognitive conflict levels could improve upon the learning process of science concepts (Akcay & Akcay, 2015; Akpan & Beard, 2016; Bao et al., 2013; Kalatskaya et al., 2016; Kang et al., 2004; Khalil & Elkhider, 2016; Knight, 2017). Social cognitive theory posits that learning occurs through observational activities to acquire additional or new behaviors and knowledge (Bandura, 1986; Cook & Artino, 2016; du Toit-Brits, 2019; Khalil & Elkhider, 2016; Lotter et al., 2018; Thoutenhoofd & Pirrie, 2015).

Studying the collected data of students’ responses to the CCLT and participation in this study may provide new perspectives on how to increase interest in science learning for middle school science students (Cook et al., 2016; Lee et al., 2003). The study sample population was taken from an inner city, Title I school, in upstate New York, and the results could present alternative strategies to improve science-learning outcomes among the science educators in the participating school district. Changing learning concepts are formulated on the significant factors of prior knowledge and levels of cognitive conflict. Identifying cognitive conflict levels provides direction to develop conceptual changes through instructional practices (Bircan & Sungur, 2016; Cook & Artino, 2016; Horsley & Moeed, 2018; Kang et al., 2004; Kim & Bao, 2008; Zohar & Aharon-Kravetsky, 2005).

Akcay and Akcay (2015) investigated the impact of improving scientific literacy among learners by comparing traditional teaching methods with science-technology-society (STS) instruction. Results demonstrated that teachers utilizing the non-traditional instruction increased scientific understanding, science interest, and improved students' attitudes about science. Teachers with an informed understanding of the nature of science (NOS) and the skill to apply non-traditional instruction, through application of STS instruction, were able to stimulate a greater interest and improve academic outcomes. The Akcay and Akcay (2015) study centered the STS instruction on how students interpret information cognitively, along with relating the relevance of social significance. Student perceptions and beliefs responded more favorably with STS instruction than with the traditional instruction utilizing textbooks, worksheets, and lectures (Akcay & Akcay, 2015). This study on identifying levels of cognitive conflict could contribute and support non-traditional science instruction, through the confirmation of the presence of cognitive conflict among the participating middle school science students.

Alismail and McGuire (2015) investigated the importance of best practices to prepare learners for the challenges of 21st century standards and curriculum delivery. Developing curriculum that promotes educational goals and teaching methods to prepare students for college and future careers in today's 21st century technological society has become a priority among STEM educators (Alismail & McGuire, 2015; Ascione, 2020). Identification of cognitive conflict levels among SWLD and students without LD could provide guidance for design and delivery of science instruction founded on the current Common Core State Standards in New York State as well as state assessment preparation.

Schulze and van Heerden (2015) studied strategies to increase student motivation to learn science concepts. Results demonstrated a significant influence on improving student motivation to learn science was generated by the science teachers' ability to promote science literacy and create a learning environment that inspires and supports learners' motivation toward improvement of academic achievement (Schulze & van Heerden, 2015). Knowledge of learners' cognitive conflict levels may contribute to designing curricula that encourages science literacy and enhance the overall learning environment of science classrooms.

Cognitive engagement and the role of motivation in science achievement was studied by Bircan and Sungur (2016). The centralized themes for science achievement in the Bircan and Sungur (2016) study focused on Bandura's (1993) self-efficacy construct in learning and cognitive engagement of comprehension, skill mastery, and processing strategies for learning. Results showed affirmative and significant correlations amid self-efficacy, how learners valued tasks, and cognitive engagement (Bircan & Sungur, 2016). Science educators with knowledge of cognitive conflict levels may become more informed of how to design best practices to increase self-efficacy, improve learners' sense of task-values, and encourage cognitive engagement (Bircan & Sungur, 2016).

Kalatskaya et al. (2016) studied how to identify and test pedagogical strategies to facilitate students' skills to acquire personal meaning with the process of learning through forming individualized subjectivity. Results demonstrated that creative and innovative instruction, which stimulates learning cognition through personal and social goals, promotes a sense of personal learning, in turn bringing value to educational professionals in pursuit of improving effective educational strategies (Kalatskaya et al., 2016). Science educators that consider cognitive conflict levels, when planning educational strategies, may generate more effective curricula when designing creative and innovative instruction.

The significance of this study, in conjunction with the findings of previous studies on how to improve learning, offers a specialized perspective regarding the presence of cognitive conflict levels among middle school science students. Global, national, and local efforts to improve upon STEM education begin in the classroom (Ascione, 2020; Autieri et al., 2016; Bao et al., 2013; Hallinen, 2015; Schrik & Wasonga, 2019). Identifying the presence of cognitive conflict in middle school science classrooms provides valuable information to science administrators, educators, and curriculum coordinators. Educating the educators on students' science misconceptions and incorrect prior beliefs of science concepts provides knowledge that could improve science education strategies for the participating school district. Coordination of science curricula between high school, middle school, and elementary school educators endorses possibilities to minimize established misconceptions and incorrect scientific beliefs, potentially improving students' interest in STEM academics and careers (Deksissa et al., 2014; Hacieminoglu, 2016; Khalil & Elkhider, 2016; Knight, 2017; Libao et al., 2016; Taylor, 2016; Yang, 2016; Zohar & Aharon-Kravetsky, 2005).

Research Questions

RQ1: Is there a difference in the *recognizing a contradiction* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ2: Is there a difference in the *interest* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ3: Is there a difference in the *anxiety* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ4: Is there a difference in the *cognitive reappraisal* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ5: Is there a difference in the overall or cumulative *cognitive conflict* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

Definitions

1. *Cognitive conflict* – An event that occurs that produces a disturbance in a child's cognitive structures such that the child's beliefs do not match the observed reality (Schunk, 2016, p. 306).
2. *Cognitive Conflict Levels Test* – An instrument validated as a reliable tool to measure cognitive conflict levels consisting of four constructs: recognition of an anomalous situation, interest, anxiety, and cognitive reappraisal of the conflict situation (Lee et al., 2003, p. 585).
3. *504 Plan* – An educational plan authorized by Section 504 of the Rehabilitation Act of 1973 that is a yearly, school specific accommodation plan created between a family and a school for a student with a diagnosed disability, providing accommodations in the general education setting (NYSED Office of Special Education, 2020).
4. *Independent t-Test* – A parametric procedure assessing whether the means of two independent groups are statistically different from one another, appropriate when comparing the means of two independent groups (Rovai et al., 2013, p. 478).
5. *Individualized Education Plan* –A tool that confirms a student with a disability will have access to the general education curriculum, and to be provided the appropriate learning

opportunities, accommodations, adaptations, specialized services and supports needed for the student to progress towards achieving the learning standards for each class, and to meet his or her unique needs related to the designated disability (NYSED Office of Special Education, 2020).

6. *Learning Disabilities* – A disorder in one or more basic psychological processes that may manifest as an insufficient ability in specified areas of learning, such as reading, written expression, or mathematics (Learning Disability Association of America, 2012).
7. *Science, Technology, Engineering, and Mathematics* – An interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts that make connections with school, community, work, and global enterprise enabling the development of STEM literacy and the ability to compete in the new global economy (Gerlach, 2012).
8. *Social Cognitive Theory* – Cognitive theory that emphasizes the role of the social environment in learning (Schunk, 2016, p. 498).

CHAPTER TWO: LITERATURE REVIEW

Overview

The purpose of this literature review was to investigate the issue of cognitive conflict surrounding learning science within the social environment of a science classroom among students with learning disabilities and students without learning disabilities. The chapter begins with the theoretical framework of the context of cognition and social interactions and elements of social learning theory and social cognitive theory. This study is based on Bandura's (1989b) social cognitive theory, advancing a model of causation connecting triadic reciprocal determinism. Additionally, science, technology, engineering, and mathematical (STEM) instructional elements and teaching students with learning disabilities (SWLD) factor into the foundation to this study. A thorough review of the literature relevant to cognitive conflict and promoting STEM instruction completes the chapter that concludes with a summary.

Theoretical Framework

This research study's theoretical framework was guided by Albert Bandura's social cognitive theory (Bandura, 1986, 1993, 1999). Bandura developed social cognitive theory over time from social learning and personality development theory (Bandura & Walters, 1963), later refined to social learning theory in 1977 (Bandura, 1977b). These theories were advanced from studies that supported tenets of learning beyond behavioral aspects and showed learning taking place within a social context (Bandura, 1977b, 1986, 1993; Bandura & Walters, 1963). A three-way explanation of human actions, which interlinks personal factors, environmental influences, and behavior, all interacting on a continual basis, became the frame of Bandura's (1986) reciprocal model in social cognitive theory.

Social Learning Theory

Observing and modeling the behaviors, attitudes, and emotional reactions of others became the emphasis in social learning theory (Bandura & Walters, 1963). Human behavior was explained through social learning theory in terms of a continual reciprocal collaboration between cognitive, behavioral, and environmental effects. A person forms ideas of how to execute new behaviors, which serves as a guide in future actions, from learning observationally through modeling (Bandura, 1977b). Bandura (1977b) agreed with the behaviorist learning theories of that time and added two significant concepts. Bandura (1977b) developed the concept that the processes of mediating occurred between a stimulus and a response. The second concept added to the previous behaviorist learning theories promoting the idea that behavior is learned interacting with the surrounding environment through processes of observational learning (Bandura, 1977b).

Mediational Processes

Social learning theory reflects as a connector between what was traditional learning theory, behaviorism, and a cognitive methodology, focusing on how cognitive factors encompass learning. Bandura (1977b) refers to humans as active processors of information relating ones' personal relationship between behavior and its consequences. Cognitive processes are a vital function of observational learning and cognitive factors intervene (mediate) through a learning progression to evaluate whether a novel response is attained (Bandura 1977b). Bandura (1977b) believed that there was prior thought before an individual could imitate observed modeling. The behaviorist model only studies what is observable (stimulus in environment), such as external behavior (response behavior). The cognitive model scientifically studies internal behavior with respect to input from the environment, the following mental event (mediational processes), and the output behavior. The four mediational processes developed by Bandura (1977b) are attention, retention, reproduction, and motivation, which lead into observational learning.

Observational Learning

Observational learning occurs from the component processes of attention, retention, motor reproduction, and motivation. Bandura's (1977b) social learning theory derived each of these four principal components. The attention component describes modeled events as distinctively observing, utilizing functional values, enacting an affective emotional valence, complexity of focus, and prevalence to attention (Bandura, 1977b). Certain forms of modeling producing intrinsic rewards and the attention given to the observation of the modeling continue for an extended period. Technology illustrates this occurrence with expansion of virtual models, now available to learners continually (Bandura, 1977b). Observers' capacities to process content viewed govern the amount of benefit from observed experiences. Learners' perceptions, derived from experiences of the past and particular situations, affect what elements are extracted from observations and how those observations were interpreted (Bandura, 1977b).

Retention refers to remembering through coding symbolically, cognitive organizational skills, repeating symbolic representations, and practicing motor skills. The advanced capacity for symbolization enables learners to learn behaviors through observations. The ability to relate to an image and process verbal interactions are factors involved with observational learning. The results of repeated experiences of modeling stimuli ultimately produce lasting, retrievable images of what was modeled (Bandura, 1977b, Schunk, 2016).

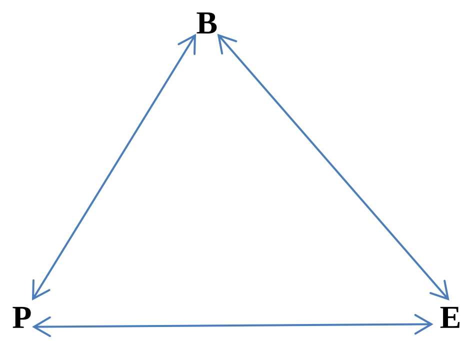
The motor reproduction component of observational learning converts symbolic representations into suitable actions by analyzing the "ideomotor mechanisms of performance" (Bandura, 1977b, p. 27). To reproduce a particular behavior, a learner organizes personal responses through space and time cognitive experiences that align with the patterns being modeled. Initiation of cognitive organization of responses, how the responses are monitored and refined, depends on feedback information (Bandura, 1977b). Selected responses are derived from learners' cognitive level. The amount of observational learning depends upon available component skills to integrate new patterns. If some response components are absent, reproducing a particular behavior would be flawed. Where response components are limited, basic sub-skills needed for complex operations must first be developed through modeling and practice (Bandura 1977b).

The fourth component of social learning theory, motivation, arises through modeling behavior that will produce results valued as positive outcomes (Bandura, 1977b). Learners tend to not necessarily apply everything they learn. Valued outcomes from observers' perspective will encourage the modeling of what was observed to be repeated. Evaluative responses that learners produce regulate which observed learning responses would be executed (Bandura, 1977b).

Bandura's research continued through the 1970's and 1980's and social learning theory expanded into the realm of a system of the self. Social cognitive theory began based on the foundation of a person's agentic conception of development, how adaptation occurs, and transformative growth processes (Bandura, 1977b, 1989a, 1999, 2005). Social cognitive theory was founded upon Bandura's (1986, p. 24) model of triadic reciprocal causation as shown in Figure 1.

Figure 1

Triadic Reciprocal Causation Pattern



Note. This figure demonstrates the relations between the three classes of determinants in triadic reciprocal causation (*B: Behavior; P: Personal and Cognitive Factors; E: Environmental Influences*).

Social Cognitive Theory

Mechanisms of learning arise from human behaviors that become significantly motivated and regulated through the continual application of self-influence in social cognitive theory. Human agency, which encompasses the mechanisms of self-regulation and self-efficacy, holds a central role in social cognitive theory, through a high impact on thought (cognition), affect (influence), motivation, and achievement (Bandura, 1988, 1989a, 1999, 2005). One of the main principles of social cognitive theory is the concept of triadic reciprocal causation. An individual's environment may stimulate an internalization of changes and an individual's behavior may likewise create changes in their surroundings because of a series of events occurring in varying order and at varying times (Bandura, 1977b, 1986, 1988, 1999, 2005). Explaining human behavior, in constructs of unidirectional causation, as shaped and controlled by their environmental effects or a compelling internal disposition, are elements of social cognitive theory (Bandura, 1977b, 1986, 1988, 1999, 2005). The social cognitive theory constructs of human agency, self-regulation, and self-efficacy will play a dominate role in the context of this study.

Mechanisms of Learning

Bandura’s social cognitive theory posits learning experiences arise from reciprocal interactions among adjacent environments and from observing the actions of other people. Social cognitive theory elucidates mechanisms of learning, human development, how knowledge becomes acquired, and self-regulation, creating a combination of personal and academic capabilities through human agency (Bandura, 1977b, 1986, 1989a, 2005; Cook & Artino, 2016; du Toit-Brits, 2019; Fletcher, 2016; Lotter et al., 2018; Morris et al., 2017). Central factors in social cognitive theory are personal beliefs, expectations and attitudes, and the impact of the surrounding physical and social environments (Bandura, 1986, 1988, 2005; Bircan & Sungur, 2016; du Toit-Brit, 2019; Dorrenbacher & Perels, 2015; Kalatskaya et al., 2016; Schunk, 2016). Learning occurs in social contexts that create reciprocal interactions with students, the surrounding environment, and learners’ behaviors. Learners’ behaviors become influenced by thoughts, beliefs, and emotions (Aligaen & Capaciete, 2016; Schrik & Wasonga, 2019; Smith & Darvas, 2017). Elements in Bandura’s social cognitive theory center on the main concepts of human agency. Self-regulation and a person’s beliefs in their self-efficacy are the key factors of human agency, an element of social cognitive theory (Bandura, 1986, 1988, 1989a, 1993, 1999, 2005).

Human Agency

The human capability to influence the way one operates and to influence the direction of events, based on one’s actions, is referred to as agency (Bandura, 1982, 1986, 1989a, 2005; Martin, 2004). An agentic operator is a concept of social cognitive theory that refers to individuals taking an active role in the direction of their lives, as opposed to being directed by environmental events (Bandura, 1999). Bandura (1982, 1989a, 1999, 2005) described four functions through which human agency is implemented, intentionality, forethought, self-reactiveness, and self-reflectiveness. Intentions become created from action plans and strategies that support the plan to be realized. Learners develop goals with forethought to probable outcomes of the actions that will guide and motivate efforts with anticipation. The third human agentic function of self-reactiveness describes agents as anticipatory fore-thinkers extending beyond planning. Bandura's human agency self-reactiveness function correlates to self-regulation. Self-reflectiveness, the fourth agentic function, refers to learners' ability to self-examine their own functioning. Functional self-awareness promotes reflecting on personal efficacy, the reliability of thoughts and actions, meaningful pursuits, and choosing corrective modifications as necessary (Bandura, 1982, 1989a, 1999, 2005). When people act as an agent over their environments, they tend to draw on their knowledge and cognitive and behavioral skills to produce the results desired. As an agent over oneself, people check their actions and procure cognitive guiding and self-inventiveness to create desired personal transformations (Bandura, 1989a).

Self-Regulation

As a self-governing system, self-regulation forms the center of causal processes. Self-regulation facilitates the effects of many external influences and provides the basis for a purposeful action. Self-regulation functions from one's performances, evaluating one's behavior aligned with their values, and affective self-reactions toward one's assessed performances (Bandura, 1986, 1988, 1996; Booth et al., 2018). Self-regulation is a system of conscious management of thoughts, behavioral choices, and emotional responses (Bandura, 1986, 1988, 1996; Booth et al., 2008; du Toit-Brits, 2019; Martin, 2004). In the realm of education, learners who become self-regulated understand how to influence their learning environment to achieve personal and academic desired outcomes (Bandura, 1986; 1996; Booth et al., 2018; Cook & Artino 2016; du Toit-Brits, 2019; Martin, 2004; Schunk, 2016; Thoutenhoofd & Pirrie, 2015). Self-perceptions regulated by internal standards motivate and regulate learners' behaviors. Self-produced influences develop through inconsistencies of established personal standards activating an evaluative process toward the establishment of self-regulation (Bandura, 1986; Booth et al., 2018; Smith & Darvas, 2017).

Cognitive regulation and emotional regulation act interdependently with respect to self-regulation. Cognitive regulation relates to the elements of control and directedness of cognitive capacities (attention and memory). Emotional regulation incorporates the inflection of emotional responses (distractions or reevaluation to reduce anxiety) (Booth et al., 2018; Martin, 2004; Schunk, 2016).

Self-Efficacy

A person's belief in the capability to implement behaviors necessary to generate specific performance achievements denotes self-efficacy (Bandura 1977a, 1986, 1988, 1993, 2005; Schunk, 2016). Self-assurance in an ability to exercise control over one's individual motivation, behavior, and social environment originates through self-efficacy. Cognitive self-evaluating influences all aspects of the human experience, which include goals people strive toward, the level of energy spent toward goal achievement, and the probability of acquiring certain levels of behavioral performance. Bandura (1977a) developed the concept of self-efficacy and separated the construct from the concept of self-confidence. Confidence pertains to strength of belief, whereas self-efficacy distinguishes a belief in an individual's personal competences to be able to achieve particular levels of accomplishment (Bandura, 1977a). Motivation is founded on desire to attain specific goals, unlike self-efficacy founded on a belief of an individual's personal aptitude to achieve goals. Bandura (1977a) found a correlation to high levels of self-efficacy with high levels of motivation, with the reverse also applicable.

Self-efficacy develops through beliefs based on interpretation of information from performance accomplishments (mastery experiences), vicarious experience (social role modeling), verbal persuasion (feedback), and emotional states (emotional and physical reactions) (Bandura, 1977a, 1977b). Performance accomplishments involve practicing to achieve a mastery level of experiences, one of the most significant sources of efficacy information. Experiences at a mastery level produce the greatest authentic indication an individual can gather for whatever is needed to generate success (Bandura, 1977a, 1977b). Social role modeling provides opportunities for one to identify personal similarities with others and observe their success sustained by determination to succeed. Vicarious experiences that relate oneself to this kind of observation encourages a belief that the capability to master comparable activity is possible (Bandura, 1977a, 1977b). Encouraging or discouraging verbal persuasion can influence self-efficacy and an individual's ability to achieve. Receiving positive verbal feedback during a challenging task encourages an individual to develop a belief that they possess the proficiency and capability to accomplish the task (Bandura, 1977a, 1977b). The remaining source of self-efficacy information involves the emotional states of physical and physiological well-being that effect personal capabilities. How emotional and physical reactions are perceived and construed is important (Bandura, 1977a, 1977b). Individuals with a high self-efficacy interpret emotional states as energizing, whereas individuals with doubtfulness interpret emotional states as incapacitating (Bandura, 1977a, 1977b).

Self-efficacy varies depending on the realm of appropriate functioning and situations surrounding the circumstance of behavior (Alemdar et al., 2018; Bandura 1977a, 1986, 1988, 1993, 2005; Bircan & Sungur, 2016; Fletcher, 2016; Morris et al., 2017; Pajares, 1996; Schrik & Wasonga, 2019; Schulze & van Heerden, 2015; Schunk, 2016). Perceived self-efficacy operates from three different levels as a significant contributor to academic development. Learners' beliefs, regarding efficacy to regulate learning to master academic skills, determines goal outcomes and establishes diverse levels of motivation and educational accomplishments (Bandura, 1993).

Related Literature

Educational practices and instructional strategies have begun to move away from traditional approaches toward methodologies to support an ever-emerging technological 21st century academic arena (Akcay & Akcay, 2015; Alismail & McGuire, 2015; Yang, 2016). Modern day students' learning skills require the combination of diverse cognitive mechanisms focused on preparation for local, national, and global academic comprehension to maintain competitive technological economies. Research literature relating 21st century efforts toward the centralization of concentrating technological literacy in the fields of science, technology, engineering, and mathematics (STEM) has demonstrated how to best proceed to motivate learning through effective curriculum delivery (Autieri et al., 2016; Cook & Artino, 2016; Kalatskaya et al., 2016; Yang, 2016). An examination of the literature shows correlations among STEM educational promotion, the ebb and flow of STEM interest, instructional strategies, and student attitudes toward learning science. The development and application of Individual Education Plans (IEP), 504 Plans, and cognitive conflicts within science education are discussed (Alismail & McGuire, 2015; Bao et al., 2013; El Takach & Yacoubian, 2020; Fletcher, 2016;

Khalil & Elkhider, 2016; Schulze & van Heerden, 2015; Zohar & Aharon-Kravetsky, 2005). Concerted efforts to focus attention on promoting STEM education began with the emphasis for the United States to become technologically competitive on a global basis over the past 20 years (Alismail & McGuire, 2015; Ascione, 2020; US Department of Education, n. d.). Understanding the mechanism of cognitive conflict in learning science could potentially enhance the academic movement in STEM education (Bao et al., 2013; Bircan & Sungur, 2016; Kim & Bao, 2008; Lee et al., 2003; Zohar & Aharon-Kravetsky, 2005).

Science, Technology, Engineering, and Mathematics (STEM) Education

Multiple sources define STEM education in diverse manners with individualized caveats dependent upon the sources' focus. The U.S. Department of Education describes a STEM education as a means of preparing young learners to develop the knowledge and skills necessary to problem solve, interpret information, and possess an ability to gather and evaluate evidence upon which to base decisions (US Department of Education, n. d.). In December, 2018, the federal government published a plan to chart a course for success and developed an educational strategy for STEM education implementation (US Department of Education, n. d.). Encyclopaedia Britannica provides an in-depth study of the origins of how STEM education became a national, and eventually global, effort to prepare students for 21st century advances of increased demands for a STEM workforce (Hallinen, 2015). The acronym of STEM was first introduced in 2001 by scientific administrators at the U.S. National Science Foundation (NSF). Several key reports published in the early 2000's suggested that American students were not achieving academic skills in STEM disciplines. One report, *Rising Above the Gathering Storm*, in 2005, was especially focused on linking prosperity, knowledge-intensive employment that depends on science and technology and how to continue innovations to focus on societal problems (Hallinen, 2015). This report projected disasterous consequences should America not be able to compete in the global economy due to an inadequately prepared workforce (Hallinen, 2015).

Attention began to focus on research in the areas of science, mathematics, technology, economic policies, and especially on education, in an effort to maintain and then improve upon American prosperity through STEM education to fulfill rising demands in a future STEM workforce (Deksissa et al., 2014; Gitari, 2016; Hallinen, 2015). Concerns where reinforced in 2006 when data results from global testing comparisons among fourth and eighth graders (Trends in International Mathematics and Science Study) and a global assessment of knowledge and skills of fifteen year olds (Programme for International Student Assessment) revealed a large proportion of U.S. students had underperformed, with a ranking of 21 out of 30 countries. The assessments focused on scientific competency and scientific knowledge (Hallinen, 2015).

Research and studies began to determine school system needs and to guide the development of targeted solutions to improve STEM educational curricula. Efforts were made to align education as an interdisciplinary approach to learning that involved academic concepts associated with real-world lessons for students to apply science, technology, engineering, and mathematics concepts and principles. This focus on STEM was designed around the context of making connections between school systems, the local community, related work, and the emerging global economics to further improve international competitiveness (Hallinen, 2015).

Current trends in STEM education are continuing to develop to improve upon student-centered effectivenss as new curriculum designs are formulating across each state in the United States. In 2018, the former U.S. Department of Education’s Secretary DeVos made STEM a centerpiece for comprehensive educational agendas. The U.S. Department of Education is funding grants to establish promotion of student achievement and to prepare for economic competitiveness globally through supporting educational criteria to meet the needs and provide equal access to all learners nationally (US Department of Education, n. d.). STEM educational trends include a concerted effort to support minority students' academic STEM skill development and to recruit more minority STEM educators. Beginning the introduction of technology as early as pre-kindergarten, expansion of STEM strategies in rural communities, promoting computer science as a teaching career, and increasing environmental advocacy locally, nationally, and globally are other trends in current STEM education (Ascione, 2020). STEM education is trending to lead the way toward authentic and applied learning practices in K-12 school systems for all learners to develop real-world skills through community service and internships (Ascione, 2020; Hallinen, 2015).

Promoting STEM Education

Educational systems globally are being challenged to promote STEM education as the answer to the call to fill careers in the fields of science, technology, engineering, mathematics, computer science, and cyberspace intelligence (Schulze & van Heerden, 2015; Smith & Darvas, 2017). Identifying current cognitive levels of learners begins the process of designing curriculum that meets students where they are and encourages the development of academic skills necessary to support inquiry-based learning through personal empowerment (Alismail & McGuire, 2015; Khalil & Elkhider, 2016; Knight, 2017; Kalatskaya et al., 2016; Lotter et al., 2018; Yang, 2016; Zohar & Aharon-Kravetsky, 2005). To improve and promote STEM education, educational leaders are endorsing improvement of STEM instructors through professional development conferences. Specialized teacher education programs, mentoring STEM-focused instruction, increasing interactive curricula, and identification of initiatives that have been productive have improved the promotion of STEM education (Akpan & Beard, 2016; Aligaen & Capaciete, 2016; du Toit-Brit, 2019; Khalil & Elkhider, 2016; Lotter et al., 2018; Schwichow et al., 2016; Winarti et al., 2018).

The Ebb and Flow of STEM Interest

Promotional efforts and educational interest in STEM curriculum development and delivery has seen several peaks and valleys historically, with continuing trends and patterns of interest to date (Bozkurt et al., 2019; Donmez & Tasar, 2020; Kubat, 2018; Kubat & Guray, 2018; Laine et al., 2020; Marksbury, 2017; Stubbs & Myers, 2016). Teaching STEM has traditionally focused on content delivery methodology rather than modeling real-life similarities for application in problem-solving academics. Research has shown that separation of individualized courses tends to promote fragmentation of information that does not support the relationships among and between STEM coursework (Donmez & Tasar, 2020; Kubat, 2018; Stubbs & Myers, 2016). The missing link of academic association tends to create disinterest or disconnect for STEM learners (Bozkurt et al., 2019; Stubbs & Myers, 2016).

Efforts to shift teacher education programs toward substantial integration of STEM curriculum and professional development, for existing STEM educators, has shown improvement in learners' interest in STEM curricula (Kubat & Guray, 2018; Stubbs & Myers, 2016). Conventional academic systems teach instructional content knowledge rather than utilizing a multidimensional approach to coordinate processes of problem solving, real-world applications, and experiences of interdisciplinary materials (Kubat & Guray, 2018). Expanded programming to promote STEM education is not sustainable beyond the middle school curricula when learners' disinterest out weights interest in STEM (Staus et al., 2020), a situation coined the "leaky STEM pipeline" (Staus et al., 2020, p. 1) as middle school learners lose interest concluding with fewer taking STEM classes in high school or college. New STEM educational trending leans toward the doing as well as learning approach with increased interactive lessons. Educational approaches toward an interdisciplinary delivery of curricula provide learners with the academic and cognitive tools to think intuitively and create higher-order summations of problem solving (Donmez & Tasar, 2020; Stubbs & Myers, 2016).

Current research demonstrates that today's supportive values and belief-systems of the personal and professional efficacy of STEM educators has created an upward trend toward patterns of increasing interest in STEM content for learners (Bozkurt, et al., 2019). However, a study by Laine et al. (2020) indicates that the time of year my influence the adolescent learners' interest in STEM, as priorities modify based on personal cognitive focus during developmental years. Organizational presentations of school instructors, a lack of continual academic support, the quality of STEM curriculum, and mode of instruction are factors with potential to sway interest toward or away from learners. The ebb and flow of STEM interest has been shown to diminish as the academic year progresses from the fall into the spring semesters (Kubat & Guray, 2018; Lane et al., 2020; Stubbs & Myers, 2016).

Promotion of STEM Integration (iSTEM) K-12 education was supported by the National Academy of Engineering (NAE) and the National Research Council (NRC) framework in 2014 (Stubbs & Myers, 2016). Expertise in all aspects of iSTEM was shown to be lacking in instructional delivery of content. Promoting STEM literacy to support 21st century competency, a technologically ready workforce, increased interest in STEM careers, and learners' ability to connect disciplines through STEM were the objectives of the NEA and NRC initiative (Stubbs & Myers, 2016). Despite this initiative, however, undergraduate interest in STEM majors continues to decline (Laine et al., 2020; Marksbury, 2017). Research suggests that changes across instructional practices, academic support and promotion, and learner relevance with content in iSTEM and STEM academics should continue to be studied and initiated to improve and sustain interest (Kubat, 2018; Kubat & Guray, 2018; Laine et al., 2020; Marksbury, 2016; Stubbs & Myers, 2016).

STEM Instructional Strategies

Development of educational strategies in STEM instruction continue to progress in primary, secondary, and higher educational systems through producing effective curricula. An effective curriculum that aligns with cognitive function to promote learning through self-regulation and self-efficacy has shown to produce positive academic results and advancement of personal development (Bandura, 1989b; Fletcher, 2016; Schulze & van Heerden, 2015; Thoutenhoofd & Pirrie, 2015). Problem-Based Learning (PBL), encouraging student potential through embedding the use of Multiple Intelligences (MI) principles, and inquiry-based instruction promote STEM education (Lotter et al., 2018; Winarti et al., 2019). Teaching STEM in a socially contextualized method promotes real-world connections between learners and society and promotes relevance of scientific concepts in science classrooms (Aligaen & Capaciete, 2016; du Toit-Brit, 2019; Autieri et al., 2016; Schwichow et al., 2016; Shammari & Faulkner, 2019). Building lessons around learners' understanding of the surrounding environment, outside of and within an educational system, presents relatable content that stimulates an interest in learning STEM materials (Akpan & Beard, 2016; Aligaen & Capaciete, 2016; Aydogmus & Senturk, 2019; Knight, 2017; Yang, 2016).

Professional development for science educators, that incorporates foundational aspects of effective science curriculum, has resulted in improving the quality of instruction and enhancing science learners' conceptualizing scientific principles (Lotter et al., 2018; Morris et al.,2017;

Taylor, 2016). Integrating learning elements of social cognitive theory into science curricula, through pedagogical processes, has shown to advance learner engagement with instructional materials and personal learning achievement. An instructional environment that does not foster lesson methodologies to promote student engagement, through elements of social cognition, may influence students' attitudes toward science education in an unfavorable manner (Alismail & McGuire, 2015; Clark, 2015; Fletcher, 2016; Yüksel & Geban, 2016; Khalil & Elkhider, 2016; Lotter et al., 2018; Taylor, 2016).

Student Attitudes Toward Learning Science

To foster learning science, the creation of an inviting environment begins the process of resolving learning conflicts toward science education (Akcay & Akcay, 2015; Aligaen & Capaciete, 2016; Bircan & Sungur, 2016; Hacieminoglu, 2016; Yang, 2016). Students' attitudes toward learning science can become influenced with positive results among educators who inspire learners through the process of modeling an interest in content materials. Engaging students to participate in their own learning process, and understanding students' perceptions of scientists, has shown to improve student attitudes in science classroom instruction (Cook & Artino, 2016; El Takach & Yacoubian, 2020; Hacieminoglu, 2016; Horsley & Moeed, 2018; Kang et al., 2004: Karacam, 2016; Libao et al., 2016; Moeed & Easterbrook, 2016; Yang, 2016). Learning science can be perceived as frustrating when students' beliefs about personal academic abilities are negative or create insecurities from a lack of previous knowledge, misunderstanding of scientific concepts, or fear of appearing foolish among peers (Akcay & Akcay, 2015; Aligaen & Capaciete, 2016; Bircan & Sungur, 2016; Hacieminoglu, 2016; Moeed & Easterbrook 2016). Cognitive conflict can contribute to an anxious attitude during the learning process, which, left unaddressed, could produce a negative impact on learners' motivation and achievement (Aligaen

& Capaciete, 2016; Bao et al., 2013; Deksissa et al., 2014; Gitari, 2016; Kim & Bao, 2008; Smith & Darvas, 2017).

Teaching STEM Concepts to Students with Learning Disabilities

Students with learning disabilities (SWLD) face a different set of academic challenges than students without learning disabilities (LD) (Asghar et al., 2017; Hwang & Taylor, 2016; Taylor et al., 2018). Multiple cognitive impairments may present within the LD student population adding to the confrontation of problem-based STEM learning, the typical format for presenting STEM content (Akpan & Beard, 2016; Asghar et al., 2017; Bao et al., 2013; Hwang & Taylor, 2016; Shammari & Faulkner, 2019). Research has shown that SWLD performance in math and science fall below that of general education peers (Akpan & Beard, 2016; Hwang & Taylor, 2016). Next Generation Science Standards promote instruction that relates science to everyday world experiences through utilization of inquiry-based lesson modes (Next Generation Science, 2018; Taylor et al., 2018).

Learning Disabled Instructional Strategies

Meeting special needs of SWLD suggests that diverse instructional designs be developed to support STEM education in a manner that would improve grasping scientific concepts. The basic foundation of a STEM educational system is built upon engineering concepts. The Universal Design for Learning (UDL) supports such curricula formats (Asghar et al., 2017; Hwang & Taylor, 2016; Taylor et al., 2018). Creating an interdisciplinary methodology utilizing iPads, multiple STEM apps, and co-teaching instruction have shown to provide connectedness of content with SWLD (Hwang & Taylor, 2016; VanUitert et al., 2020; Zimmer et al., 2018).

Cognitive limitations are frequently seen in students with learning disabilities. Designing learning activities and lessons that minimize operational memory excess, by using external pictures or symbols and memory aids, could reduce cognitive processing challenges (Asghar et al., 2017; Hwang & Taylor, 2016; VanUitert et al., 2020; Zimmer et al., 2018). Scaffolding strategies providing a step-by-step design reduce cognitive burden to assist with how to solve a problem-based assignment. Encouraging SWLD to make connections between previous and new idea scientific concepts by creating concept maps, graphic organizers, prompts, and cues can develop logical understanding of content materials and minimize cognitive conflict (Hwang & Taylor, 2016; VanUitert et al., 2020).

Structuring argument-based inquiry as a method to teach science instruction utilizing the Science Writing Heuristic (SWH) approach has shown to increase science academic success for students with learning disabilities (Taylor et al., 2018; Zimmer et al., 2018). Components of the SWH approach include knowledge construction using guided inquiry following pre-constructed formatted lessons (Akpan & Beard, 2016; Bircan & Sungur, 2016; Jufrida et al., 2019; Taylor et al., 2018; Zimmer et al., 2018). Science Writing Heuristic engages learners toward inquiry-based learning and systematic reasoning, improving critical thinking skills. Self-discovery that is supported and encouraged through writing-to-learn strategies allows students to make generalized concept connections with science knowledge promoted through discussions with peers and experimental designs to intensify comprehension of scientific principles (Akpan & Beard, 2016; Bircan & Sungur, 2016; Jufrida et al., 2019; Taylor et al., 2018).

Self-Determination Instruction and Students With Learning Disabilities

Learning disabled educators teaching self-determination skills to students with an IEP or 504 Plan have shown to improve academic performance for SWLD. Students with a learning disability have shown to possess lower self-determination skills than students without a learning disability. Research has shown that self-determination is an ability that can be learned (Chao &

Chou, 2017, Schunk, 2016). Students' self-awareness of how to identify and pursue personal and academic goals supports educators' efforts to design the most productive learning strategies, especially with regard to SWLD and development of an IEP or 504 Plan (Chao & Chou, 2017).

Effectively predicting learning outcomes increases as students are able to apply self-determination skills. Self-determination abilities are a set of complex concepts that include making appropriate choices and decisions, the ability to problem-solve successfully, set obtainable goals, apply self-advocacy, and internalize self-control (Chao & Chou, 2017; Schunk, 2016). Self-determination skill development for students with an IEP or 504 Plan correlates with positive academic outcomes (Chao & Chou, 2017).

Students With Learning Disabilities in STEM Education

Educational efforts to support learners with disabilities created at the federal level, with the Individuals with Disabilities Education Act (IDEA), and the Section 504 of the Rehabilitation Act of 1973, provides funding to school districts in support of educating identified children with disabilities (Dragoo & Cole, 2019; NYSED Office of Special Education, 2020). IDEA and the 504 Rehabilitation Act support the educational rights of children with disabilities and their families in public school districts in the United States. How disabilities are defined, how eligibility for services and protections are determined, and how learners with disabilities receive accommodations and services relies on the statutory provisions and regulation implementation of IDEA and the 504 Rehabilitation Act (Dragoo & Cole, 2019; NYSED Office of Special Education, 2020). Research has shown an underrepresentation of students with learning disabilities (SWLD) in the area of science education, specifically STEM programs (Zimmer et al., 2018). Learners identified with disabilities receive accommodations designed to meet individualized needs with a specifically written Individualized Education Plan or 504 Plan and are included in general education classes (Chao & Chou, 2017; Dragoo & Cole, 2019; NYSED Office of Special Education, 2020; VanUitert et al., 2020; Zimmer et al., 2018).

Individualized Education Plan, 504 Plan, and STEM Education

If a learner with at least one of 13 conditions specific to the categories in IDEA and, because of that condition (disability), the learner must require learning disabled services to benefit from a public education, then that student will receive accommodating educational assistance and IDEA benefits (NYSED Office of Special Education, 2020). An individualized education program (IEP) is a detailed plan adapted to the learner's individual educational needs Inclusion places students with an IEP among students without learning disabilities as cohorts (Dragoo & Cole, 2019; NYSED Office of Special Education, 2020).

A 504 Plan has two requirements, a student with any disability (covering a wide scope of diverse struggles in school) and any disability that interferes with a student's ability to learn (NYSED Office of Special Education, 2020). Students with learning disabilities provided with a 504 Plan are placed within regular curriculum classes as inclusion students among peers without learning disabilities (NYSED Office of Special Education, 2020). Research has shown the impact of learning-disabled teachers' self-efficacy beliefs toward STEM content may increase or decrease academic success for students with an IEP or 504 Plan in a linear manner. Academic success in STEM courses runs parallel to positive or negative beliefs of learning-disabled teachers' self-efficacy toward STEM curricula (Ates et al., 2019; Zimmer et al., 2018).

Twenty-first century STEM curricula should accommodate all students, inclusive of students with an IEP or 504 Plan, and research shows a need for improvement in the area of scientific education for SWLD (VanUitert et al., 2020; Zimmer et al., 2018). Placing learning disabled teachers within science classes to co-teach along with science teachers to develop

STEM-based curricula, to meet the needs of all students (students with an IEP, 504 Plan and students without educational plans), improved learning-disabled teachers' self-efficacy toward science courses. Research results demonstrated an improvement of IEP students' academic success in STEM courses as learning disabled teachers' science curricula self-efficacy improved (Shammari & Faulkner, 2019; Zimmer et al., 2018).

Science Literacy and Students with Learning Disabilities

Learners are scientifically literate when the learners demonstrate an ability to analyze and then apply a scientific concept to solve daily life problems (Chao & Chou, 2017; Jufrida et al., 2019; VanUitert et al., 2020). Research has shown a correlation between scientific literacy and science education achievement at the middle school level (Autieri et al., 2016; Jufrida et al., 2019). Statistically, students with an IEP or 504 Plan score lower on STEM achievement assessments than students without LD, furthering the underrepresentation of SWLD in STEM careers (Asghar et al., 2017; Hwang & Taylor, 2016; Taylor et al., 2018; VanUitert et al., 2020). Common learning characteristics of students with an IEP or 504 Plan include memory and information processing challenges and poor reading skills (Asghar et al., 2017; Autieri et al., 2016; VanUitert et al., 2020). For effective education of scientific terms taught to all students, STEM educators should incorporate effective practices differentiated to meet learning styles and academic skill levels of SWLD and students without LD. Research has shown access to multimedia videos incorporating evidence-based STEM practices influence all students' science literacy assessments in a positive direction (Asghar et al., 2017; Hwang & Taylor, 2016; Taylor et al., 2018; VanUitert et al., 2020). Academic achievement increased as the number of evidence-based STEM videos viewed increased, improving STEM assessments (Asghar et al., 2017; Hwang & Taylor, 2016; Taylor et al., 2018; VanUitert et al., 2020). Designing the manner in which science literacy is taught to sustain an IEP or 504 Plan may improve representation of SWLD in STEM secondary education, STEM higher education, and STEM careers (Autieri et al., 2016; VanUitert et al., 2020).

Impediments to Integrating Students with Learning Disabilities in Science

Educators without adequate training to respond to the specific needs of students with learning disabilities risk not being able to meet the instructional accommodations as outlined in an IEP or 504 Plan (Asghar et al., 2017; Hwang & Taylor, 2016; Staus et al., 2020). Studies have revealed that science educators commonly do not possess knowledge of learning disabilities and the pedagogical skill level to differentiate lessons specific to the individualized educational plans designed for each SWLD (Asghar et al., 2017; Hwang & Taylor, 2016; Staus et al., 2020). Planning time to adjust in-class instruction, homework assignments, laboratory experiments, and content assessment to meet accommodations for SWLD is limited, further impeding adequate integration in a class among peers without learning disabilities (Asghar et al., 2017; Hwang & Taylor, 2016).

Students with learning disabilities often struggle with limited study skills, lower levels of self-efficacy, inadequate prior knowledge, and focus challenges that minimize the capacity to stay on task (Asghar et al., 2017; Hwang & Taylor, 2016; Staus et al., 2020). Research shows that integrating SWLD into the science classroom creates a need for additional instructional strategies to accommodate the learning environment, given the preponderance of academic disparity (Asghar et al., 2017; Ates et al., 2019; Deksissa et al., 2014; Hwang & Taylor, 2016; Shammari & Faulkner, 2019; Staus et al., 2020). The inabilities of a school district to provide a special education instructor, to co-teach science content, and to create curricular activities that include all students further impedes productive integration of SWLD into the general education population (Asghar et al., 2017; Ates et al., 2019; Deksissa et al., 2014; Hwang & Taylor, 2016; Shammari & Faulkner, 2019).

Cognitive Conflict Within Science Education

Cognitive conflict arises when a discrepancy between the mental processes that an individual uses to process and understand information (cognitive structures) and their personal experiences do not align. The discrepancy occurs at the same moment an active, equally incompatible picture or symbol competes for a cognitive response (Bao et al., 2013; Kim & Bao, 2008; Lee et al., 2003; Schwichow et al., 2016; Zohar & Aharon-Kravetsky, 2005). Learning science requires a combination of multiple factors, prior knowledge, problem solving skills, observational ability, memory recall, and relevance or relatability to content materials (Akcay & Akcay, 2015; Aligaen & Capaciete, 2016; Bao et al., 2013; Bircan & Sungur, 2016; Cook & Artino, 2016; Deksissa et al., 2014; Gitari, 2016; Kalatskaya et al., 2016; Kim & Bao, 2008; Schwichow et al., 2016; Zohar & Aharon-Kravetsky, 2005). Students with high academic abilities may actually benefit from cognitive conflict, while students with learning disabilities, or of lower academic skills, may be unable to utilize the presence of cognitive conflict to achieve positive results in science instruction (Bao et al., 2013; Bircan & Sungur, 2016; Kim & Bao, 2008; Lee et al., 2003; Zohar & Aharon-Kravetsky, 2005).

Statistically significant correlations have been found among degrees of cognitive conflict and learners’ conceptual change of observed science lessons, implying that cognitive conflict may have a role in concept learning and social interactions (Bandura, 1986, 1989b; Bircan & Sungur, 2016; Cook & Artino, 2016; Horsley & Moeed, 2018; Kang et al., 2004; Kim & Bao, 2008; Zohar & Aharon-Kravetsky, 2005). Students with well-developed logical thinking skills tend to diminish cognitive conflict independently. Students with less developed logical thinking skills pursue solutions from alternate sources or ignore the conflict and do not seek out solutions (Cook & Artino, 2016; Kang et al., 2004; Horsley & Moeed, 2018; Kalatskaya et al., 2016).

Identifying Cognitive Conflict

Cognitive conflict can be identified through observational activities. Observing an activity can be measured using the Cognitive Conflict Levels Test (CCLT), developed specifically for this purpose (Lee et al., 2003). There are four components of cognitive conflict, recognition of an atypical situation, interest, anxiety, and cognitive reappraisal. Cognitive conflict possesses the potential for creating either a highly constructive or a highly destructive outcome with respect to these components (Lee et al., 2003). If science students do not recognize the anomaly (atypical situation) or choose to ignore it, or if students dislike being in a conflict state, then the cognitive conflict could be minimal. However, if students experience frustration or feel threatened, rather than becoming interested, cognitive conflict may become a negative experience to learning (Bao et al., 2013; Hacieminoglu, 2016; Kim & Bao, 2008; Lee et al., 2003; Zohar & Aharon-Kravetsky, 2005). Understanding how students feel when experiencing cognitive conflict, and how those experiences relate to a response, can become a factor for educators when designing science lessons, activities, and overall curricula (Akcay & Akcay, 2015; Akpan & Beard, 2016; Aydogmus & Sentuirk, 2019; Bao et al., 2013; Bircan & Sungur, 2016; Kim & Bao, 2008; Lee et al., 2003; Libao et al., 2016; Zohar & Aharon-Kravetsky, 2005). Lee et al. (2003) developed four measurement components to determine cognitive conflict levels in designing the CCLT instrument, recognition of a contradiction, interest, anxiety, and cognitive reappraisal.

Recognition of a Contradiction. Contradictions are part of the human experience. Recognizing a contradiction may influence a variety of attitudes, thoughts, and feelings in the moment the contradiction is recognized (Berliner et al., 2016; Bird, 2017; Lee et al., 2003). Recognition of something familiar or unfamiliar originates within neural areas of brain cognition (Bird, 2017). Doubting the explanations of a scientific principle precipitates into cognitive conflict, as the learner discovers that the scientific concepts are a contradiction of the expected outcome (Bandura, 1986; Lee et al., 2003; Permatasari & Suyono, 2016; Schulze & van Heerden, 2015). Recognition of a contradiction may be feelings-based and not influenced by whether or not the observed principle was ever seen before (Bird, 2017). Detection of a contradiction may produce an uncommon sense of strangeness and astonishment (Lee et al., 2003; Li et al., 2017). The experience of recognizing a contradiction functions as a measurement factor when evaluating learners' cognitive conflict levels. The level of cognitive conflict is dependent upon the intensity of the learners' doubtfulness, surprised response, or sense of unusual feelings (Bandura, 1986; Lee et al., 2003; Permatasari & Suyono, 2016; Schulze & van Heerden, 2015).

Interest. Multiple elements constitute various levels of interest for students observing science concepts (Laine et al., 2020; Odudukudu, 2019; Staus et al., 2020; Wong et al., 2020). Measuring interest levels as a component of cognitive conflict levels reveals learners' curiosity and amount of attention in the moment of observing science principles (Bandura, 1989b; Laine et al., 2020; Lee et al., 2003; Odudukudu, 2019; Staus et al., 2020). Learners' personalized interest, desire to increase knowledge and understanding of scientific principles, objective thinking abilities, uncertainty of presented concepts, and the type of learning environment are elements contributing to interest levels (Laine et al., 2020; Odudukudu, 2019; Staus et al., 2020; Wong et al., 2020).

The quality of early exposure to scientific principles and demonstrations at the elementary instructional level may influence personalized levels of academic interest in middle school (Odudukudu, 2019; Staus et al., 2020; Taylor et al., 2018). Curriculum delivered by supportive and innovative educators has shown to increase interest in STEM instruction (Aligaen & Capaciete, 2016; Horsley & Moeed, 2018; Schulze & van Heerden, 2015; Staus et al., 2020; Yang, 2016). Research has shown that interest in learning increases as a relational effect of relevance and personal applicability are realized by the learner (Horsley & Moeed, 2018; Schulze & van Heerden, 2015; Staus et al., 2020). Learners able to associate STEM concepts within personal experiences outside the classroom environment were shown to have a greater interest in science instruction and maintained interest over time (Horsley & Moeed, 2018; Schulze & van Heerden, 2015; Staus et al., 2020).

Students with higher-order objective thinking skills show a greater level of interest and curiosity capable of maintaining attention during instructional demonstrations, an aspect of measuring cognitive conflict (Bandura, 1986; Odudukudu, 2019; Staus et al., 2020). Interest may be personalized or situational-based contingent upon learners' perspective and beliefs. Research shows a correlation of interest and thinking (cognition) subjective to values placed upon personal interactions or circumstances (Deksissa et al., 2020; Odudukudu, 2019; Staus et al., 2020).

Urban Setting Factors Regarding Interest. The educational environment in an urban setting creates other caveats contributing to cognitive conflict and its component of learner interest. Multiple factors influencing urban student interest in observing science principles contribute to the level of interest or disinterest (Akcay & Akcay, 2015; Alemdar et al., 2018; Ascione, 2020; Staus et al., 2020). Socioeconomic status, parental involvement level, a school district's ability to provide afterschool programming, students' access to nature and curricula applications of relevance to everyday student life contribute to the interest levels in science among urban learners (Akcay & Akcay, 2015; Alemdar et al., 2018; Ascione, 2020; Staus et al., 2020).

Anxiety. Manifestation of confusion, a sense of uncomfortableness, or an emotional sadness (depression) create a state of anxiousness (Bandura, 1986; Bao et al., 2013; Kim & Bao, 2008; Lee et al., 2003; Yüksel & Geban, 2016). Cognitive conflict levels contribute to the level of anxiety experienced by learners. Observing a science concept that does not align with previous knowledge or lack of knowledge may promote an emotional response of being confused, distressed or despondent (Bao et al., 2013; Kim & Bao, 2008; Lee et al., 2003; Yüksel & Geban, 2016). Anxiety associated with cognitive conflict may emerge from a sense of empty or blank thoughts, anticipation of poor performance or outcome, or misaligned thoughts of irrational thinking (Bandura, 1986; Bao et al., 2013; Kim & Bao, 2008; Lee et al., 2003; Yüksel & Geban, 2016; Taylor et al., 2018).

The anxiety component of cognitive conflict levels may produce both negative and positive results toward academic outcomes (Asghar et al., 2017; Kim & Bao, 2008; Lee et al., 2003; Taylor et al., 2018). A positive outcome could be realized resulting in clarification and improved understanding of the concept being observed. The anxiety created from cognitive conflict could stimulate learners toward motivation of choosing a desire to understand what was misunderstood, thereby improving the learning experience (Bandura, 1986; Kim & Bao, 2008; Lee et al., 2003; Taylor et al., 2018). A negative outcome may occur should a student ignore the anxiety from cognitive conflict as a means of avoiding the experience of uncertainty, confusion, or dismay (Bandura, 1986; Lee et al., 2003; Taylor et al., 2018).

Cognitive Reappraisal. Learners' personal interpretation of a situation may ultimately influence the level of cognitive conflict experienced. Cognitive reappraisal may potentially regulate the response to a situation and create a positive result (Asghar et al., 2017; Brockman et al., 2017; Jamieson et al., 2018; Liu et al., 2019). Research shows that stressful situations stimulating cognitive reappraisal may allow an optimization of a stress response. Cognitive reappraisal may then promote adaptability, motivating a learner to seek the correct information when incorrect thinking occurred (Brockman et al., 2017; Jamieson et al., 2018; Liu et al., 2019). Cognitive reappraisal may stimulate emotional regulation, a critical process in the social-emotional development of learners (Bandura, 1963, 1977b, 1986, 1989b, 1996; Jamieson et al., 2018; Liu et al., 2019; Schunk, 2016). Learners' level of cognitive reappraisal, during cognitive conflict, may influence the effectiveness of how to utilize regulatory means to enhance stress response, facilitating active coping (Jamieson et al., 2018). Emotional regulation assists learners with responding to cognitive conflict situations (Brockman et al., 2017; Jamieson et al., 2018; Liu et al., 2019).

The cognitive reappraisal of a situation component within cognitive conflict levels could determine future academic progress or become a detriment to a desire to increase knowledge, improve understanding, or establish motivational learning (Bandura, 1986; Brockman, 2017). Learners use cognitive reappraisal to increase a response to a stimulus. The stimulus for cognitive reappraisal stems from a desire to improve understanding of an incorrect idea, the need to contemplate the unexpected results of a situation, or a need to comprehend the basis of the observed scientific principle (Asghar et al., 2017; Brockman et al., 2017; Jamieson et al., 2018; Lee et al., 2003; Liu et al., 2019).

Summary

Learning science within the social environment of a science classroom involves cognitive functioning as described in Bandura's (1986) social cognitive theory. Learning that takes place in a social context centralized around human behavior of the reciprocal model may produce cognitive conflict when scientific principles are presented that do not align with prior knowledge or beliefs of scientific concepts (Bandura, 1986; Bircan & Sungur, 2016; Cook & Artino, 2016; Deksissa et al., 2014; Yang, 2016). Self-regulation and learners' beliefs in personal self-efficacy are significant factors in human agency (Bandura 1986, 2005). Cognitive capacity, directed by cognitive and emotional regulation, relate to elements of cognitive control (Booth et al., 2018; Martin, 2004; Schunk, 2016). Academic development operates from perceived self-efficacy, based on learners' beliefs, regulating goal outcomes and establishing levels of motivation and academic accomplishments (Bandura, 1993).

Establishment of an equitable education for all learners was created legislatively in United States' public-school systems with the IDEA (creating IEPs) and the Rehabilitation Act of 1973 (creating 504 Plans) and implemented into the public-school educational systems nationwide. Identifying SWLD and creating IEPs and 504 Plans, to meet specific learning levels, improved underrepresentation of SWLD in STEM courses allowing for inclusion among students without LD (Dragoo & Cole, 2019; NYSED Office of Special Education, 2020; VanUitert et al., 2020; Zimmer et al., 2018). Recognition of the importance of strong STEM literacy and student self-determination skills have been promoted with an infusion of learning-disabled teachers co-teaching with STEM teachers, resulting in an increase in STEM academic accomplishments for SWLD (Autieri et al., 2016; Chao & Chou, 2017).

A review of the literature reveals that concentrated efforts to promote STEM programs in most primary and secondary educational systems have not been able to answer the call of the demand to fill related professional positions or provide adequate and equitable instruction for SWLD and students without LD (Asghar et al., 2017; Deksissa et al., 2014; Horsley & Moeed, 2018: Moeed & Easterbrook, 2016; Hwang & Taylor, 2016; Staus et al., 2020). When students experience cognitive learning conflict, social conflict (personal and technological), and motivational conflict, it has been shown to discourage a preference for learning science concepts. Minimized interest in science education and an inability to identify content relevance pose potential challenges to improving STEM educational goals (Asghar et al., 2017; Cook & Artino, 2016; Khalil & Elkhider, 2015; Lee et al., 2003; Pajares, 1996; Schulze & van Heerden, 2015; Thoutenhoofd & Pirrie, 2015).

Understanding applications of the elements of social cognitive theory has demonstrated an effective adjustment to science education in research literature. Study within the context of reciprocal interactions, how learning occurs and self-regulation, in the preparation of modern-day students, has supported effective curriculum development (Booth et al., 2018; Deksissa et al., 2014; Gitari, 2016). However, limited research targeted specifically on the influence of cognitive conflict in learning science in middle school limits the knowledge and understanding necessary for potential improvements in academic achievement and learners' sense of relevance toward science content. Further research on the correlation of cognitive conflict and learning science concepts could improve science curricula methodologies and potentially increase interest in the pursuit of STEM study.

CHAPTER THREE: METHODS

Overview

A causal-comparative design was used to investigate the significant differences of cognitive conflict among middle school science students with learning disabilities and students without learning disabilities in an upstate New York public school district. Descriptions of the research design, research questions, and the null hypotheses are provided. The population, sample, groups, and setting are described. The instrument used to collect data was examined and described in detail. Discussion includes validation and reasoning for the application of the instrument in this study. Precise procedures for conducting this study have been provided for future replication. A description of the data analysis used in this study, the justification for the analysis, assumption tests, alpha level, and effect size statistics are presented.

Design

This study employed a causal-comparison research design with five dependent variables. Causal-comparative research is a nonexperimental method that seeks to uncover possible cause-and-effect explanations by studying phenomena that have already occurred naturally. Known also as *ex post facto* research because the method seeks to explain phenomena retroactively, causal-comparative's "critical feature . . . is that the independent variable is measured in the form of categories" (Gall et al., 2007, p. 306) that are naturally occurring. A determination is then made to discover whether the groups differ on the dependent variable within the groups (Gall et al., 2007). A causal-comparison design is appropriate for this study as the values for the independent variable occurred naturally and were not manipulated (Rovai et al., 2013). Moreover, the dependent variable was a naturally occurring, pre-existing variable, as required by causal-comparative research.

The dependent variables this study were cognitive conflict, recognizing a contradiction, interest, anxiety, and cognitive reappraisal. Cognitive conflict is defined as an internal experience of opposing contradictions creating mental discomfort produced when a person is presented with new information that contradicts prior beliefs and ideas (Lee et al., 2003; Schunk, 2016). Recognizing a contradiction occurs when a student identifies with a belief or idea that does not align with the actual reality of the scientific principle being observed (Berliner et al., 2016; Bird, 2017; Lee et al., 2003). Measuring students' interest defines curiosity levels and the extent of attention given during an observable activity (Bandura, 1989b; Laine et al., 2020; Lee et al., 2003; Odudukudu, 2019; Staus et al., 2020). Anxiety arises when a physiological state becomes characterized by cognitive, emotional, physical, and behavioral elements (Bandura, 1986; Bao et al., 2013; Kim & Bao, 2008; Lee et al., 2003; Yüksel & Geban, 2016). Cognitive reappraisal involves altering the meaning of a situation without an objectifying shift of the meaning (Asghar et al., 2017; Brockman et al., 2017; Liu et al., 2019).

Cognitive conflict was measured through the application of the Cognitive Conflict Levels Test (CCLT), created by Lee et al. (2003). The independent variable is the type of student, consisting of two groups: students with learning disabilities (SWLD) and students without learning disabilities (LD). Students with learning disabilities are provided with individual education plans (IEP) or a 504 Plan designed to meet the diverse academic needs of each individual student (Akpan & Beard, 2016; NYSED Office of Special Education, 2020; Shammari & Faulkner, 2019). Students without learning disabilities do not receive specialized learning accommodations and receive curriculum and teaching methodologies in the same manner in each class, regardless of students' learning abilities (Mahoney, 2020). Based on the pre-existing, naturally occurring make-up of the selected variables for this study, including the categorical nature of the independent variable, causal-comparative research is the necessary and sufficient method to employ.

Research Questions

RQ1: Is there a difference in the *recognizing a contradiction* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ2: Is there a difference in the *interest* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ3: Is there a difference in the *anxiety* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ4: Is there a difference in the *cognitive reappraisal* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ5: Is there a difference in the overall or cumulative *cognitive conflict* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

Hypotheses

$H_0$1: There is no difference in the *recognizing a contradiction* scores between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

$H_0$2: There is no difference in the *interest* scores between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

$H_0$3: There is no difference in the *anxiety* scores between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

$H_0$4: There is no difference in the *cognitive reappraisal* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

$H_0$5: There is no difference in the overall or cumulative *cognitive conflict* scores between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

Participants and Setting

The participants for the study were drawn from a convenience sample of middle school science students located in upstate New York during the fall semester of the 2021-2022 school year. This public school district ranges from low to upper-middle class income and is designated as a Title I district. The elementary, middle, and high school buildings are located in a small inner city just north of the capital of New York. The capital district of upstate New York is made up of several cities with populations ranging from approximately 50,000 to 100,000 and numerous smaller cities and towns, both suburban and rural. There are eight significant industries of the capital district of upstate New York; construction, manufacturing, transportation and warehousing, finance and insurance, professional, scientific and technical services, education, health care and social assistance, and accommodation and food services (New York

State Department of Labor, 2019). The small inner city this study focused on has a population of 9,986 with a median household income of $43,176 and a per capita income of $26,061 (United States Census Bureau, 2019). The population of this inner city is predominately caucasian, followed by African-American, Hispanic or Latino, and two or more races, with less than five percent Asian (United States Census Bureau, 2019).

Public Schools

The capital region of New York state provides a public education for students from pre-kindergarten (Universal Pre-K) through twelfth grade in urban, suburban, and rural districts. Students of all abilities are served an education, including students identified with learning disabilities, individual education plans (IEP), 504 Plans, special needs students, general education students, and gifted and honors students. Curriculum and courses align to the New York State Common Core Education Standards (Common Core Curriculum & Assessments, n.d.; NYSED Office of Special Education, 2020). The capital district of upstate New York is centralized around the capital, Albany, in Albany county.

The school district from which this study's population is drawn is located in the north east portion of Albany county. Demographically, Albany County's population is 71.6% white, 11.4% African American, and 9.98% Asian with a total population of 307,117. The median household income is $64,435 and the poverty rate in the county is 12.4% (Albany County, NY, 2018). The largest universities in Albany County are Excelsior (5,137 degrees awarded in 2017), State University at Albany (4,895 degrees awarded in 2017), and the College of Saint Rose (1,772 degrees awarded in 2018). The median property value in Albany County is $224,300 with a homeownershp rate of 56.3% (Albany County, NY, 2018). An international airport is located in the northern section of Albany County. There are three major medical centers in Albany County, one with a medical school, and one for veterans (Albany County, NY, 2018).

Sample

The sample was derived from a population of 268 middle school students attending a public school in Albany County of upstate New York (Districts: Enrollment, 2019). The school for this study was chosen based on the researcher's previous professional relationships with the superintendent of the school district and the science department's faculty members. The sample of students was taken from middle school science classes. The number of participants in the sample was 56 students (28 students with learning disabilities and 28 students without disabilities), which exceeds the required minimum when assuming a large effect size with statistical power of .7 and alpha level, $\alpha = .05$ (Gall et al., 2007, p. 145).

Participants

The students in the sample were comprised of 28 students with learning disabilities and 28 students without learning disabilities. Current middle school science teachers with knowledge of educational plan designations selected participants. The study was introduced to students as an opportunity to assist the school district with the development of future science curriculum enhancements with the potential to benefit science education in their local school district. The average age of the students in the sample was 13 years old. Racial demographics of the middle school students in the sample are shown in Table 1.

Table 1

Racial Demographics of the Sample

Ethnicity	Middle School Students
Caucasian	26
African American	11
Hispanic-Latino	8
American Indian	0
Asian	7
Pacific Islander	0
Two or More Races	4
Total	56

Note. Adapted from *Districts: Enrollment* by data.nysed.gov, 2019.

The students in the sample were enrolled in middle school science classes. New York State physical science courses include the topics of magnetism and electricity, heat and light, forces in liquids and gases, waves, mechanical, electrical, and nuclear energy, Newton's laws of motion, simple machines, atomic structure, the periodic table of elements, compounds and mixtures, and chemical changes. New York State life science topics include structure, life function and processing, growth development and reproduction of organisms, matter and energy in organisms and ecosystems, interdependent relationships in ecosystems, and natural selection and adaptations (New York State Department of Education, 2019). A combination of curriculum delivery includes direct instruction, lecture, online activities, hands-on activities, and laboratory experiments. Assignments are comprised of homework completed on paper, online, in projects, and journal entries. Assessments include New York State Common Core science testing for middle school students, local content testing, and project-based scores (Common Core

Curriculum & Assessments, n.d.).

Groups

The two groups were formed by randomly choosing participants from each group. Groups were formulated from the education program designated, students with learning disabilities (SWLD), with an IEP or 504 Plan, and students without learning disabilities (LD), without an IEP or 504 Plan. Each student group consisted of 28 students. The average age of SWLD was 13 years old. The students without LD group will consist of 28 students. The average age of the students without LD group was 13 years old. Table 2 provides the configuration of the SWLD group and the students without LD group.

Table 2

Group Configuration According to Educational Plan

Group	Total
Students with Disabilities	28
Students without Disabilities	28
Total	56

Treatment Setting

The middle school science classrooms are comprised of rows of six desks deep (facing the front of the room) and four desks across. Counter tops measuring 28 inches deep and 36 inches high align each side of the classroom for 24 feet. Storage cabinets with glass front doors are hung 30 inches above the surface of the countertops and rise to the ceiling. Storage cupboards are placed underneath the countertops. A large teacher's lab table is located in the front of the room and measures six feet long by three feet wide and three feet high. The entry door is at the front of the classroom just behind the teacher's lab table approximately five feet on the diagonal. The science demonstration was viewed as a video recording. The exact same recording was shown to all classes.

Instrumentation

The instrument used was the *Cognitive Conflict Levels Test* (CCLT) created by Lee et al. (2003). The purpose of this instrument was to create a reliable method to assess and measure the level of cognitive conflict with middle and secondary school level students' experience in learning. The CCLT is comprised of general statement-type items, which are free of content, and may be applied to measure students' cognitive conflict in verbal, imaginary, or hands-on activities in diverse subject classes (Lee et al., 2003). The CCLT has been successfully used to measure the cognitive conflict levels of 788 middle school students (Lee et al., 2003). Cognitive conflict has been identified as an important factor in conceptual change. Discovery of how to influence cognitive conflict could result in positive outcomes toward conceptual change in science education (Kang et al., 2004; Lee et al., 2003).

The instrument was developed from a cognitive conflict process model used to explain cognitive conflict occurring when a student is met with an unusual situation incompatible with the student's preconception of learning science (Lee et al., 2003). Lee et al. (2003) identified measurement components of cognitive conflict based on the development of a cognitive conflict process model. The final CCLT instrument was developed through the refinement of this cognitive conflict process model, designed to measure the dependent variable of cognitive conflict levels of middle school science students. The CCLT instrument has been used in numerous studies (Bao et al., 2013; Kang et al., 2004; Kang et al., 2011; Kim & Kwon, 2004; Lee & Byun, 2012; Permatasari & Suyono, 2016; Zohar & Aharon-Kravetsky, 2005).

The CCLT instrument is comprised of four constructs that determine the level of cognitive conflict. The four constructs of cognitive conflict are validating recognition of an anomalous situation, interest, anxiety, and cognitive reappraisal of the conflict situation (Lee et al., 2003). Recognition of an anomalous situation occurs when a student recognizes that a situation is not congruous with their conceptions, which should produce interest or anxiety about the situation. Constructs of recognition, interest, and anxiety relate to uncertainty, which indicates cognitive conflict (Lee et al., 2003). Once this stage is experienced, students could reappraise the cognitive conflict situation to a resolution or dismiss it by ignoring the response (Lee et al., 2003). Cognitive conflicts are a part of psychological theories of cognitive change and social cognitive theory (Lee et al., 2003; Schunk, 2016). Lee et al. (2003) first developed a cognitive conflict process model to explain the cognitive conflict that occurs at the moment a student is faced with an anomalous situation that is not compatible with the preconception in learning science the student currently possesses. The recognition of an anomalous situation construct occurs when a student does not recognize the anomaly (irregularity or incongruence) or ignores it. However, constructive cognitive conflict may be created when students recognize an anomaly, experience strong interest with appropriate anxiety, and then reappraise the cognitive conflict situation. If the student prefers not to be in a conflict state, the cognitive conflict may be negligible in the situation and ignored. The cognitive conflict process has been shown to be influenced by students' diverse characteristics and learning environment factors (Lee et al., 2003; Schunk, 2016).

The instrument consisting of the four identified constructs was supported by factor analysis. Six experts using a five-stage Likert scale determined the validity of each item assessed in the CCLT instrument. The mean value of content validity coefficients among the experts was .93 (Lee et al., 2003).

The four measurement components, (a) recognition of an anomalous situation, (b) interest, (c) anxiety, and (d) cognitive reappraisal of the situation, comprise a total of 12 test items. Each construct contains three statements. The scale of measurement for each component of the constructs utilizes a five-point Likert scale (1 = "strongly disagree," 5 = "strongly agree"). The combined possible score of all constructs could range from the lowest score of 12 to the highest possible score of 60, and individually for each construct from the lowest score of 3 to the highest score of 20. A high score for recognition of a contradiction (anomalous situation) indicates that one's recognition of conceptions are inconsistent with the results of the demonstration. A high score with the interest construct indicates curiosity and focused attention. A high score with the anxiety construct denotes confusion, a sense of agony, or melancholy. A high score for cognitive reappraisal of the observed scientific demonstration posits a suspension of attention, a need to take more time to think about what happened, or a need to discover an alternate logical reason for the results (Lee et al., 2003).

The CCLT was administered to the participating students as a written questionnaire, with the associated test items, for each of the four construct measurement components using the aforementioned Likert scale, after observing a scientific demonstration. The researcher asked participating students to think about predictions of what may happen during the demonstration. See Appendix A, Figure 1A. The anticipated time to answer the 12 test items is approximately 20 minutes. The CCLT procedure is comprised of two steps, a demonstration and then a written questionnaire after observing a science-based demonstration as shown in Appendix A. Scores of the four measurement components based on the 12-subset test items in the CCLT were collected, analyzed, and scored by the researcher.

The CCLT reliability of the cognitive conflict test items was measured by calculating internal consistency values utilizing Cronbach's alpha, creating a range of .86 to .91 (Lee et al., 2003). The developers of the CCLT were contacted to request permission to use the measurement scale. Permission was granted to use the CCLT instrument. See Appendix B for permission to use the instrument.

Procedures

Permission from the Institutional Review Board (IRB) was obtained (see Appendix C for IRB approval). Permission to conduct the study was acquired from the school district superintendent of the participating school. The school district's superintendent assigned a science faculty member to assist with the study. The researcher met with all middle school students and teachers virtually via Zoom interface to invite students to participate in the study (see Appendix D for the script to invite students to participate in the study).

Four weeks prior to the study, the researcher met with the science department assigned faculty member assistant to review introductory procedures and deliver consent forms (see Appendix E for consent forms). Teachers distributed the informational letter and consent forms to students to take home. Parents/guardians received the informational letter and informed consent form electronically. Participating teachers explained that participation is voluntary, and that parental/guardian consent is a requirement to participate. Completed consent forms were required to be returned to the participating teachers by a specific date prior to the study. The researcher met with the science department assigned faculty member assistant prior to the study to collect the signed consent forms.

To promote consistency throughout the study, the researcher created a video of the science demonstration which was shown to all participants, who were provided all necessary materials, and the Google docs assess link to the demonstration survey. Participating teachers were encouraged to contact the researcher at any time prior to or after the study. A predetermined code matched the educational plan, post-demonstration survey questionnaire, and student number. Participating teachers used the predetermined code for each survey questionnaire as a student with a learning disability or student without a learning disability. Upon completion of the study, participating teachers assisted the researcher to secure results in an anonymous Excel spreadsheet for each of the two groups. The researcher received the anonymous coded response choices of each students' survey from the CCLT survey questions electronically from the assisting participating teacher. The assisting faculty member maintained a spreadsheet to match each student's name with the code.

Data was collected from the survey questions answered after viewing the science demonstration video. The demonstration included a ping-pong ball and standard hairdryer. This demonstration was selected for its physics concepts and contexts (Bernoulli's Principle). Previous research shows that middle school students have preconceived ideas about physics principles (Lee et al., 2003) and how the flow of air pressure relates to lift (Brophy, 2017). The demonstration chosen was a mechanism for middle school students to be able to express ideas about fluid dynamics and the relationship of speed of motion and air pressure in a fluid (Merali, n.d.).

The ping-pong ball and hairdryer demonstration showed a ping-pong ball floating above a blowing hairdryer vertically as well as at several angles to the left and right. The researcher asked students to think about what will happen to the ping-pong ball when released in the blowing air above the hairdryer when the hairdryer is turned on. Students were asked to predict whether or not the ping-pong ball will fall down if the hairdryer was turned slightly from side to side. A diagram of the demonstration is shown in Appendix A. Participating students answered 12 survey questions immediately after observing the scientific demonstration (see Appendix F).

Survey questionnaire answers were scored by the researcher and all data was entered into an Excel spreadsheet. The researcher scored the results of the surveys, keep data confidential, coded the data, and entered specific data into Excel for analysis.

Data Analysis

This causal-comparative study will used *t*-tests to determine if a statistically significant difference exists between the means of each cognitive conflict construct scores and the composite cognitive conflict scores of middle school SWLD and middle school students without LD. A *t* test is an appropriate choice as the parametric procedure to assess the means of two independent groups to determine statistical differences (Gall et al., 2007; Green & Salkind, 2017; Rovai et al., 2013; Warner, 2013). Five *t*-tests evaluated whether the mean score of the test variable for SWLD differs from the mean score of the test variable for students without LD. The *t*-test constant score (*test value neutral point)* was 24 for combined scores of all four constructs and six for each of the four individual constructs (Green & Salkind, 2017).

Data was visually screened for missing data and inaccuracies. Assumption testing included a box and whisker plot for each group to identify outliers, according to Green and Salkind (2017). A Kolmogorov-Smirnov assumption of normality test and the Levene's Test of Equity of Error assumption of equal variance tests were performed to proceed with *t*-tests by group (*SWLD and students without LD*) from the four cognitive conflict constructs scores and the composite cognitive conflict scores (Green & Salkind, 2017; Rovai et al., 2013).

Cohen's *d* was used to measure effect size (Green & Salkind, 2017; Warner, 2013). Cohen's *d* is applicable to measure the standardized difference between the mean scores of the two independent groups (*SWLD and students without LD*) (Gall et al., 2007; Warner, 2013). Since five *t*-tests were conducted (*recognition of a contradiction, interest, anxiety, cognitive* *reappraisal*, *and cognitive conflict*), a Bonferroni correction was needed to guard against Type I error. The alpha level is calculated to be: 0.05/5 = .01 (Warner, 2013).

CHAPTER FOUR: FINDINGS

Overview

The purpose of this study was to see if there was a significant difference between cognitive conflict levels of middle school students with learning disabilities (SWLD) and middle school students without learning disabilities (LD). The independent variable is made up of two groups, middle school students with learning disabilities (SWLD) and middle school students without learning disabilities (LD). The dependent variables were the levels of the four cognitive conflict constructs (recognizing a contradiction, interest, anxiety, and cognitive reappraisal) and the level of the overall or cumulative cognitive conflict. Independent Samples *t*-tests were used to test the hypotheses. The Findings section includes the research questions, null hypotheses, data screening, descriptive statistics, assumption testing, and results.

Research Questions

RQ1: Is there a difference in the *recognizing a contradiction* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ2: Is there a difference in the *interest* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ3: Is there a difference in the *anxiety* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ4: Is there a difference in the *cognitive reappraisal* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ5: Is there a difference in the overall or cumulative *cognitive conflict* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

Null Hypotheses

$H_0$1: There is no difference in the *recognizing a contradiction* scores between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

$H_0$2: There is no difference in the *interest* scores between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

$H_0$3: There is no difference in the *anxiety* scores between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

$H_0$4: There is no difference in the overall or cumulative *cognitive reappraisal* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

$H_0$5: There is no difference in the *cognitive conflict* scores between middle school students with learning disabilities and students without learning disabilities of an observed scientific concept in an urban inner-city science class.

Data Screening

Data screening was conducted on each group’s dependent variables. The researcher sorted the data on each variable and scanned for inconsistencies. No data errors or inconsistencies were identified. Box and whiskers plots were used to detect outliers on each dependent variable. The data for recognizing a contradiction, interest, anxiety, cognitive reappraisal, and cognitive conflict were independently screened for outliers. In the analysis of the data for SWLD, two outliers were identified in the cognitive reappraisal construct for cognitive conflict. The researcher ran the analysis again for this data with the outliers removed to determine whether removal was required. The results did not cause a change in the significance levels (zero difference on the Means of Difference and p remained unchanged at $< .001$) of the results. Thus, the two outlier data points were deemed atypical and included for the final analysis (Gall et al., 2007). See Figure 2 for box and whisker plots for SWLD in the four cognitive conflict constructs.

The analysis of cognitive conflict sub-constructs for students without LD identified no outliers in the review of a boxplot graph. See Figure 3 for box and whisker plots for students without LD in the four cognitive conflict constructs. The analysis of overall or cumulative cognitive conflict levels for SWLD and students without LD identified no outliers in the review of a boxplot graph. See Figure 4 for box and whisker plots for SWLD and students without LD in overall or cumulative cognitive conflict.

Figure 2

Boxplot for Cognitive Conflict Constructs for Students With Learning Disabilities.

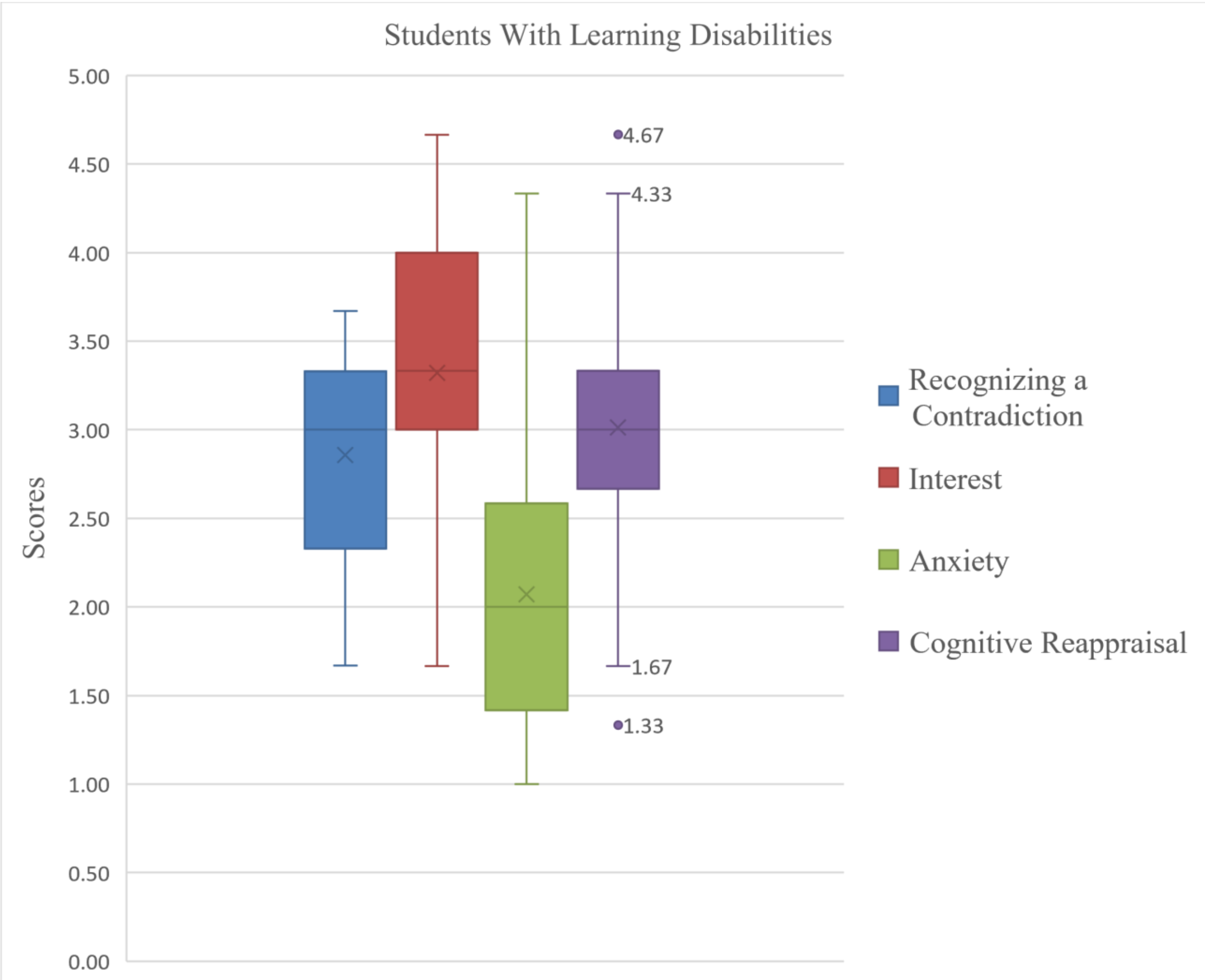


Figure 3

Boxplot for Cognitive Conflict Constructs for Students Without Learning Disabilities.

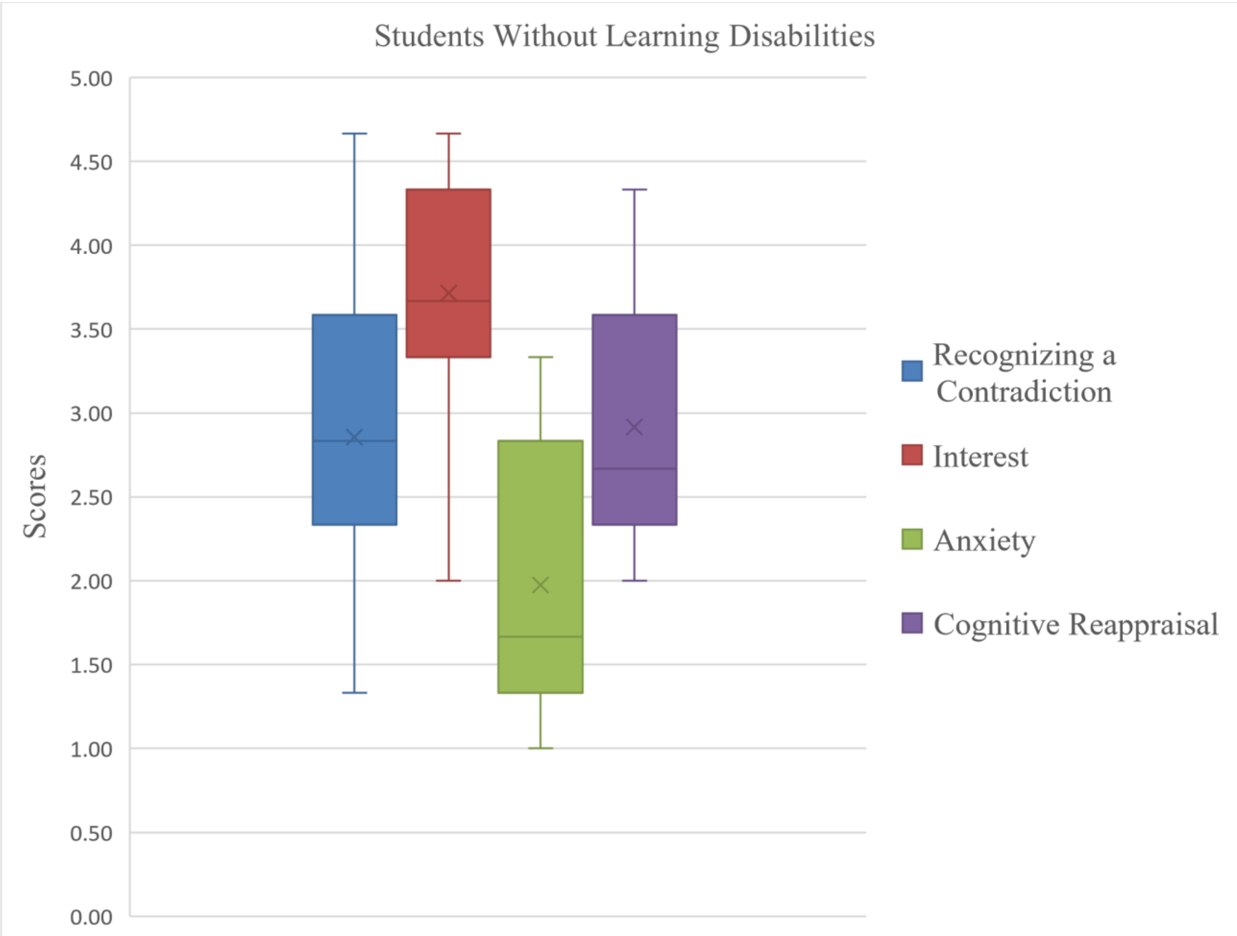
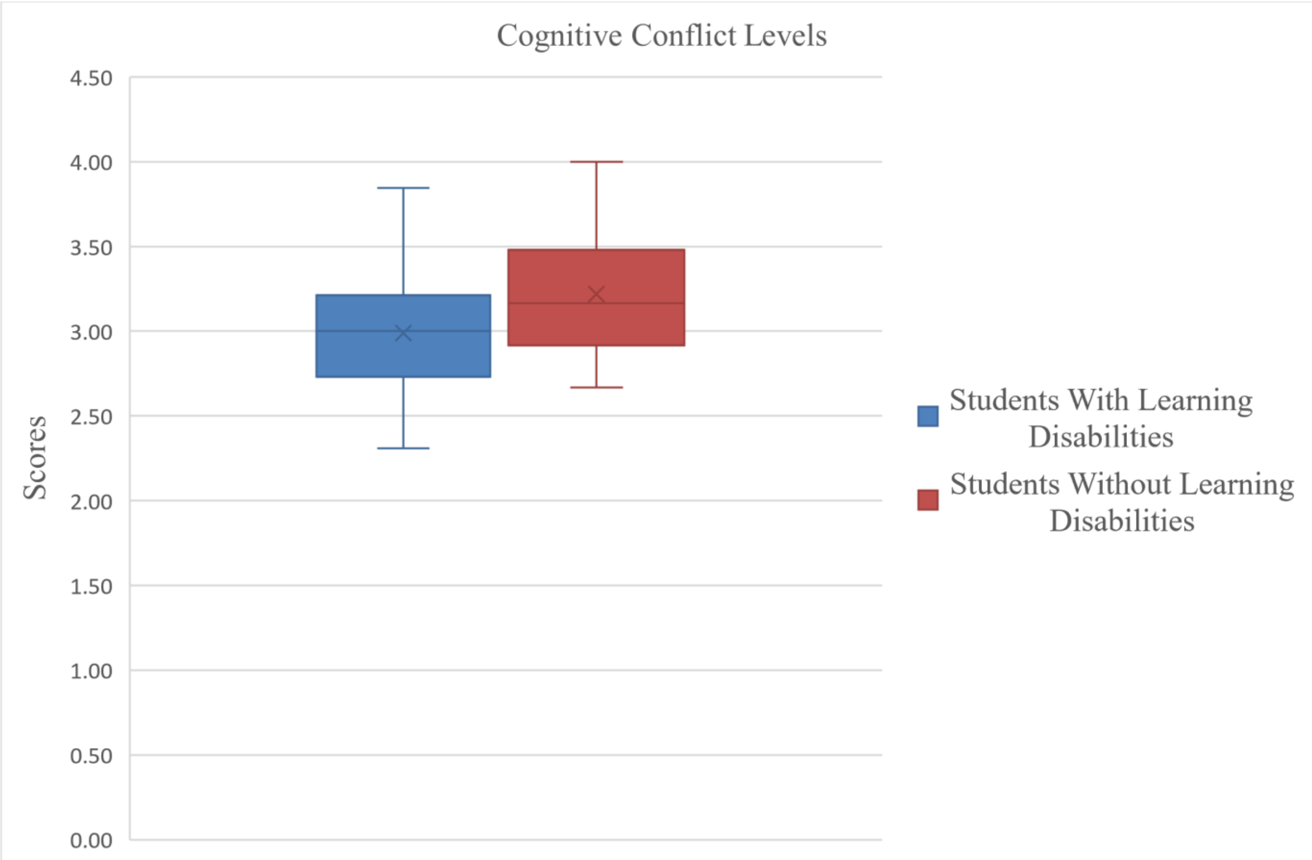


Figure 4

Boxplot for Overall or Cumulative Cognitive Conflict Levels for Students With Learning Disabilities and Students Without Learning Disabilities.



Descriptive Statistics

Descriptive statistics were obtained on the dependent variables for each group. The sample consisted of 56 participants, 28 in each group. The data for this study were generated using a survey. The central tendency data point is 3.0 from the Likert scale on the survey used to collect data. Descriptive statistics for each sub-construct of cognitive conflict for students with learning disabilities (SWLD) are found in Table 3. Descriptive statistics for each sub-construct of cognitive conflict for students without learning disabilities (LD) are found in Table 4. Descriptive statistics for overall or cumulative cognitive conflict levels for SWLD and students without LD are displayed in Table 5.

Table 3

Descriptive Statistics for each Construct of Cognitive Conflict for Students With Learning Disabilities

Construct	*N*	Mean	Standard Deviation
Recognizing a contradiction (RQ1)	28	2.86	0.60
Interest (RQ2)	28	3.32	0.80
Anxiety (RQ3)	28	2.07	0.79
Cognitive reappraisal (RQ 4)	28	3.01	0.85

Table 4

Descriptive Statistics for each Construct of Cognitive Conflict for Students Without Learning Disabilities

Construct	*N*	Mean	Standard Deviation
Recognizing a contradiction (RQ1)	28	2.86	0.83
Interest (RQ2)	28	3.71	0.70
Anxiety (RQ3)	28	1.98	0.80
Cognitive reappraisal (RQ4)	28	2.92	0.76

Table 5

Descriptive Statistics for Cognitive Conflict

	N	*M*	*SD*
Students with Learning Disabilities	28	2.99	.34
Students without Learning Disabilities	28	3.22	.35

Cognitive conflict level data were a composite of the scores from the four constructs that determine presence or no presence of cognitive conflict. Scores for the six survey questions establishing levels for interest (RQ2) and cognitive reappraisal (RQ4) are reverse coded to establish cognitive conflict levels.

Assumption Testing

Assumption of Normality

The Independent Samples *t*-test requires that the assumption of normality be met. Normality was examined using Kolmogorov-Smirnov. The assumption of normality was met for all five dependent variables.

The recognizing a contradiction scores (Research Question One) for SWLD and students without LD were determined to be normally distributed with a $p > 0.01$ as shown. See Table 6 for Test of Normality for recognizing a contradiction (Research Question One).

Table 6

Test of Normality for Recognizing a Contradiction Scores

	Kolmogorov-Smirnov[a]		
Student Group	*D* Statistic	*df*	Sig.
Students with Learning Disabilities	.165	28	.300
Students without Learning Disabilities	.088	28	.300

Note. [a] Bonferroni correction.

The interest scores (Research Question Two) for SWLD and students without LD were determined to be normally distributed with a $p > 0.01$ as shown. See Table 7 for Test of Normality for interest (Research Question Two).

Table 7

Test of Normality for Interest Scores

	Kolmogorov-Smirnov[a]		
Student Group	*D* Statistic	*df*	Sig.
Students with Learning Disabilities	.149	28	.300
Students without Learning Disabilities	.123	28	.300

Note. [a] Bonferroni correction.

The anxiety scores (Research Question Three) for SWLD and students without LD were determined to be normally with a $p > 0.01$ as shown. See Table 8 for Test of Normality for anxiety (Research Question Three).

Table 8

Test of Normality for Anxiety Scores

	Kolmogorov-Smirnov[a]		
Student Group	*D* Statistic	*df*	Sig.
Students with Learning Disabilities	.197	28	.300
Students without Learning Disabilities	.187	28	.300

Note. [a] Bonferroni correction.

The cognitive reappraisal scores (Research Question Four) for SWLD and students without LD were determined to be normally distributed with a $p > 0.01$ as shown. See Table 9 for Test of Normality for cognitive reappraisal (Research Question Four).

Table 9

Test of Normality for Cognitive Reappraisal Scores

	Kolmogorov-Smirnov[a]		
Student Group	*D* Statistic	*df*	Sig.
Students with Learning Disabilities	.129	28	.300
Students without Learning Disabilities	.138	28	.300

Note. [a] Bonferroni correction.

The cognitive conflict scores (Research Question Five) for SWLD and students without LD were determined to be normally distributed with a $p > 0.01$ as shown. See Table 10 for Test of Normality for cognitive conflict (Research Question Five).

Table 10

Test of Normality for Cognitive Conflict Scores

	Kolmogorov-Smirnov[a]		
Student Group	*D* Statistic	*df*	Sig.
Students with Learning Disabilities	.086	28	.300
Students without Learning Disabilities	.091	28	.300

Note. [a] Bonferroni correction.

Assumption of Homogeneity of Variance

The independent samples *t*-test requires that the assumption of homogeneity of variance be met. The assumption of homogeneity of variance was examined using the Levene's test. The assumption of homogeneity of variance was met for all five dependent variables (recognizing a contradiction, interest, anxiety, cognitive reappraisal, and cognitive conflict) where ($p = 0.01$). See Table 11 for Levene's test of Equality of Error Variance for all five constructs of cognitive conflict.

Table 11

Levene's Test for Equality of Error Variance

	F	Sig.
Recognizing a Contradiction	1.929	.171
Interest	.232	.632
Anxiety	.283	.597
Cognitive Reappraisal	.005	.943
Cognitive Conflict	.256	.615

Results

An independent samples *t*-test was conducted to see if there was a significant difference between cognitive conflict levels of middle school students with learning disabilities (SWLD) and middle school students without learning disabilities (LD). The independent variable's two groups were middle school students with learning disabilities (SWLD) and middle school students without learning disabilities (LD). The dependent variables were the levels of the four cognitive conflict constructs (recognizing a contradiction, interest, anxiety, and cognitive reappraisal) and the level of the overall or cumulative cognitive conflict. The researcher failed to reject the null hypotheses. Equal variance is assumed as the *p*-value for these data were greater than 0.05. There were no statistical differences between SWLD and students without LD for each of the dependent variables. Cohen's *d* is zero as the means are equal demonstrating no difference with respect to effect size. See Table 12 for Independent Samples *t*-test results for all five dependent variables.

Table 12

Independent Samples t-tests

	t	*df*	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference		
					Std. Error Difference	Lower	Upper
Recognizing a Contradiction	.000	54	1.000	.000	-.043	-.087	.087
Interest	-1.956	54	2.005	-.390	.098	-.538	-.242
Anxiety	.449	54	2.670	.100	-.001	.090	.092
Cognitive Reappraisal	.442	54	2.670	.09	.015	.051	.130
Cognitive Conflict	-2.484	54	2.670	-.23	-.011	-.237	-.223

CHAPTER FIVE: CONCLUSIONS

Overview

The rationale for this quantitative causal-comparative study is to determine the existence of a difference in the level of cognitive conflict in middle school science students with learning disabilities (SWLD) and middle school science students without learning disabilities (LD). This chapter will discuss the results of the statistical analysis for each research question, along with implications to existing knowledge. Limitations of this study and recommendations for additional research was addressed.

Discussion

The objective of this study was to identify different levels in cognitive conflict between SWLD and students without LD in an urban inner-city middle school after observing a science demonstration pertinent to middle school curriculum. The following research questions governed the direction of the study:

RQ1: Is there a difference in the *recognizing a contradiction* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ2: Is there a difference in the *interest* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ3: Is there a difference in the *anxiety* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ4: Is there a difference in the *cognitive reappraisal* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

RQ5: Is there a difference in the overall or cumulative *cognitive conflict* scores of an observed scientific concept between middle school students with learning disabilities and students without learning disabilities in an urban inner-city science class?

Research Question One on Recognizing a Contradiction

The first research question focused on differences of recognizing a contradiction between SWLD and students without LD. The data set of 56 middle school students (28 SWLD and 28 students without LD) was assessed. An independent *t*-test was run to differentiate any differences of students' level of ability to recognize a contradiction after observing a scientific demonstration. Mean scores for SWLD and students without LD were the same ($M = 2.86$) and the standard deviation was slightly lower for SWLD (SWLD $SD = 0.60$ and students without LD $SD = 0.83$). No statistically significant difference was shown between the scores for recognizing a contradiction ($p = 1.000$); therefore, the researcher failed to reject the null hypothesis.

The recognition of a contradiction potentially provides an impact in the direction of a viewpoint, mindset, and emotional response in the moment of that recognition (Berliner et al., 2016; Bird, 2017; Lee et al., 2003). Students with a learning disability and students without a learning disability recognized a contradiction when observing the presented scientific principle, given the analysis of the data in this study, although SWLD did so slightly less than students without LD. Cognitive conflict levels are dependent upon the amount of doubtfulness (inability to decide), unaccustomed response, or sense of unusual feelings (Bandura, 1986; Lee et al., 2003; Permatasari & Suyono, 2016; Schulze & van Heerden, 2015). Studies have shown that

SWLD tend to be more academically challenged connecting an observation with identifying a conflict than students without LD and SWLD are less likely to recognize a contradiction. However, there was no statistically significant difference between SWLD and students without LD in recognizing a contradiction during this study, which is not supported in previous studies. (Asghar et al., 2017; Hwang & Taylor, 2016; Taylor et al., 2018).

Research Question Two on Interest

The second research question focused on differences of interest between SWLD and students without LD. The data set of 56 middle school students (28 SWLD and 28 students without LD) was assessed. An independent *t*-test was run to differentiate any differences of students' level of interest after observing a scientific demonstration. The mean and standard deviation scores for SWLD (M = 3.32, SD = 0.80) were marginally different than the mean and standard deviation scores for students without LD (M = 3.71, SD = 0.70). The researcher failed to reject the null hypothesis as there was not a statistically significant difference between the interest scores (p = 2.005).

Determining interest levels of observing a scientific principle contributes to measuring the level of cognitive conflict (Bandura, 1989b; Laine et al., 2020; Lee et al., 2003; Odudukudu, 2019; Staus et al., 2020). Students with learning disabilities tend to be easily distracted and less interested in academic endeavors (Akpan & Beard, 2016; Asghar et al., 2017; Learning Disability Association of America, 2012). Analyzed data showed that SWLD were slightly less interested than students without LD, therefore supporting previous research. Nonetheless, this study demonstrated no statistically significant difference between SWLD and students without LD in the cognitive conflict construct of interest during the observation of a scientific demonstration.

Research Question Three on Anxiety

The third research question focused on differences of anxiety between SWLD and students without LD. The data set of 56 middle school students (28 SWLD and 28 students without LD) was assessed. An independent *t*-test was run to differentiate any differences of students' level of anxiety after observing a scientific demonstration. The mean and standard deviation scores for SWLD (M = 2.07, SD = 0.0.79) were marginally different than the mean and standard deviation scores for students without LD (M = 1.98, SD = 0.0.80). The researcher failed to reject the null hypothesis as there was not a statistically significant difference between the anxiety scores (p = 2.005).

Data on the cognitive construct of anxiety for this study showed limited values, therefore, limited anxiety, albeit its presence. However, research has shown that ignoring anxiety (resulting in a low-level score in this study) does not necessarily demonstrate lack of anxiety, merely an avoidance of experiencing uncertainty, misperception, or discomfort (Bandura, 1986; Lee et al., 2003; Taylor et al., 2018). Data in this study showed a slightly higher level of anxiety among SWLD than students without LD. Identifying anxiety in prior studies presented SWLD manifesting higher levels of anxiety than students without LD, precipitated by low self-efficacy, self-doubt, and processing information challenges (Akpan & Beard, 2016; Asghar et al., 2017; Bao et al., 2013; Learning Disability Association of America, 2012; Yuksel & Geban, 2016). These earlier findings support the data in this study. Even so, data in this study revealed no statistically significant difference between SWLD and students without LD for the cognitive conflict construct of anxiety.

Research Question Four on Cognitive Reappraisal

The fourth research question focused on differences of cognitive reappraisal between

SWLD and students without LD. The data set of 56 middle school students (28 SWLD and 28 students without LD) was assessed. An independent *t*-test was run to differentiate any differences of students' level of cognitive reappraisal after observing a scientific demonstration. The mean and standard deviation scores for SWLD ($M = 3.01$, $SD = 0.85$) were marginally different than the mean and standard deviation scores for students without LD ($M = 2.92$, $SD = 0.76$). The researcher failed to reject the null hypothesis as there was not a statistically significant difference between the cognitive reappraisal scores ($p = 2.670$).

Analyzed data showed the presence of cognitive reappraisal. The cognitive conflict construct level of cognitive reappraisal may impact the level of cognitive conflict experienced. Learners may theoretically regulate a response to a situation when cognitive reappraisal is applied in evaluating a situation (Asghar et al., 2017; Brockman et al., 2017; Jamieson et al., 2018; Liu et al., 2019). Cognitive reappraisal may provide adapting to the situation which may motivate learners to seek correcting thoughts (Brockman et al., 2017; Jamieson et al., 2018; Liu et al., 2019).

Students with learning disabilities tend to approach challenging academic situations as too difficult to correct or may not be motivated to correct incorrect thinking without external encouragement from special education/resource educators (Asghar et al., 2017; Brockman et al., 2017; Liu et al., 2019). Lacking cognitive skills to understand the advantages of cognitive reappraisal would demonstrate less cognitive reappraisal among SWLD than students without LD (Asghar et al., 2017; Brockman et al., 2017; Jamieson et al., 2018; Liu et al., 2019). Analyzed data in this study showed no statistically significant difference between the cognitive reappraisal scores of SWLD and students without LD, therefore, data results in this study do not support results of earlier research.

Research Question Five on Cognitive Conflict

The fifth research question focused on differences on the overall or cumulative cognitive conflict between SWLD and students without LD. The data set of 56 middle school students (28 SWLD and 28 students without LD) was assessed. An independent *t*-test was run to differentiate any differences of students' level of cognitive conflict after observing a scientific demonstration. The mean and standard deviation scores for SWLD (M = 2.99, SD = 0.34) were moderately different than the mean and standard deviation scores for students without LD (M = 3.22, SD = 0.35). The researcher failed to reject the null hypothesis as there was not a statistically significant difference between the cognitive conflict scores (p = 2.670).

Analyzed data revealed the presence of cognitive conflict, the aggregate of the four constructs (recognizing a contradiction, interest, anxiety, and cognitive reappraisal), through the applicable instrument (Cognitive Conflict Levels Test). Data showed a slightly higher level of cognitive conflict among SWLD. Students with learning disabilities tend to demonstrate challenges grasping the tenets of Bandura's social cognitive theory (human agency, self-regulation, and self-efficacy), therefore inhibiting learning mechanisms (Asghar et al., 2017; Bandura, 1977b, 1986, 1989a, 2005; Cook & Artino, 2016; du Toit-Brits, 2019). Although a measurable difference disclosed a small elevation in cognitive conflict amid SWLD, which supports previous research, no statistically significant difference was determined between SWLD and students without LD.

Implications

The multidimensional dynamics of cognitive conflict (consisting of the four aforementioned constructs) may combine to create an anxious attitude thereby producing a negative impact on students' motivation to learn and negatively impact efforts toward future academic achievements (Aligaen & Capaciete, 2016; Bao et al., 2013; Dekissa et al., 2014; Gitari, 2016; Kim & Bao, 2008; Smith & Darvas, 2017). The findings of this study exhibited no statistically significant differences between cognitive conflict levels of middle school science students with learning disabilities (SWLD) and students without learning disabilities (LD). Research literature is exceedingly limited in the study of middle school science students' aversion to science, technology, engineering and mathematical (STEM) academia, as well as the study of cognitive conflict, which may be a contributing factor (Akcay & Akcay, 2015; Alemdar et al., 2018; Aligaen & Capaciete, 2016; Bandura, 1986; Bao, et al., 2013; Bircan & Sungur, 2016; Brockman et al., 2017; Cook & Artino, 2016; Dragoo & Cole, 2019; Hwang & Taylor, 2016; Jufrida et al., 2019; Kang et al., 2004; Lee et al., 2003; Tatar et al., 2016; Yang, 2016; Zohar & Aharon-Kravetsky, 2005).

This study contributes to the growing array of literature examining why students continue to perform poorly and avoid college courses and professions in the STEM arena locally, nationally, and globally in this 21st-century of technological education (Ascione, 2020; Bao et al., 2013; Hwang & Taylor, 2016; Kubat & Guray, 2018; Laine et al., 2020; Marksbury, 2017; Staus et al., 2020). Albeit this study's findings determined no statistically significant difference between SWLD and students without LD, regarding cognitive conflict after observing a scientific principle, the presence of cognitive conflict did exist as shown in the data analysis.

Given that analyzed data presented no significant differences in cognitive conflict between the two groups of the independent variable implies either highly effective services are being provided to SWLD or the possibility that students without LD may be under identified and in need of additional educational services. Research has shown SWLD tend to present with lower levels of intellectual and academic performance aptitudes (Liang & Li, 2019). This researcher suggests that the environmental impacts of the past two years may have been contributing factors in these findings. The governmental response to the recent pandemic, which mandated academia to isolate, socially separate, and visually impair facial responses of learners, created developmental and cognitive gaps among all students (Bonal & González, 2020). The effects of learning gaps may pose academic and cognitive challenges among SWLD and students without LD into the next several years of education (Bonal & González, 2020; Liang & Li, 2019).

This study's findings will contribute to fill the gap regarding middle school students' challenges relating to scientific principles and provide information to course correct developing STEM curriculum in primary and secondary education. This study's findings provide information to scientific educational literature, primary and secondary academic professionals, and educational policy makers.

Limitations

Cogency for this study is curbed by the reality of research hazards within (casual-comparative research design) and without (sample size, accessibility to participants, and a pandemic) regarding data analysis and collection. Limitations are present in any research project. The causal-comparative research design and the present-day time frame contributed to the limitations that exist within this study.

Causal-comparative research design limits a researcher's ability to manipulate the experiment to set controls. Conditions in an educational setting are influenced by a multitude of uncontrollable variables (Creswell & Guetterman, 2019). Participating teachers may focus on some students more than others. The possibility of distractions during the observation of this study's demonstration, misunderstanding how to answer the survey questions, and rushing through the survey without much thought contribute to limitations of accurate and authentic data collection.

Students with learning disabilities (SWLD) receive additional support and educational resources beyond the classroom that students without learning disabilities (LD) do not receive (NYSED Office of Special Education, 2020). There may be students who would qualify for an Individual Education Plan (IEP) or a 504 Plan that are not yet identified or have parents/guardians who decline offered educational services (Dragoo & Cole, 2019; National Center for Education Statistics, 2019; NYSED Office of Special Education, 2020; Shammari & Faulkner, 2019). This potential disparity in the participating population of this study could limit the accuracy of collected data. Data analysis must be carefully interpreted, as the cause and effect being sought may only be a connection between the groups (independent variable) and the result (dependent variable) which potentially may skew the analysis (Creswell & Guetterman, 2019). Multiple methods of data analysis (boxplots, testing for normality of an independent *t*-test) were employed to minimize data distortion.

Due to the ongoing COVID-19 pandemic, data collection could not be scheduled in the spring of 2021 as planned and postponing this study until late fall of 2021 did not eliminate many of the mandated constraints. Inviting 12 individual middle school classes through a virtual Zoom presentation, all at the same time, did not have the same effect as personally interacting with potential participants might have had. This limitation was mandated by COVID restrictions of not being able to enter the participating school building. Several participating teachers were less than enthusiastic and did not encourage participation at the level this researcher would have preferred. From a pool of potentially 268 students, 56 participated. This small sample size was acceptable at a large effect level; however, a larger sample size may have provided greater accuracy (Gall et al., 2007). This external limitation could have been improved had data collection occurred before March 2020 or after mandates were lifted in New York public schools on March 2, 2022 (New York State, 2022).

Another external limiting hazard to accurate data collection was the fact that participants watched a one-minute video of the scientific demonstration instead of viewing it live. Survey data collected might have been more precise had the participants experienced the scientific demonstration in person versus watching it projected on a SMART Board. Observing a scientific demonstration in person may have resulted in different choices on the survey participants took right after the demonstration was completed. Duplicating this study in person could influence greater accuracy in the collected data sets.

Recommendations for Future Research

A review of this study's findings brings the following recommendations for subsequent research in cognitive conflict among middle school science students.

1. Utilizing a larger sample size to strengthen data results and support the consideration of resolutions of how to best address the increasing need to fill positions in science, technology, engineering, and mathematics (STEM) created by the disinterest in STEM.
2. Deliver invitations and scientific demonstrations in person and in small, individual classes. This may encourage more participation (larger sample size) and result in less-biased data.
3. This study should be expanded into primary grades with grade-appropriate scientific demonstrations and grade-appropriate language in the follow-up survey.
4. An area to consider for further research is primary and secondary education STEM curriculum development and classroom delivery.

5. Create a study that identifies the connection between improved personal and academic cognition, how to utilize cognitive conflict in a positive way, self-efficacy, self-regulation, and personal agency among primary and secondary students.
6. Utilize a variety of existing instruments that measure primary and secondary learners' level of self-efficacy and self-regulation, components of social cognitive theory.
7. Identify learners not receiving educational services (do not have an IEP or 504 Plan) but could be recommended for such services. This may create a third group among the independent variable.

REFERENCES

Akcay, B., & Akcay, H. (2015). Effectiveness of science-technology-society (STS) instruction on student understanding of the nature of science and attitudes toward science. *International Journal of Education in Mathematics, Science and Technology, 3*(1), 37-45. https://files.eric.ed.gov/fulltext/EJ1059047.pdf

Akpan, J. P., & Beard, L. A. (2016). Using constructivist teaching strategies to enhance academic outcomes of students with special needs. *Universal Journal of Educational Research, 4*(2), 392-398. https://doi.org/10.13189/ujer.2016.040211

Albany County, NY. (2018). Data USA. https://datausa.io/profile/geo/albany-county-ny

Alemdar, M., Moore, R. A., Lingle, J. A., Rosen, J., Gale, J., & Usselman, M. C. (2018). The impact of a middle school engineering course on students' academic achievement and non-cognitive skills. *International Journal of Education in Mathematics, Science and Technology, 6*(4), 363-380. https://doi.org/10.18404/ijemst.440339

Aligaen, J. C. & Capaciete, M. E. C. (2016). Sustainability science as a neo-normal: A case study. *Universal Journal of Educational Research, 4*(10), 2229-2235. https://files.eric.ed.gov/fulltext/EJ1116356.pdf

Alismail, H. A., & McGuire, P. (2015). 21st Century standards and curriculum: Current research and practice. *Journal of Education and Practice, 6*(6), 150-154. https://files.eric.ed.gov/fulltext/EJ1083656.pdf

Alverson, R., DiCicco, M., Faulkner, S. A., & Cook, C. (2019). The status of middle schools in the southeastern United States: Perceptions and implementation of the middle school model. *Middle Grades Review, 5*(2), 1-17. https://files.eric.ed.gov/fulltext/EJ1230727.pdf

Asghar, A., Sladeczek, I. E., Mercier, J., & Beaudoin, E. (2017). Learning in science, technology, engineering, and mathematics: Supporting students with learning disabilities. *Canadian Psychology Association, 58*(3), 238-249. https://psycnet.apa.org/fulltext/2017-31810-005.pdf?auth_token=4023dbe51370d8c3a76585ea331fbaa3513234f3

Ascione, L. (2020, February 4). *10 trends and predictions for STEM education in 2020*. eSchool News: Today's Innovations in Education: https://www.eschoolnews.com/2020/02/04/10-trends-and-predictions-for-stem-education-in-2020/

Ates, Y. T., Ates, H., Ozbek, N., & Afacan, O. (2019). Learning disabled teachers' self-efficacy belief toward science course. *Science Education International, 30*(4), 241-250. http://www.icaseonline.net/journal/index.php/sei/article/view/145

Autieri, S. M., Amirshokoohi, A., & Kazempour, M. (2016). The science-technology-society framework for achieving scientific literacy: An overview of the existing literature. *European Journal of Science and Mathematics Education, 4*(1), 75-89. https://files.eric.ed.gov/fulltext/EJ1107767.pdf

Aydogmus, M., & Sentuirk, C. (2019). The effects of learning stations technique on academic achievement: A meta-analytic study. *Research in Pedagogy, 9*(1), 1-15. https://files.eric.ed.gov/fulltext/EJ1221628.pdf

Badri, M. (2019). School emphasis on academic success and TIMSS science/math achievements. *International Journal of Research in Education and Science 5*(1), 176-189. https://www.ijres.net/index.php/ijres/article/view/376/pdf

Bandura, A. & Walters, R. H. (1963). *Social learning and personality development.* Holt, Rinehart, and Winston.

Bandura, A. (1977a). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84*(2), 191-215. doi:10.1037/0033-295X.84.2.191

Bandura, A. (1977b). *Social learning theory*. Prentice-Hall, Inc.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*, 122-147. https://pdfs.semanticscholar.org/8bee/c556fe7a650120544a99e9e063eb8fcd987b.pdf

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Prentice-Hall, Inc.

Bandura, A. (1988). Organisational applications of social cognitive theory. *Australian Journal of Management, 13*(2), 275-302. doi:10.1177/031289628801300210

Bandura, A. (1989a). Human agency in social cognitive theory. *American Psychologist, 44*(9), 1175-1184. https://doi-org.ezproxy.liberty.edu/10.1037/0003-066X.44.9.1175

Bandura, A. (1989b). Social cognitive theory. In R. Vasta, *Annals of child development: Six theories of child development* (pp. 1-60). JAI Press. Retrieved from https://www.uky.edu/~eushe2/Bandura/Bandura1989ACD.pdf

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117-148. https://www.uky.edu/~eushe2/Bandura/Bandura1993EP.pdf

Bandura, A. (1996). Failures in self-regulation: Energy depletion or selective disengagement? *Psychological Inquiry, 7*, 20-24. https://www-jstor-org.ezproxy.liberty.edu/stable/1449147?pq-origsite=summon&seq=1#metadata_info_tab_contents

Bandura, A. (1999). Social cognitive theory: An agentic perspective. *Asian Journal of Social Psychology, 2*(1), 21-41. https://doi-org.ezproxy.liberty.edu/10.1111/1467-839X.00024

Bandura, A. (2005). The evolution of social cognitive theory. In K. G. Smith, *Great Minds in Management* (pp. 9-35). Oxford: Oxford University Press. https://www.uky.edu/~eushe2/Bandura/Bandura2005.pdf

Bao, L., Kim, Y., Raplinger, A., Han, J., & Koenig, K. (2013). Affective factors in STEM learning and scientific inquiry: Assessment of cognitive conflict and anxiety [PDF document]. *Special Issue of Research on Education Assessment and Learning*. https://arxiv.org/ftp/arxiv/papers/1403/1403.0599.pdf

Berliner, D., Lambek, M., Shweder, R., Irvine, R., & Piette, A. (2016). Anthropology and the study of contradictions. *Journal of Ethnographic Theory*, *6*(1), 1-27. https://www.journals.uchicago.edu/doi/10.14318/hau6.1.002

Bircan, H., & Sungur, S. (2016). The role of motivation and cognitive engagement in science achievement. *Science Education International, 27*(4), 509-529. https://files.eric.ed.gov/fulltext/EJ1131144.pdf

Bird, C. M. (2017). The role of the hippocampus in recognition memory. *Cortex, 93*, 155-165. https://www.sciencedirect.com/science/article/pii/S0010945217301715?via%3Dihub

Bonal, X., & González, S. (2020). The impact of lockdown on the learning gap: family and school divisions in times of crisis. *International Review of Education, 66*(5-6), 635-655. https://doi.org/10.1007/s11159-020-09860-z

Booth, A., Hennessy, E., & Doyle, O. (2018). Self-regulation: Learning across disciplines. *Journal of Child & Family Studies, 27*(12), 3767-3781. https://doi.org/10.1007/s10826-018-1202-5

Bozkurt, A., Ucar, H., Durak, G., & Idin, S. (2019). The current state of the art in STEM research: A systematic review study. *Cypriot Journal of Educational Sciences, 14*(3), 374-383. https://files.eric.ed.gov/fulltext/EJ1231579.pdf

Brockman, R., Ciarrochi, J., Parker, P., & Kashdan, T. (2017). Emotion regulation strategies in daily life: mindfulness, cognitive reappraisal and emotion suppression. *Cognitive Behaviour Therapy*, *46(*2), 91-113. https://www.tandfonline.com/doi/pdf/10.1080/16506073.2016.1218926?needAccess=true

Brophy, B. (2017). *The Curious Incident of the Ping-Pong Ball and the Hairdryer* [LinkedIn page]. https://www.linkedin.com/pulse/curious-incident-ping-pong-ball-hairdryer-barry-brophy

Chao, P., & Chou, Y. (2017). Correlation and predictive relationship between self-determination instruction and academic performance of students with learning disabilities. *Universal Journal of Educational Research, 5*(5), 799-805. https://files.eric.ed.gov/fulltext/EJ1143907.pdf

Clark, I. (2015). Formative assessment: Translating high-level curriculum principles into classroom practice. *Curriculum Journal, 26*(1), 91-114. https://doi.org/10.1080/09585176.2014.990911

Common Core Curriculum & Assessments. (n.d.). EngageNY: https://www.engageny.org/common-core-curriculum-assessments

Cook, D., & Artino, A. R. (2016). Motivation to learn: An overview of contemporary theories. *Medical Education, 50*, 997-1014. https://doi.org/10.1111/medu.13074

Creswell, J. W., & Guetterman, T. C. (2019). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (6th ed.). Pearson.

Deksissa, T., Liang, L. R., Behera, P., & Harkness, S. J. (2014). Fostering significant learning in sciences. *International Journal for the Scholarship of Teaching and Learning, 8*(2). https://doi.org/10.20429/ijsotl.2014.080212

Districts: Enrollment. (2019).data.nysed.gov. https://data.nysed.gov/enrollment.php?year=2019&instid=800000055260

Donmez, I., & Tasar, M. F. (2020). A self-study of the values and beliefs of science teachers and their science, technology, engineering and mathematics (STEM) applications. *Participatory Educational Research, 7*(1), 59-79. https://files.eric.ed.gov/fulltext/EJ1244217.pdf

Dorrenbacher, L., & Perels, F. (2015). Volition completes the puzzle: Development and evaluation of an integrative trait. *Frontline Learning Research, 3*(4), 14-36. https://journals.sfu.ca/flr/index.php/journal/article/view/179/268

Dragoo, K. E., & Cole, J. P. (2019). *Laws affecting students with learning disabilities: Preschool through postsecondary education.* CRS Report R45595, Version 5. Congressional Research Service. https://files.eric.ed.gov/fulltext/ED597875.pdf

du Toit-Brits, C. (2019). A focus on self-directed learning: The role that educators' expectations play in enhancement of students' self-directedness. *South African Journal of Education, 39*(2), 1-9. https://doi.org/10.15700/saje.v39n2a1645

El Takach, S., & Yacoubiam, H. (2020). Science teachers' and their students' perceptions of science and scientists. *International Journal of Education in Mathematics, Science and Technology, 8*(1), 65-75. https://files.eric.ed.gov/fulltext/EJ1240534.pdf

Ellerbrock, C. R., Main, K., Falbe, K. N., & Franz, D. P. (2018). An examination of middle school organizational structures in the United States and Australia. *Education Sciences, 8*, 1-18. https://www.mdpi.com/2227-7102/8/4/168/htm

Fletcher, A. K. (2016). Exceeding expectations: Scaffolding agentic engagement through assessment as learning. *Educational Research, 58*(4), 400-419. https://doi.org/10.1080/00131881.2016.1235909

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Pearson Education, Inc.

Gerlach, J. (2012, April 11). STEM: Defying a simple definition. *National Science Teaching Association*. https://www.nsta.org/publications/news/story.aspx?id=59305

Gitari, W. (2016). The application of school science by urban high school youth through problem-solving in everyday life. *Science Education International, 27*(3), 344-368. https://files.eric.ed.gov/fulltext/EJ1118432.pdf

Green, S. B., & Salkind, N. J. (2017). *Using SPSS for Windows and Macintosh: Analyzing and Understanding the Data* (8th ed.). Pearson Education, Inc.

Hacieminoglu, E. (2016). Elementary school students' attitude toward science and related variables. *International Journal of Environmental and Science Education, 11*(2), 35-52. https://files.eric.ed.gov/fulltext/EJ1086987.pdf

Hallinen, J. (2015, October 21). *STEM*. Encyclopedia Britannica: https://www.britannica.com/topic/STEM-education

Horsley, J., & Moeed, A. (2018). "Inspire Me" - high-ability students' perceptions of school science. *Science Education International, 29*(3), 163-173. https://files.eric.ed.gov/fulltext/EJ1190542.pdf

Hwang, J., & Taylor, J. C. (2016). Stemming on STEM: A STEM education framework for students with learning disabilities. *Journal of Science Education for Students with learning disabilities*, *19*(1), 39-49. https://files.eric.ed.gov/fulltext/EJ1169381.pdf

Jamieson, J. P., Crum, A. J., Goyer, J. P., Marotta, M. E., & Akinola, M. (2018). Optimizing stress responses with reappraisal and mindset interventions: an integrated model. *Anxiety, Stress, & Coping, 31*(3), 245-261. https://files.eric.ed.gov/fulltext/ED585077.pdf

Jufrida, J., Basuki, F. R., Kurniawan, W., Pagestu, M. D., & Fitaloka, O. (2019). Scientific Literacy and Science Learning Achievement at Middle School. *International Journal of Evaluation and Research in Education, 8*(4), 630-636. https://files.eric.ed.gov/fulltext/EJ1238303.pdf

Kalatskaya, N. N., Selivanova, O. G., & Ilesanmi, R. A. (2016). Personal meanings of learning in the process of formation of students' subjectivity. *International Journal of Environmental and Science Education, 11*(5), 685-692. https://doi.org/10.12973/ijese.2016.341a

Kang, S., Scharmann, L. C., & Noh, H. (2004). Reexamining the role of cognitive conflict in science concept learning. *Research in Science Education, 34*, 71-96. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.469.686&rep=rep1&type=pdf

Kang, S., Scharmann, L. C., Noh, T., & Koh, H. (2011). The influence of students' cognitive and motivational variables in respect of cognitive conflict and conceptual change. *International Journal of Science Education, 27*(9), 1037-1058. https://www.researchgate.net/publication/228355571_The_influence_of_students'_cognitive_and_motivational_variables_in_respect_of_cognitive_conflict_and_conceptual_change

Karacam, S. (2016). Scientist-image stereotypes: The relationships among their indicators. *Educational Sciences: Theory and Practice, 16*(3), 1027-1049. https://doi.org/10.12738/estp.2016.3.0005

Khalil, M. K., & Elkhider, I. A. (2016). Applying learning theories and instructional design models for effective instruction. *Advances in Physiology Education*, *40*(2), 147-156. https://doi.org/10.1152/advan.00138.2015

Kim, Y., & Bao, L. (2008). Assessment of students' cognitive conflicts and anxiety. *Journal of Korean Association for Research in Science Education*, *28*(3), 227-240. https://www.researchgate.net/publication/264079723_Assessment_of_Students'_Cognitive_Conflicts_and_Anxiety

Kim, Y., & Kwon, J. (2004). Students' attributions and characteristics of cognitive conflict resolution in physics learning. In Y. Park, *Teaching and Learning of Physics in Cultural Contexts* (pp. 251-270). World Scientific Publishing Co. Pte. Ltd. https://doi.org/10.1142/9789812702890_0024

Knight, T. (2017). Enhanced student success through personalized learning strategies. *BU Journal of Graduate Studies in Education, 9*(1), 38-41. https://files.eric.ed.gov/fulltext/EJ1230424.pdf

Kubat, U. (2018). The integration of STEM into science classes. *World Journal on Educational Technology: Current Issues, 10*(3), 165-173. https://files.eric.ed.gov/fulltext/EJ1185407.pdf

Kubat, U., & Guray, E. (2018). To STEM or not to STEM? That is not the question. *Cypriot Journal of Educational Sciences, 13*(3), 395-406. https://files.eric.ed.gov/fulltext/EJ1193465.pdf

Labonte, C., & Smith, V. R. (2019). Validation of a questionnaire assessing students' self-directed and collaborative learning with and without technology in Canadian middle school classrooms. *Canadian Journal of Learning and Technology, 45*(2), 1-19. https://files.eric.ed.gov/fulltext/EJ1232515.pdf

Laine, E., Veermans, M., Gegenfurtner, A., & Veermans, K. (2020). Individual interest and learning in secondary school STEM education. *Frontline Learning Research, 8*(2), 90-108. https://files.eric.ed.gov/fulltext/EJ1252769.pdf

Learning Disability Association of America. (2012, September 22). *What are learning disabilities.* https://ldaamerica.org/advocacy/lda-position-papers/what-are-learning-disabilities/

Lee, E. (2017). Effects of South Korean high school students' motivation to learn science and technology on their concern related to engineering. *Educational Sciences: Theory and Practice, 17*(2), 549-571. https://doi.org/10.12738/estp.2017.2.0160

Lee, G., & Byun, T. (2012). An explanation for the difficulty of leading conceptual change using a couterintuitive demonstratuion: The relationship between cognitive conflict and responses. *Research in Science Education, 42,* 943-965. https://link.springer.com/article/10.1007/s11165-011-9234-5

Lee, G., Kwon, J., Park, S., Kim, J., Kwon, H., & Park, H. (2003). Development of an instrument for measuring cognitive conflict in secondary-level science classes. *Journal of Research in Science Teaching, 40*(6), 585-603. https://doi.org/10.1002/tea.10099

Li, L., Qin, B., & Liu, T. (2017). Contradiction detection with contradiction-specific word embedding. *Algorthms, 10*(2),1-14. https://www.mdpi.com/1999-4893/10/2/59

Liang, F., & Li, P. (2019). Characteristics of cognitive in children with learning difficulties. *Translational Neuroscience, 10*, 141-146. https://doi.org/10.1515/tnsci-2019-0024

Libao, N. J. P., Sagun, J. J. B., Tamagan, E. A., Pattalitan, A. P., Dupa, M. E. D., & Bautista, R. G. (2016). Science learning motivation as correlate of students' academic performances. *Journal of Technology and Science Education, 6*(3), 209-218. htpps://doi.org/10.3926/jotse.231

Liu, W., Liu, F., Chen, L., Jiang, Z., & Shang, J. (2019). Cognitive reappraisal in children: Neuropsychological evidence of up-regulating positive emotion from an ERP study. *Frontiers in Psychology, 10*(147), 1-10. https://www.frontiersin.org/articles/10.3389/fpsyg.2019.00147/full

Lotter, C. R., Thompson, S., Dickenson, T. S., Smiley, W. F., Blue, G., & Rea, M. (2018). The impact of a practice-teaching professional development model on teachers' inquiry instruction and inquiry efficacy beliefs. *International Journal of Science & Mathematics Education, 16*(2), 255-273. https://doi.org/10.1007/s10763-016-9779-x

Mahoney, M. (2020, January). Implementing evidence-based practices within multi-tiered systems of support to promote inclusive secondary classroom settings. *The Journal of Learning disabled Apprenticeship, 9*(1), 1-12. https://files.eric.ed.gov/fulltext/EJ1241841.pdf

Marksbury, N. (2017). Monitoring the pipeline: STEM education in rural U.S. *Forum on Public Policy Online, 2017*(2), 1-20. https://files.eric.ed.gov/fulltext/EJ1173822.pdf

Martin, J. (2004). Self-regulated learning, social cognitive theory, and agency. *Educational Psychologist, 39*(2), 135-145. https://doi.org/10.1207/s15326985ep3902_4

Merali, A. (n.d.). Floating ping-pong balls. *Physics Central*: https://www.physicscentral.com/experiment/physicsathome/ping-pong-physics.cfm#:~:text=The%20ping%2Dpong%20ball%20stays,than%20the%20air%20around%20it.

Moeed, A., & Easterbrook, M. (2016). Promising teacher practices: Students' views about their science learning. *European Journal of Science and Mathematics Education, 4*(1), 17-25. https://files.eric.ed.gov/fulltext/EJ1107742.pdf

Morris, D., Usher, E., & Chen, J. (2017). Reconceptualizing the sources of teaching self-efficacy: A critical review of emerging literature. *Educational Psychology Review, 29*(4), 795-833. https://doi.org/10.1007/s10648-016-9378-y

National Center for Education Statistics. (2019, May). *The condition of education.* https://nces.ed.gov/programs/coe/indicator_cta.asp

New York State Department of Education. (2019). *Curriculum and instruction: Science.* http://www.nysed.gov/curriculum-instruction/science

New York Department of Labor. (2019, October). *Significant industries capital region* [PDF document]. (2019, October). https://labor.ny.gov/stats/PDFs/Significant-Industries-Capital-Region.pdf

New York State. (2022, February 27). Governor Hochul announces plan to end mask requirement in schools starting March 2 [press release]. https://www.governor.ny.gov/news/governor-hochul-announces-plan-end-state-mask-requirement-schools-starting-march-2#:~:text=Governor%20Kathy%20Hochul%20today%20announced,parents%2C%20teachers%20and%20school%20administrators.

Next Generation Science Standards for States, by States. (2018). Next Generation Science Standards. https://www.nextgenscience.org/lead-state-new-york

NYSED Office of Special Education. (2020, January 14). http://www.p12.nysed.gov/specialed/

Odudukudu, M. (2019). Pure and objective thinking: Interest and desire. *SAGE Open, 9(*2). https://journals.sagepub.com/doi/10.1177/2158244019844086

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66*(4), 543-578. https://ssrlsite.files.wordpress.com/2018/02/pajares-1996-self-efficacy-beliefs-in-academic-settings.pdf

Panadero, E. (2017, April 28). *A review of self-regulated learning: Six models and four directions for research*. Frontiers in Psychology. https://www.frontiersin.org/articles/10.3389/fpsyg.2017.00422/full

Permatasari, R. & Suyono. (2016). *Description of Cognitive Conflict Levels in Chemistry College Students in Conceptual Change Strategy*. https://www.researchgate.net/publication/313027201_Description_of_Cognitive_Conflict_Levels_in_Chemistry_College_Students_in_Conceptual_Change_Strategy

Rovai, A. P., Baker, J. D., & Ponton, M. K. (2013). *Social science research design and statistics: A practitioner's guide to research methods and SPSS analysis.* Waterfree Press, LLC.

Saw, G. K., Swagerty, B., Brewington, S., Chang, C., & Culbertson, R. (2019). Out-of-school time STEM program: Students' attitudes toward and career interests in mathematics and science. *International Journal of Evaluation and Research in Education, 8*(2), 356-362. https://doi.org/10.11591/ijere.v8i2.18702

Schrik, P., & Wasonga, T. A. (2019). The role of a school leader in academic outcomes: Between self-efficacy and outcome expectations. *Athens Journal of Education, 6*(4), 291-306. https://files.eric.ed.gov/fulltext/EJ1235230.pdf

Schulze, S., & van Heerden, M. (2015). Learning environments matter: Identifying influences on the motivation to learn science. *South African Journal of Education, 35*(2), 1-9. https://files.eric.ed.gov/fulltext/EJ1135006.pdf

Schunk, D. (2016). *Learning theories: An educational perspective* (7th ed.). Pearson.

Schwichow, M., Croker, S., Zimmerman, C., Hoffler, T., & Hartig, H. (2016). Teaching the control-of-variables strategy: A meta-analysis. *Developmental Review, 39*, 37-63. https://www.sciencedirect.com/science/article/pii/S0273229715000581

Shammari, Z. A., & Faulkner P. E. (2019). Effects of learning disabled teachers' specialization and teaching experience on using evidence-based cognitivist instructional strategies in inclusion classrooms [PDF document]. *International Conference on Research in Education, Teaching and Learning.* Paris. https://www.dpublication.com/wp-content/uploads/2019/04/8-ICETL-O-324.pdf

Smith, V. D., & Darvas, J. W. (2017). Encouraging student autonomy through higher order thinking skills. *Journal of International Research, 6,* 29-34. https://files.eric.ed.gov/fulltext/EJ1153306.pdf

Snyder, T. D. (1993, January). *120 Years of American education: A statistical portrait* [PDF document]. National Center for Education Statistics. https://nces.ed.gov/pubs93/93442.pdf

Staus, N. L., Falk, J. H., Penuel, W., Dierking, L., Wild, J., & Bailey, D. (2020). Interested, disinterested, or neutral: Exploring STEM interest profiles and pathways in a low-income urban community. *EURASIA Journal of Mathematics, Science and Technology Education. 16*(6). https://www.ejmste.com/download/interested-disinterested-or-neutral-exploring-stem-interest-profiles-and-pathways-in-a-low-income-7927.pdf

Stubbs, E. A., & Myers, B. E. (2016). Part of what we do: Teacher perceptions of STEM integration. *Journal of Agricultural Education*, *57*(3), 87-100. https://files.eric.ed.gov/fulltext/EJ1123039.pdf

Tatar, E., Tüysüz, C., Tosun, C., & Ilhan, N. (2016). Investigation of factors affecting students' science achievement according to student science teachers. *International Journal of Instruction*, *9*(2), 153-166. https://files.eric.ed.gov/fulltext/EJ1106343.pdf

Taylor, J. C., Tseng, C., Murillo, A., Therrien, W., & Hand, B. (2018) Using argument-based science inquiry to improve science achievement for students with learning disabilities in inclusive classrooms. *Journal of Science Education for Students with Learning Disabilities, 21*(1), 1-14. https://files.eric.ed.gov/fulltext/EJ1172295.pdf

Taylor, M. W. (2016). From effective curricula toward effective curriculum use. *Journal for Research in Mathematics Education*, *47*(5), 440-453. https://doi.org/10.5951/jresematheduc.47.5.0440

Thompson, V. (2018, June 25). *What percent of high school students attend college after graduation?* https://www.theclassroom.com/percentage-high-school-students-attend-college-after-graduation-1423.html

Thoutenhoofd, E. D., & Pirrie, A. (2015). From self-regulation to learning to learn: Observations on the construction of self and learning. *British Educational Research Journal, 41*(1), 72-84. https://doi.org/10.1002/berj.3128

United States Census Bureau. (2019). https://www.census.gov/quickfacts/watervlietcitynewyork

Urbani, J. M., Roshandel, S., Michaels, R., & Truesdell, E. (2017). Developing and modeling 21-st century skills with perservice teachers. *Teacher Education Quarterly*, *44*(4), 27-50. https://files.eric.ed.gov/fulltext/EJ1157317.pdf

US Department of Education. (n. d.). *Science, Technology, Engineering, and Math, including Computer Science.* https://www.ed.gov/stem

VanUitert, V. J., Kennedy, M. J., Romig, J. E., & Carlisle, L. M. (2020). Enhancing science vocabulary knowledge of students with learning disabilities using explicit instruction and multimedia. *Learning Disabilities: A Contemporary Journal*, *18*(1), 3-25. https://files.eric.ed.gov/fulltext/EJ1264269.pdf

Wallace, E., & Bodzin, A. M. (2017). Developing scientific citizenship identity using mobile learning and authentic practice. *Electronic Journal of Science Education*, *21*(6), 46-71. https://files.eric.ed.gov/fulltext/EJ1187996.pdf

Warner, R. M. (2013). *Applied statistics from bivariate through multivariate techniques,* (2nd ed.). Sage Publications, Inc.

Winarti, A., Yuanita, L., & Nur, M. (2019). The effectiveness of multiple intelligences based teaching strategy in enhancing the multiple intelligences and science process skills of middle school students. *Journal of Technology and Science Education*, *9*(2), 122-135. https://doi.org/10.3926/jotse.404

Wong, L., Chan, T., Chen, W., Looi, C., Chen, Z., Liao, C. C. Y., King, R. B., & Wong, S. L. (2020). IDC theory: interest and the interest loop. *Research and Practice in Technology Enhanced Learning*, *15*(3). https://doi.org/10.1186/s41039-020-0123-2

Yang, L. (2016). Interpersonal relationships and the development of student interest in science. *Electronic Journal of Science Education, 20*(1), 18-38. https://files.eric.ed.gov/fulltext/EJ1188261.pdf

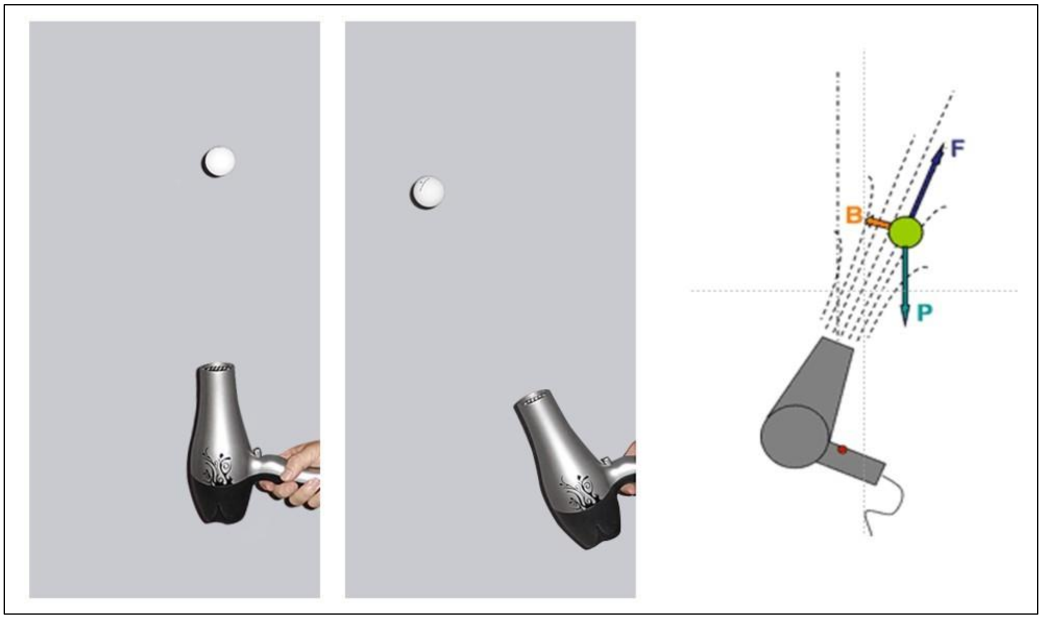
Yüksel, M., & Geban, O. (2016). Examination of science and math course achievements of vocational high school students in the scope of self-efficacy and anxiety. *Journal of Education and Training Studies, 4*(1), 88-100. https://files.eric.ed.gov/fulltext/EJ1078586.pdf

Zimmer, K. E., McHatton, P. A., Driver, M. K., Datubo-Brown, C. A., & Steffen, C. (2018). Innovative Communities: Embedding Special Education Faculty in Science Methods Courses. *Teacher Education Quarterly, 45*(4), 73-92. https://files.eric.ed.gov/fulltext/EJ1193791.pdf

Zohar, A., & Aharon-Kravetsky, S. (2005, September). Exploring the effects of cognitive conflict and direct teaching for students of different academic levels. *Journal of Research in Science Teaching, 42*(7), 829-855. https://doi.org/10.1002/tea.20075

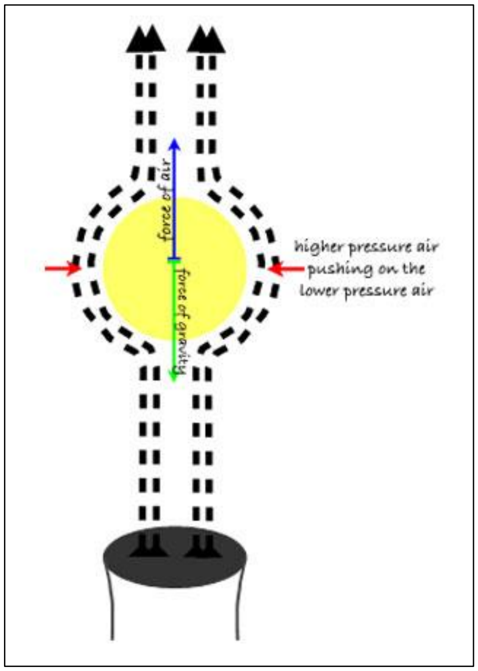
Appendix A: Science Demonstration Diagram

Figure 1A Ping Pong Ball and Hairdryer



Note. From "The curious incident of the ping-pong ball and the hairdryer" by A. Brophy, B., 2017, https://www.linkedin.com/pulse/curious-incident-ping-pong-ball-hairdryer-barry-brophy

Figure 1B Bernoulli's Principal Explained on Ping-Pong Ball



Note. From "Floating ping-pong balls" by A. Merali, A., n.d., *Physics Central.* https://www.physicscentral.com/experiment/physicsathome/ping-pong-physics.cfm#:~:text=The%20ping%2Dpong%20ball%20stays,than%20the%20air%20around%20it.

Appendix B: Permission to Use and Publish Cognitive Conflict Levels Test Instrument

On Fri 8/28/2020 1:36 PM, Randall, Stephanie wrote:

To: [redacted]
Cc: Ford, Angela (School of Education)

Subject: Request to Use Your CCLT In My Doctoral Research

Dear Dr. Lee,
I am a doctoral student in the School of Education at Liberty University completing my dissertation titled, Differences in Cognitive Conflict Levels Between Learning disabled and General Education Middle Science Students, under the direction of my dissertation committee chaired by Dr. Angela Ford, who may be reached at [redacted]
I am requesting permission to utilize the Cognitive Conflict Levels test survey/questionnaire instrument in my research study. Your instrument would be used and printed with the following conditions:

- I will use the CCLT only for my research study and will not sell or use it with any compensation or curriculum development activities.
- I will include a citation of your work on all copies of the instrument.
- I will send a copy of my completed research study to your attention upon completion of the study.

A citation of your work in my dissertation and any published manuscripts will be shown as follows:
Lee, G., Kwon, J., Park, S., Kim, J., Kwon, H., & Park, H. (2003). Development of an instrument for measuring cognitive conflict in secondary-level science classes. *Journal of Research in Science Teaching*, *40*(6), 585-603. https://doi.org/10.1002/tea.10099
Should this request and conditions be acceptable, please inform me of your decision through this email address [redacted]

Thank you for your consideration of this request.

Best regards,

Stephanie Randall
Doctoral Candidate
School of Education
Liberty University
Lynchburg, VA, USA

On Thu 9/3/2020 2:36 AM, [redacted] wrote:

Dear Stephanie Randall,
How are you?
I am very happy to have your request.
You request and conditions are acceptable.
I send you my permission to use CCLT.
If you have any question about CCLT and related issues, please let me know.
I wish you have a great time in your dissertation work.
With my best wishes,

Gyoungho Lee
Professor
Department of Physics Education
Seoul National University, South Korea

From: "Randall, Stephanie" [redacted]
To: [redacted] [redacted]
Cc:
Sent: 2022-07-08 (금) 01:03:39 (UTC+09:00)

Subject: Re: [External] RE: Permission to Use the Cognitive Conflict Levels Test (CCLT)

Hello Dr. Lee,

I hope you are doing well and staying safe.

In September of 2020, you gave me permission to use your CCLT as the instrument for the research of my dissertation.

I have just successfully defended my dissertation and a Liberty University requirement is to upload it to their library's Scholars Crossing section.

The university is requesting proof that you give me permission to ***publish*** the use of your CCLT.

Thank you and once my dissertation is published at my university library, I will send you a copy.

Be well ~ Stephanie

Stephanie E. Randall, Ed.D.
School of Education
Liberty University

[redacted]
To: Randall, Stephanie
Fri 7/8/2022 2:35 AM

Dear Dr. Randall,

How are you?

Thank you very much for the good news.
Congratulations on your graduation.

And I gladly consent to the use of CCLT.
[I give you permission to ***publish*** the use of my CCLT!]

I pray that the path of God's blessing will unfold after your graduation.

With my best wishes,

Gyoungho Lee

Professor
Department pf Physics Education
Seoul National University, South Korea

Appendix C: Institutional Review Board Approval

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

September 3, 2021

Stephanie Randall
Angela Ford

Re: IRB Approval - IRB-FY21-22-55 Cognitive Conflict Levels Between Middle School Students With Learning Disabilities and Students Without Learning Disabilities

Dear Stephanie Randall, Angela Ford:

We are pleased to inform you that your study has been approved by the Liberty University Institutional Review Board (IRB). This approval is extended to you for one year from the following date: September 3, 2021. If you need to make changes to the methodology as it pertains to human subjects, you must submit a modification to the IRB. Modifications can be completed through your Cayuse IRB account.

Your study falls under the expedited review category (45 CFR 46.110), which is applicable to specific, minimal risk studies and minor changes to approved studies for the following reason(s):

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your stamped consent form(s) and final versions of your study documents can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. Your stamped consent form(s) 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(s) should be made available without alteration.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

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

Appendix D: Consent Forms

Middle School Science Study Participation Script

Hello Science Students,

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 purpose of my research is to see how a student's understanding (thinking) of a particular scientific demonstration is received and if you meet my participant criteria and are interested, I would like to invite you to join my study.

Participants must be middle school science students. Participants, if willing, will be asked to watch a 2-minute video of a science demonstration and then decide at what level they agree with 12 statements on a survey which should take approximately 20 minutes. Participation will be completely anonymous, and no personal, identifying information will be collected.

Would you like to participate? Great!

A packet containing a recruitment letter and consent document will be sent home with you today. The consent document contains additional information about my research. After your parent/guardian has read the consent form, they would only sign it to opt you out of the study, and then you would return the signed form to your science teacher. If your parent/guardian allows you to participate, they will understand that not returning the consent document gives you permission to take part in the study and indicates that they have read the consent information.

Thank you for your time. Do you have any questions?

Appendix E: Consent Forms

October 25, 2021

Dear Middle School Parent/Guardian,

As a graduate student in the School of 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 evaluate what level of agreement a middle school science student does or does not have with a scientific demonstration, and I am writing to invite eligible participants to join my study.

Participants must be a middle school student. Participants, if willing, will be asked to watch a 2minute video of a scientific demonstration and then choose the level of agreement they have with 12 statements on a short survey. It should take approximately 20 minutes to complete the procedure listed. Participation will be completely anonymous, and no personal, identifying information will be collected.

To participate, please follow the instructions on the attached parental/guardian consent document. The consent document is attached to this letter. The consent document contains additional information about my research. If you choose to participate, no further action is required. If you choose not to participate, please complete the opt-out section of the consent form and have your child return it to their science teacher by October 29, 2021.

Sincerely,

[redacted]

Stephanie E. Randall
Doctoral Candidate [redacted]
[redacted]

Child Assent to Participate in a Research Study

What is the name of the study and who is doing the study?
The name of the study is *Cognitive Conflict Levels Between Middle School Students With Learning Disabilities and Students Without Learning Disabilities* and the person doing the study is Ms. Stephanie Randall.

Why is Ms. Randall doing this study?
Ms. Randall wants to know what and how you might think about observing a specific scientific demonstration.

Why am I being asked to be in this study?
You are being asked to be in this study because you are a middle school science student.

If I decide to be in the study, what will happen and how long will it take?
If you decide to be in this study, you will watch a two-minute video of a science demonstration and then decide at what level you agree or disagree with twelve survey statements, which will take approximately twenty minutes.

Do I have to be in this study?
No, you do not have to be in this study. If you want to be in this study, then tell the researcher. If you don't want to, it's OK to say no. The researcher will not be angry. You can say yes now and change your mind later. It's up to you.

What if I have a question?
You can ask questions any time. You can ask now. You can ask later. You can talk to the researcher. If you do not understand something, please ask the researcher to explain it to you again.

Signing my name below means that you want to be in the study.

____

Signature of Child   Date

Ms. Stephanie Randall
[redacted]

Dr. Angela Ford
[redacted]

Liberty University Institutional Review Board
1971 University Blvd, Green Hall 2845, Lynchburg, VA 24515
[redacted]

Liberty University
IRB-FY21-22-55
Approved on 9-3-2021

Parental/Guardian Consent and Parental/Guardian Opt-Out Form For a Brief Science Class Survey

Title of the Project: Cognitive Conflict Levels Between Middle School Students with Learning Disabilities and Students Without Learning Disabilities

Principal Investigator: Stephanie Randall, Science Education, Doctoral Candidate
Liberty University

Invitation to be Part of a Research Study

Your child is invited to participate in a research study. Participants must be in middle school. Taking part in this research project is voluntary.

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

What is the study about and why are we doing it?

The purpose of this study is to determine if there is a difference in cognitive conflict *(misunderstanding of a scientific concept)* among middle school students with or without a learning disability after viewing a science demonstration. This study is being conducted to understand how to improve science, technology, engineering, and mathematic curricula.

What will participants be asked to do in this study?

If you agree to allow your child to be in this study, I will ask him/her to do the following things:

1. Watch a two-minute video of a science demonstration.
2. Take a survey of 12 statements that your child will agree or disagree with. The survey should take approximately 20 minutes.

How could participants 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 the potential for improved interest in science, technology, engineering, and mathematics that may encourage students toward careers in science, helping to fill those positions.

What risks might participants experience from being in this study?

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

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 will have access to the records.

- Participant responses will be anonymous to the researcher
- When they complete the survey, the student participants will write their names on their survey forms. After they turn in their surveys, their teachers will mark on each survey whether the student has an IEP or 504 Plan or not, and then the teachers will remove the students' names before providing the completed surveys to the researcher.
- Data will be stored on a password-locked computer and may be used in future presentations.

Parental/Guardian Consent and Parental/Guardian Opt-Out Form
For a Brief Science Class Survey

Title of the Project: Cognitive Conflict Levels Between Middle School Students with Learning Disabilities and Students Without Learning Disabilities
Principal Investigator: Stephanie Randall, Science Education, Doctoral Candidate
Liberty University

Invitation to be Part of a Research Study

Your child is invited to participate in a research study. Participants must be in middle school. Taking part in this research project is voluntary.

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

What is the study about and why are we doing it?

The purpose of this study is to determine if there is a difference in cognitive conflict *(misunderstanding of a scientific concept)* among middle school students with or without a learning disability after viewing a science demonstration. This study is being conducted to understand how to improve science, technology, engineering, and mathematic curricula.

What will participants be asked to do in this study?

If you agree to allow your child to be in this study, I will ask him/her to do the following things:

1. Watch a two-minute video of a science demonstration.
2. Take a survey of 12 statements that your child will agree or disagree with. The survey should take approximately 20 minutes.

How could participants 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 the potential for improved interest in science, technology, engineering, and mathematics that may encourage students toward careers in science, helping to fill those positions.

What risks might participants experience from being in this study?

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

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 will have access to the records.

- Participant responses will be anonymous to the researcher

- When they complete the survey, the student participants will write their names on their survey forms. After they turn in their surveys, their teachers will mark on each survey whether the student has an IEP or 504 Plan or not, and then the teachers will remove the students' names before providing the completed surveys to the researcher.
- Data will be stored on a password-locked computer and may be used in future presentations.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect your or his/her current or future relations with Liberty University or Watervliet City Schools. If you decide to allow your child to participate, she or he is free to not answer any question or withdraw at any time prior to submitting the survey without affecting those relationships.

What should be done if a participant wishes to withdraw from the study?

If you choose to withdraw your child from the study or your child chooses to withdraw, please inform the researcher that you or your child wish to discontinue their participation, and your child should not submit the study materials. Your child's 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 Stephanie Randall. you may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at [redacted]. You may also contact the researcher's faculty sponsor, Dr. Angela Ford, at [redacted]

Whom do you contact if you have questions about 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.

Disclaimer: The Institutional Review Board (IRB) is tasked with ensuring that human subjects research will be conducted in an ethical manner as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University

Your Opt-Out

If you would prefer that your child NOT PARTICIPATE in this study, please sign this document and return it to your child's science teacher by October 29, 2021. If you choose to allow your child to participate, no further action is required.

____

Printed Child's/Student's Name

____

Parent's Signature Date

Appendix F: Cognitive Conflict Levels Test Instrument

Survey Taken After Observing a Scientific Demonstration

1. When I saw the results, I had doubts about the reasons.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

2. When I saw the result, I was surprised by it.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

3. The difference between the result and my expectation made me feel strange.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

4. The result of the demonstration is interesting.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

5. Since I saw the result, I have been curious about it.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

6. The result of the demonstration attracts my attention.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

7. The result of the demonstration confuses me.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

8. Since I cannot solve the problem, I am uncomfortable.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

9. Since I cannot understand the reason for the result, I feel depressed.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

10. I would like to understand further whether my idea is incorrect .

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

11. I need to think about the reason for the result a little longer.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

12. I need to find a proper base for explaining the result.

Check ONLY ONE Answer:
[ ] Strongly Disagree
[ ] Disagree
[ ] Undecided
[ ] Agree
[ ] Strongly Agree

(Lee et al., 2003)