2017

Improving Instructional Strategies in Higher Education for Students with a Learning Disability in a General Education Science Course

Brian Ogle
University of Central Florida

IMPROVING INSTRUCTIONAL STRATEGIES IN HIGHER EDUCATION FOR STUDENTS WITH A LEARNING DISABILITY IN A GENERAL EDUCATION SCIENCE COURSE

by

BRIAN W. OGLE

A.A.S. Iowa Western Community College, 2008
B.S. Bellevue University, 2011
M.S. Canisus College, 2014

A dissertation in practice submitted in partial fulfillment of the requirements
for the degree of Doctor of Education
in the College of Education and Human Performance
at the University of Central Florida
Orlando, Florida

Summer Term
2017

Major Professor: Thomas Cox

ABSTRACT

This Dissertation in Practice employed a mixed-methods design to identify preferred instructional methods in a college level science course as well as the self-reported challenges to learning science in college by students with a learning disability. In addition, the relationships between preferred instructional strategies and learner characteristics such as declared major, and learning disability were examined.

Qualitative and quantitative data was collected from a sample of 48 participants using an electronic survey. Additionally, eight participants participated in focus groups to collect in-depth qualitative data. All participants are current students enrolled full-time at Beacon College. Each participant completed a science college course and has a diagnosed learning disability. Analysis of the data demonstrated hands-on instruction guided by the instructor is the preferred method of learning and the use of traditional lecture and cooperative learning are self-reported as being least helpful to this student population to learn science.

Findings from this study were provided to Beacon College to shape instruction in science courses as well as to shape recommendations for future research activities. Intentional design of instruction following the recommendations found in this study should assist in increasing student performance in college science courses as well as increase engagement to science as a process and field of study.

This dissertation is dedicated to my grandmother and mother, who both provided me the encouragement and pushed me throughout my lifetime to become the best individual possible. Without their love and support I would have never became the dedicated person I am today.

This dissertation is also dedicated to my partner, Matthew, who has always stood by my side, while providing me with the structure and patience needed for me to pursue my dreams. Without this support, I would not have achieved my goals both professionally and academically.

Finally, I would like to dedicate this work to my administrators, colleagues, and students of Beacon College. Through my experiences at the College, I have grown personally and professionally. These individuals provide me the strength to better myself as an educator and professional. Your passion influenced the selection of this topic and encouraged me to work as hard as possible to better serve each of you.

ACKNOWLEDGMENTS

I want to acknowledge the academic expertise of my dissertation committee. Dr. Cox, you provided me with a practical insight into research and your guidance as a professor and committee chair has been invaluable. To my other committee members, Dr. Thomas Vitale, Dr. Laurie Campbell, and Dr. Shelly Chandler, your coaching throughout this process has been vital to my success.

I also want to acknowledge all of the professors in the program. Your dedication to me as a learner and as an individual inspired and empowered me as a learner and as a professional educator. I am forever changed as a direct result of your teachings.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

ADHD:	Attention Deficit Hyperactivity Disorder
CIP:	Cognitive Information Processing
IDEA:	Individuals with Disabilities Education Act
IPM:	Information Processing Model
LD:	Learning disability
NCLD:	National Center for Learning Disabilities
PBL:	Problem-based learning
PISA:	Program for International Student Assessment
STEM:	Science, Technology, Engineering, Mathematics

CHAPTER ONE: INTRODUCTION

Background of Study

Students diagnosed with a learning disability are expected to master the content within a college's general education core to graduate with a degree; however, science has been recognized as a barrier for a majority of students diagnosed with a learning disability (Brigham, Scruggs, & Mastropieri, 2011). Ofiesh (2007) notes there is limited understanding regarding appropriate accommodations and instructional strategies for students enrolled in math, science, and foreign language courses in higher education institutions; it also argued those accommodations often recommended are created based off instructor feedback rather than empirical evidence or literature support. Limited resources and training have impeded academic staff and faculty from providing the necessary tools to increase student performance in the classroom across multiple disciplines (Kayhan, Sen, & Akcamete, 2015). Knowledge of science andragogy, time of creating a new course, and existing beliefs about science are the major barriers identified in adjusting the way faculty teach, both to science and non-science majors (Sunal, Hodges, Sunal, et al, 2001). The reviewed literature has highlighted many K-12 science teachers have little training or expertise in teaching science content to students with learning disabilities (Grumbine & Alden, 2006); this can be especially true to those teaching science in a higher education institution.

Studies focusing on the instruction of students with a learning disability enrolled in higher education are limited. Those studies examining instructional strategies for the college science course for this student population is limited even further. In 2009, Sparks and Lovett estimated less than 30% of studies published on this topic collected original empirical data. Currently, the literature focusing on instructional strategies for students diagnosed with a learning disability focuses on the K-12 learning environment. In addition, there are a larger percentage of studies focusing on the content areas of language and mathematics in comparison to science.

The 2009 Program for International Student Assessment (PISA) demonstrated students in the United States struggle with skills related to science content. Through findings of the PISA, it is estimated nearly 70% of American students are unable to demonstrate how scientific principles are utilized in everyday life; this means less than 30% of students can be classified as being scientifically literate (Therrien, Taylor, Hosp, Kaldenberg, & Gorsh, 2011). Schroeder, Scott, Tolson, Huang, & Lee (2007) found repeating themes when it comes to the correlation of student achievement and instruction within science classrooms; for example, the highest gains in achievement came from lessons that connected the information and skills to real-world scenarios and situations. When the material becomes personally relevant to the student, it helps them make more meaningful connections. Curriculum can become more engaging when it has been intentionally designed to connect a student to recognizable, everyday applications of science. Engagement can lead to a positive increase in attitudes towards science as well as demonstrate improvement in academic performance (Partin, Underwood, & Worch, 2013).

Literature suggests that content may not be the biggest factor to influence a student's attitude towards science. Rather, it is the instructional strategies that play a major role (Osborne, Simon, & Collins, 2003). The quality of exposure has the ability to negatively or positively impact a student's perception of science. Authentic learning experiences, shaped by meaningful instruction, foster a perceived higher quality exposure to science during an introductory course (Gogolin, & Swartz, 1992). Some have raised concerns regarding the content or the utilization of a traditional textbook as a primary roadblock for student success in science courses (Scruggs & Mastropieri, 2007). The utilization of complex texts can be incompatible with some learning disabilities and does not demonstrate a clear connection between the presented content and the learner's personal experiences with science in the real-world.

The literature supports the notion of when students engage in experiential and/or inquiry-based learning they are more likely to continue the action and engage in further independent learning. Furthermore, when students engage in experiential, and/or inquiry-based, learning they are more likely to continue the action and engage in further independent learning (Spronken-Smith, Walker, Batchelor, et al., 2012). Simply enhancing, or altering, the instructional materials had the lowest gains in student achievement increase.

Differing forms of instruction are necessary when conveying complex scientific theories, concepts, and vocabulary to students. Inquiry-based learning has been linked to the highest levels of student achievement in science for students diagnosed with learning disabilities (Jarrett, 1999); however, it is assumed that more structure rather than free-choice learning is needed for this student population (Therrien, Taylor, Hosp, Kaldenberg, & Gorsh, 2011). The instructional practices within the inquiry-based learning model fall onto a continuum and are selected by the instructor based on the content, learning goals, and desired skills (Jarrett, 1999).

Instruction in science education is often an area of concern. It has been documented that many science teachers often describe a teaching philosophy that is entrenched in inquiry-driven and hands-on instruction; however, their practices in the classroom do not match their philosophy of science education (Hofstein & Lunetta, 2004, pg. 39). Unfortunately, the andragogy employed by the professional scientist leading the course and the non-science majors' preferred method of accessing the content are often incompatible (Udo, Ramsey, & Mallow, 2004).

Because of this disconnect, students often are disconnected and disengaged in the higher education science course. The quality of exposure has the ability to negatively or positively impact a student's perception of, and performance in, science. Authentic learning experiences, shaped by meaningful instruction, foster a perceived higher quality exposure to science during an introductory course (Gogolin, & Swartz, 1992). Unfortunately, the andragogy employed by the professional scientist leading the course and the students' preferred method of accessing the content are often incompatible (Udo, Ramsey, & Mallow, 2004).

There is limited knowledge available regarding specific accommodations in science which have been proven to be most effective in facilitating knowledge transfer, let alone information regarding instructional practices utilized by faculty; however, literature has established modified instruction is the most effective mode for knowledge transmission (Ofiesh, 2007). Accommodations in the higher education classroom for students with a learning disability are often put into place based upon recommendations of the demands of the course, how accommodations can aid in learning, and the individual's diagnosed learning disability.

Problem Statement

As part of the general education core, Beacon College students are required to complete 34 credits in the areas of English and communication, computer information systems, humanities and fine arts, mathematics, natural sciences, social/behavioral sciences, and critical thinking. Historically, students at Beacon College have underperformed in the required natural science course in comparison to the other core courses required for graduation. Successful alterations to course content and curriculum have been made; however, comparison of the general education competencies demonstrate students often under perform in meeting established performance criteria when compared to other courses required for graduation. Common areas of concern with student performance in science center on the synthetization of scientific principles into practice as well as examination of a problem using critical thinking and reasoning skills. In addition, approximately >20% of students earn a final semester grade of a D+ or below each semester.

Beacon College is a private, liberal-arts college located in Leesburg, Florida and was the first institution in the United States to grant bachelor degrees exclusively to students diagnosed with learning disabilities and ADHD. The college strives to offer students high quality educational experiences through the implementation of student centered learning models. According to Beacon College (2016), the college strives to "partner with and engage undergraduates who learn differently. [To] provide an education and campus culture that empowers and guides our students along their individual paths to knowledge, self-discovery, and success." Currently, Beacon College offers seven undergraduate majors and thirteen minors. There are a total of 306 students enrolled, representing 38 states and eight foreign countries.

Beacon College is considered to be a selective admission institution with an acceptance rate of 68%. Documentation of a learning disability is required for admittance (Beacon at a glance, n.d.).

The organizational structure at Beacon College is a professional bureaucracy model, which allows for autonomy within the organization and a high level of expertise built into the skeleton organization (Bolman & Deal, 2013).The Beacon College faculty are placed into a simple hierarchy. Faculty members report to designated department heads, who report to the Provost. Department chairs and the Provost equally share responsibilities in goal setting related to academics, student performance in academics, and supervision of faculty.

The culture of engaging in science learning and the exploration of scientific understanding is developing in the student tribe at Beacon College. Tierney (1998) argues this lack of daily integration into the culture inhibits any meaningful change to student learning outcomes. Monahan & Shah (2011) echoes this idea of culture change being vital to creating authentic change in the performance of higher education institutions by stating that most college administrators have a tendency to focus on creating change through the structural and human resource frames. The symbolic frame is often times the last frame utilized as a method of creating a change in the institution's performance.

The researcher serves as the supervising faculty member for the Anthrozoology program. Under this role, he is charged with curriculum and instruction design of all science courses offered, faculty supervision, and coordinating the Anthrozoology degree program.

Because instructional strategies employed by science faculty have a direct impact on student achievement (Scruggs & Mastropieri, 2007), the problem of practice that this Dissertation in Practice will address is the identification of preferred instructional strategies by students with a learning disability to increase student achievement in college science courses.

Purpose of the Study

The purpose of this research is to examine the relationship of learning theories to practice through the collection of empirical evidence and student self-reports. Implementation of findings will guide the development of instructional plans for science courses taught at Beacon College. Additionally, the examination of the development of authentic learning experiences in science courses in other institutions of higher education with a high percentage of students diagnosed with learning disabilities enrolled in science courses.

Cognitive Information Processing Theory (CIP) will serve as the theoretical framework for research activities. Cognitive functions are a primary concern for education practitioners; key areas that have been identified for students with a learning disability include: executive function, working memory, as well as receptive and expressive language. Because of deficits in performance in these areas of concern, students with a learning disability often underperform academically when compared to their peers without a diagnosed learning disability (Johnson, Humphrey, Mellard, Woods, & Swanson, 2010). CIP was selected as the theoretical framework for this study due to the direct implications the theory has on the practice of instruction design, especially for students with a learning disability. Swanson and Harris (2013) argue there is “solid evidence [demonstrating] the biological and cognitive bases of LD." Furthermore, they note there the literature supports the awareness of the differences in the cognitive processes of this student population, especially when compared directly to their neurotypical peers.

Research Questions

This study will answer the following research questions:

1. Which science-specific instructional strategies are preferred by students?
2. Are there differences in preferred instructional strategies in students who have declared a science major versus those who have not?
3. Are there differences in preferred instructional strategies based upon diagnosed learning disability?

Advancing Knowledge

The results of this study can possibly guide the instructional practices of 1) the administration of Beacon College, 2) the faculty of Beacon College, and 3) science faculty at higher institutions across the country in creating authentic learning experiences to increase academic performance of their students. The findings from this study can be used by the aforementioned stakeholders to alter typical practice by designing instruction specifically for this unique college student population with the ultimate hopes of increasing academic performance in science courses.

Significance of Study

In a seven-year observation period, it was demonstrated secondary students with a learning disability attempted fewer science courses and earned fewer science credits in comparison to English or social sciences. The only subject area in which students were less confident than science was a foreign language (National Center for Special Education Research, 2011). Ofiesh (2007) echoes the findings of this study by shedding light onto a trend in higher education science courses: students diagnosed with a learning disability do not perform equally to their peers without a learning disability.

Introductory science courses are often the key driver in discouraging a student's interest in science (Sunal, Hodges, Sunal, et al,, 2001). Goglin & Swartz (1992) demonstrated non-science majors display elevated anxiety levels and decreased levels of motivation in science courses. These students often leave with a negative attitude towards science. Udo, Ramsey, & Mallow (2004) found that a student's major can be a predictor of the student's anxiety level in regards to taking a science course. Humanities and social sciences majors demonstrate the highest level of anxiety when compared to any other grouping of majors. It stands to note, these academic areas of study have the highest enrollment at Beacon College.

Science courses can be perceived as a barrier to graduation in this specific student population. Deliberate design of instruction can aid in the removal of these perceived barriers to increase academic performance. The unique blend of two identified barriers in science learning (learning disability and non-science major studying social sciences) present a complex problem of practice for the science faculty members of Beacon College. In order to increase student performance in science courses, three exploratory questions have been proposed. Stakeholders for this study include the Beacon College administration, science faculty members, and the students, both science and non-science majors. Each group of stakeholders will be involved throughout the process.

Rationale for Methodology

To effectively answer the research questions, a mixed-methods approach has been selected. The analysis of the relationship of data collected by two complimentary tools will provide multiple perspectives of participants regarding preferred instructional methods.

Surveys are utilized to gather representative data from a large group of individuals. The role of a survey often is to assess behaviors, skills, attitudes, and knowledge regarding characteristics of a particular subject or program. Constructed questions will include the use of open-ended questions, which encourage participants to provide more in-depth information; close-ended questions, to allow for responses to be easily converted for statistical analysis; and ranking, which will allow for participants to display their personal thoughts and opinions on the subject while allowing for statistical analysis of the response (Dunsworth and Billings, 2012).

Surveys distributed electronically allow for a quick distribution to a wider audience, which may be difficult to access or access in a timely manner. While these surveys allow for ease of access and distribution, they are limited in questions and cannot gather in-depth information like a face-to-face or telephone interview (Fitzpatrick, Sanders, & Worthen, 2011). As a direct result, it is necessary to include focus groups into the study.

The inclusion of focus groups as a method for data collection allowed for the addition of information with an “interpretive, naturalistic approach” as defined by Creswell (2013). Focus groups build on the group process and obtain authentic reactions from participants over a provided situation. Through this process, participants are able to describe their own experiences, recommend changes, and expose any beliefs or attitudes towards the study subject. Focus groups typically consist of a relatively homogenous group of six to ten individuals. The purpose of this data collection technique is to move beyond representative or base information to gathering in-depth information regarding one particular subject or experience (Fitzpatrick, Sanders, & Worthen, 2011).

The mixed-methods approach allows for the complementarity measurement to construct a participant-oriented perspective to elucidate new findings regarding the best instructional methods for students with a diagnosed learning disability enrolled in a higher education science course.

Nature of Research Design

The estimated duration of the research activities is three months, from January 2017 through March 2017. This study combines qualitative and quantitative data collection methods, including the use of electronic surveys and focus groups. The combination of tools will allow for the exploration of the following: self-report of preferred instructional strategies, identification of trends amongst diagnosed learning disabilities, and differences between declared majors.

The identity of focus group participants will be confidential and participants of electronic surveys will remain anonymous. An emphasis will be placed onto student-centered participation to inform the students this research activity will enhance their learning opportunities.

Assumptions, Limitations, and Delimitations

The assumption will be made that all student participants have a diagnosed learning disability. This assumption will be made as result of their active enrollment in Beacon College, which requires a diagnosis of a learning disability as part of the application process.

A perceived risk of participation, and possible limitation, may include the student feeling obligated to respond to the investigator in a certain manner as this individual could potentially be a former or current professor.

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

When professional scientists are expected to teach within the collegiate environment, the andragogy employed often does not align with how a student prefers to learn science (Udo, Ramsey, & Mallow, 2004). This disconnect between the preference of how to learn and how the learner is taught often create deficits in academic performance. These deficits can become exaggerated in students with a learning disability. Ultimately, this may create a barrier for students to meet their graduation requirements (Brigham, Scruggs, & Mastropieri, 2011).

This chapter presents the rationale for conducting research on a identifying which instructional strategies are preferred by students with a learning disability. The review of literature has been structured on examining the challenges faced by students with a learning disability in higher education as well as learning science. In this chapter, the conceptual framework guiding this study includes the following elements: 1) Cognitive Information Processing as a learning theory, 2) CIP in instruction design, and 3) instruction design in science. These elements are discussed independently in the chapter. In addition, this chapter provides an overview of learning disabilities.

Overview of Learning Disabilities

The definitions of a learning disability presented by the medical and educational communities often differ due to their operational conditions in which the practitioner approaches the learning disability. However, the *Individuals with Disabilities Education Act (IDEA)*, the federal education law, designates a specific learning disability as:

> "Specific learning disabilities means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning problems, which are primarily the result of visual, hearing, or motor handicaps, or mental retardation, of emotional disturbance, or of environmental, cultural or economic disadvantage."

Learning disabilities can be classified by symptoms exhibited by the individual stemming from difficulty with academic studies in a formal environment and can be expressed as lack of clear expression verbally or written, inaccurate reading, slow reading pace, inability to complete mathematical reasoning, and difficulties in remembering and recalling information. The range of recognized learning disabilities meeting this classification include: Dyslexia, Dysgraphia, Dyscalculia, Auditory Processing Disorder, Language Processing Disorder, and Visual Perception Disorder. It is important to note one of the primary conditions for diagnosis of a learning disability is for the learner to demonstrate near average, average, or above average IQ; as a result, a learning disability has been called a “hidden handicap.” As the understanding of learning disabilities has increased over the years, other disorders have been included under this umbrella term. These other disorders include attention-deficit as well as executive function and emotional issues (Harwell & Jackson, 2014).

Causes of learning disabilities are not the direct result of an individual’s immediate environment, intellectual disabilities, emotional disturbance, and/or inadequate instruction. However, it has been demonstrated exposure to chemical toxins and the lack of proper nutrients during key developmental stages have an impact on the development of a learning disability (Cortiella & Horowitz, 2014).

According to the National Center for Learning Disabilities (2014), approximately 66% of all individuals diagnosed with a learning disability are male. Frequency of diagnosis is higher in populations living in lower economic environments compared to those living above the poverty line, but there is no difference amongst students identified as Caucasian, black, or Hispanic. Those identified as Asian report lower cases of diagnosis.

The perception of learning disabilities and students diagnosed with a learning disability held by educators can often be troubling. Seventy percent of surveyed individuals believe a learning disability is directly linked with intellectual disabilities (formerly referred to as “mental retardation”) and half of all education administrators exhibit this belief as well. It is estimated, a majority of the general public believe learning disabilities are caused by the home environment and a lack of parental involvement. It has been documented four out of ten teachers and three out of ten administrators share this belief with the general public. Nearly half of all surveyed individuals believe learning disabilities are the direct result of the individual not being motivated or being lazy (Tremaine Foundation, 2010).

It is believed these perceptions of learning disabilities are created by the limited cultural views held by educators, especially those views of race and ethnicity. Not only do these views shape instructional practice, but also have wider implications related directly to policy and research in the areas of learning disabilities (Artiles, Kozleski, Trent, Osher, & Ortiz, 2010).

While these students can perform academically under the right conditions; executive function issues as well as the pedagogy, learning environment, and support conditions play a larger role in determining student success. Sixty-eight percent of students complete high school earning a standard diploma; however, nearly 20% drop out of school. Students with a learning disability report post-secondary plans similar to neurotypical students, but often do not follow through with these plans on their own or face difficulties during the transition. The National Longitudinal Transition Study-2 (2011) found diagnosed students enter the 2-year college system twice the rate of their neurotypical peers and attendance in vocational schools is reported to be 16% higher than those without a learning disability diagnosis. However, enrollment in the 4-year college system is half the rate of the regular student population.

The completion rate for students in post-secondary education is estimated to be 41%, which is 11% lower than the remaining college student population. Students have a higher completion rate in vocational schools compared to two and four year colleges. The number one reported reason for leaving post-secondary education was affordability, which is the same reason as their neurotypical peers. Only four percent of students named not receiving services or accommodations as a reason for leaving school, even though 44% of students reported receiving accommodations would have been beneficial in completing their post-secondary education (Wagner, Newman, Cameto, Garza, & Levine, 2005).

It is estimated one out of every eleven students attending college have a learning disability. This presents a challenge for faculty and administrators to effectively offer adequate accommodations as well as adjust their individual instructional style (Quinlan, Bates, & Angell, 2012). Instruction of students with a learning disability presents many unique challenges as learning disabilities are wide-ranging and often co-morbid. Despite a recognized need for increasing academic performance in science and mathematics as well as a growing student population with a recognizable learning disability, it has been argued there is limited research exploring instructional practices in P-20 education (Basham and Marino, 2010).

In recent years, a heavy focus has been placed onto STEM education and career development. This emphasis is a direct result of the United States' performance comparison in the areas when differing metrics focusing on academic performance, job creation, and ingenuity related to STEM are compared to other countries. It is also argued teaching STEM concepts to students at all grade levels has the potential to enhance the individual's quality of life, with a special emphasis placed onto students with a learning disability (Hwang & Taylor, 2016).

It is hypothesized by researchers, students with a learning disability often experience greater anxiety and lower academic performance, especially when directly compared to their neurotypical peers. This is alarming due to the fact that over two-thirds of 8th grade students were described as not being proficient in science and mathematics in the 2009 National Report Card. It has been suggested, time spent in the classroom is not only shrinking, but the quality of instruction received by students is also decreasing. With the recognition of the challenges faced by students with a learning disability, it is critically important to explore instructional strategies that will enhance not only student performance in science courses, but also aid in alleviating the anxiety and stress experienced by these students (Hwang & Taylor, 2016).

Conceptual Framework

Cognitive Information Processing Theory (CIP) will serve as the theoretical framework for the research activities in this study. The deficits in academic performance between students with a learning disability compared to their peers without a learning disability has been recognized as a direct result from their inability to cognitively process information in a similar manner (Johnson, Humphrey, Mellard, Woods, & Swanson, 2010).

In higher education, faculty members are responsible for designing curriculum and instruction, often without receiving any formal training on this topic. The lack of understanding of the science behind teaching and learning may have detrimental impacts on students. To understand the process of instruction, the definition of learning first must be established. While it is important to note there are many differing definitions of learning, educational researchers often utilize a working definition centering on an enduring change in behavior resulting from practice or personal experiences (Ertmer & Newby, 2013).

The traditional model of learning domains focuses on five major areas: motor skills, verbal information, intellectual skills, cognitive strategies, and attitudes or perceptions. Each of these identified domains play a critical role in shaping the learning process. Three primary learning theories have been developed to explain the process in which the learner is shaped by instruction and the learning environment. The three learning theories of behaviorism, cognitivism, and constructivism all differ in their definitions of the role of the learner, the instructor, and the learning environment. As a direct result of these theories, multiple models for instruction have been developed. These models focus on implementing strategies for knowledge transfer and retention in a predictable and repeatable manner (Khalil & Elkhider, 2016).

The cognitive architectures, or structures and processes, are a critical consideration in learning and instruction design. It is paramount for the instructional designer to be aware of these individual architectures and how the learner retains information to memory through these cognitive structures. For example, understanding of these pathways can determine the appropriate instructional methods to directly impact episodic, perceptual, and procedural memory (Lucentini & Gudwin, 2015).

CIP theory refers to a grouping of models actively examining how humans sequence and execute cognitive events. An explanative analogy for this theory is borrowed from the computer science field. Using an active comparison of the learner to a computer, the repeatable process of how information is gathered, inputted into the processor (brain), processed, and stored for later retrieval is explained. This process does have mechanical similarities and can be used to create overreaching models for instructional planning. It is important to note that each individual learner is unique and presents individual challenges that are influenced by previous experiences, interpretation of social environments, and differences in the neuropathways (Kandarakis & Poulos, 2008).

This theory is similar to the Human Cognitive Architecture theory, which focuses on understanding how human cognitive structures are organized. As in CIP, both short term and long term memories are important considerations in understanding how humans learn and retain information (Kirschner, Sweller, & Clark, 2006). These mechanical models of information encoding include how individuals interact with their environment, encode and store new information, and how the brain functions to retrieve stored information. As a central theme to this theoretical concept, the learner is often described as being an active seeker and processor of information (Schunk, 1996).

McLeod (2008) describes four basic assumptions made in information processing for instruction: 1) the environment presents information, which is processed by a series of systems; 2) the processing systems transform the information in an organized manner; 3) these processes resemble information processing in computers; 4) the goal of understanding the process is to determine the cognitive process for performance. McLeod notes it is important to understand the brain, unlike a computer, has the ability to engage in parallel processing. In addition, humans are directly influenced by their immediate environment, biological state, and social conditions. In order to counteract the differences, Flavell, Miller, & Miller (2002) describe critical aspects of developmental focus from an information processing angle, some include:

1. Changes in the brain are a result of experience and biological maturation;
2. Increased performance in processing (efficiency, speed, and capacity) are a result of maturation and knowledge development;
3. Adjustments of connections in a neural network;
4. New ideas ascend from repeated self-organization as a result of adapting to change; and
5. Increased ability to perform problem-solving and metacognition.

The processing systems in McLeod's assumptions center upon how a stimulus is processed, stored, and retrieved or recalled for action. It has been recognized there are three main storage systems for the processed information, including: sensory memory, short-term or working memory, and long-term memory. The storage of information is directly related to the manner in which the information has been processed and coded by the brain. Information must be successfully processed and stored into the working and long-term memories in order to be routinely recalled as well as to create a permanent change in cognitive understanding. However, in order for this to occur, the learner must engage with the material that is presented in a way that allows for interpretation and implementation (Lutz & Huitt, 2003).

The brain is designed to filter out stimuli in order to only respond, or pay attention to, what is deemed important in a given situation. Most of the stimuli come directly from the external environment. Additional filters can include an individual's physical and emotional state. If the learner is unable to move into a state in which their physical and emotional needs are met or stable, the brain will continue to filter out any external stimuli, including information being presented in the classroom environment. Sorting and storing stimuli in the different memory systems is often referred to as Information Processing Model (IPM). IPM places each stage, or level, of filtering into a linear model in which information is rehearsed and retained in the cognitive structures and memory systems. If information is unable to be processed and stored beyond the short-term memory, it will be forgotten by the learner. IPM is supported by the work of Donald Hebb, who reasoned it was unrealistic a chemical process could occur fast enough to accommodate the sensory memory, while maintaining stability to accommodate the working or long-term memory (Huitt, 2003).

The human memory can be conceptualized as a structural system in which stimuli has been registered by the neurological system. From there, executive control processes are exerted over the information to aid in the analysis, transformation, and storage. Short term memory is hypothesized to be responsible for initial analysis of the stimuli. Once the information has been transformed or coded, it can be stored for routine recall. Okano, Hirano, & Balaban (2000) argue memory is one of the most "fundamental mental processes." They define memory as the ability to alter behavior as a result of an experience. This is similar to many of the definitions of learning that have been presented by Gredler (2009). Conversely, Okano, Hirano, & Balaban defined learning as the process of obtaining the memories that will later influence behavior. The two processes are interconnected, but they each play a separate cognitive role. Due to the complexity of the storage and retrieval system, it is believed different sections of the brain are responsible for the processing and storage of information. The mechanism of learning requires the individual to properly synthesize the information in order for quick and routine recall in the future.

Cognitive load, or the defined burden of the working memory during a given task, has a direct impact on instructional interventions. Many instructional practices have been designed without considering the amount of information that can be simultaneously interpreted and stored by the brain. By passing the cognitive load or the total amount of mental effort available to process information, the learner is unable to code the information into the working or long-term memory systems. This can occur as the concepts being studied increase in complexity while the learner is being asked to complete increasingly complex tasks related to the subject matter. This can be commonly observed in situations where learners are working in a multimedia environment or multiple platforms. The difference between a novice and expert learner is their ability to create and organize schema related to the learning and performance task (Paas, Renkl, & Sweller, 2003). Not only does the prescribed intervention place a cognitive load onto the individual learner, but the classroom environment itself places a cognitive load onto the educator (Feldon, 2007).

The instructional strategy of “chunking” is an example of preventing cognitive load and working with the cognitive structures to ensure knowledge is properly interpreted and stored in the working or long-term memory systems (Miller, 1956). Because learning is centered upon the storage of information into the memory systems, information processing and the understanding of cognitive structures as they relate to instruction are at the center of CIP learning theory.

All of these conditions can be skewed in a learner with a learning disability. Because a learning disability directly impacts the neurological structures in which information is processed, it directly impacts the storage and retrieval mechanisms. Often times, learners with a learning disability have noticeable deficits in their ability to store and retrieve information from their working memory. For example, Attention Deficit Hyperactivity Disorder (ADHD), which has been described as a deficit in behavioral inhibitions as a result of development, has been demonstrated to disrupt the encoding of information in four different memory systems (Kandarakis & Poulos, 2008).

Kirschner, Sweller, & Clark (2006) argue the lack of understanding of how the human cognitive structures function by educators directly impacts a student's ability to retain information. Taking the cognitive structures into consideration during instructional planning serves as a motivation for ignoring recommendations of instructional practices supported in research. The lack of student learning is a direct result of not adhering to instructional practices. In the case of students with a learning disability, the cognitive weaknesses present a new challenge to the learner and the instructor. Due to the higher processing demands on the learner's working memory, instructional strategies need to be adapted when compared to their cognitively normal peers (Georgiou & Das, 2015).

Students with a Learning Disability in Higher Education

The primary goal of a higher education institution is to provide quality educational experiences with the ultimate outcome of awarding a degree in a field of study. It has been demonstrated learning environments in which faculty and students share the responsibility for learning, while the student is actively engaged in the center of the learning, have been effective. Student-centered learning has moved to the forefront as a best-practice in higher education as a result. In fact, student self-reports demonstrate an estimated 50% in content retention (Blumberg, 2016).

Brigham, Scruggs, & Mastropieri (2011) notes students with a learning disability pose unique instructional challenges, especially in those courses required in the general education package. Their research has provided faculty with useful strategies for instruction in this area, including: verbal learning of declarative information, direct assistance in the processing of text, and the utilization of scientific reasoning & experimentation to teach course content.
Students with a learning disability often self-report many different barriers related to higher education. Common identified barriers include reluctance in seeking accommodations, not receiving proper accommodations, perception and realization of needing to work harder than peers as well as the feeling of being misunderstood by faculty (Denhart, 2008).

These feelings of being misunderstood by faculty are not unfounded. Faculty members in the sciences self-report mixed feelings regarding the instruction of students with a disability. While a faculty member’s age, rank, or gender were not found to be a unifying factor of these perceptions, discipline was noted. For example, faculty in the ‘hard sciences,’ such as chemistry and engineering, often exhibit less positive attitudes related to teaching students with a disability when compared to those faculty in the ‘softer sciences,’ such as the life sciences (Rao, 2004).

Students with a learning disability also self-report feeling unsupported by their college campus and support staff. Peer relationships and access to co-curricular activities are also viewed negatively by this student population. This is in stark contrast to their peers who do not have a learning disability. Findings also suggest in order to ensure academic success, it is important to adapt services across the campus to meet the individualized needs of the population (Hedrick, Dizén, Collins, Evans, & Grayson, 2010)

Decreases in student performance are a symptom of disengagement, which heightens the risk of a student not completing their academic path. In order to ensure successful student performance and completion of college, higher education institutions must engage the student in the classroom through effective instruction and learning opportunities that are tailored to the demographic of the student population (Quaye & Harper, 2009). When educational activities are meaningful to the individual student, they are more likely to have higher levels of persistence. This is especially true during the first and second year of a student’s academic career (Kuh, Cruce, Shoup, & Kinzie, 2008).

In addition, student concerns about the delivery of course material are often not unfounded. It has been documented at individual institution levels faculty do not engage in varying forms of instructional methods beyond the traditional lecture. It has been argued this is due to the lack of understanding of andragogy techniques as well as their detailed understanding and commitment to their content area (Pathamathamakul, 2016).

Heiman and Precel (2003) found students in the humanities self-reported more academic difficulties compared to other areas of study. This is primarily due to more frequent expectations of creating academic writing pieces and the reading of complex texts for analysis. In this study, the authors found a common theme of low-self efficacy in students as well as students perceiving there were no strategies to aid in their academic struggles. Despite these differences, no academic performance gap between LD students and non-LD students were observed in this particular instance. Interpretation and analysis of complex texts is commonly described as a barrier to academic success for students with a learning disability. In the case of science, this form of educational practice can be the cornerstone of many traditional science courses at all levels.

Another commonly indicated contention of stress is the high stakes exams employed by many college faculty. In fact, students with a learning disability self-report examinations to be one of the primary challenges encountered in higher education (Heiman & Precel, 2003). Cooper, Lingo, Whitney, & Slaton (2011) hypothesize the overreliance on support services received by students in higher education often leave them dependent on others for academic support and to perform under stressful situations. This can be reflected in the testing environment, which adds additional stress onto the learner. Instead, it has been proposed the inclusion of targeted academic strategies will provide the skills necessary for the student to perform independently, thus increasing self-efficacy and persistence. Results of their study demonstrated students with a learning disability were able to meet mastery level of performance as a result of teaching strategies rather than focusing on providing accommodations alone.

Mooney and Cole (2014) interviewed college students with a learning disability regarding their experiences in the college environment. One struggle for this student population, which often goes overlooked by faculty, is the ability to effectively engage in conversations with peers. They note many students with a learning disability often underperform academically mainly due to their inability to participant in group discussion. Processing difficulties often impede a student's ability to keep up with a group conversation. As a result, the student becomes withdrawn, disengaged, and unwilling to participate in this classroom environment.

Hedrick, Dizén, Collins, Evans, & Grayson (2010) state one of the core aspects of a student with a learning disability to thrive in higher education is their ability to form positive relationships with their faculty. It was found students with a learning disability are more likely to self-report a more positive relationship with faculty and more likely to engage with faculty regarding academic topics than their peers without a learning disability. Furthermore, there were little differences in self-reported perceptions of the access to enriching academic experiences and exposure to opportunities. This provides an opportunity for faculty to utilize evidence-supported instruction to provide students with the tools necessary to be successful in the college environment while increase student self-efficacy and persistence.

Cognitive Information Processing in Instruction

CIP models are at the core of instructional design as these models attempt to create repeatable methods in which a learner can engage with and rehearse new information. The process of encoding and structuring information for storage is critical for the information to be stored properly for later retrieval. For most educators, the goal is for the information to be stored in the long-term memory. Therefore, instruction must be carefully planned so connections can be made in the neurological network. One of the more popular instructional processes for this to occur is the Taxonomy of the Cognitive Domain developed by Bloom and recently revised by Anderson and Krathwohl.

When designing instruction following recommendations described in the CIP theory, there are four base implications that directly influence instructional design choices: 1) memory is limited and can be overwhelmed, 2) prior knowledge directly impacts encoding and retrieval of information, 3) automatic processing increases efficiency by reducing demands, and 4) learning strategies improve retention because learners engage with material at a deeper level (Schraw & McCrudden, 2013).

In the field of inclusion education, it is critical to incorporate evidence supported practices to ensure student performance objectives are met. However, theoretical foundations for implementation are often missing or misinterpreted when put into practice. In some instances the support for actions has been lost, which in return does not develop the educator fully to understand the nature of the instructional practice employed (Zundans-Fraser & Auhl, 2016).

Effective instruction is defined in a fashion that puts the learner first and in control, which is opposite of many instructional practices employed by faculty members (Mintz, 2016). The many interpretations of instructional terminology creates lack of clear understanding of differing terms and their applications by college faculty. This lack of understanding by these individuals, who are professionally trained in their specific field of study and not education, can lead to inappropriate implementation of teaching strategies. It can be argued effective instruction is effective instruction regardless of the labels or corresponding terminology that has been applied; however, it is important to be familiar with modern approaches of instruction and implementing what is best for that specific context (Weimer, 2015).

The selection of instructional practices does not stem from a ‘one-size-fits-all’ learning theory. Instead, it is critical to understand the individual learners and how they engage with the material as a result of their previous experiences, the learning environment, and individual cognitive structures. The gain of knowledge is not a single event; rather it occurs on a continuum. This creates a unique opportunity for the instructional designer who should be aware of how each individual will learn and engage with the presented material. At the core, the designer’s role is not to understand necessarily the attributes of each individual learning theory and model, but to understand the learner and their individual learning needs shaped by previous experiences and neurostructures (Ertmer & Newby, 2013).

Many instructional interventions are designed to increase student learning and engagement by creating learning moments reflective of an individual’s learning style. However, the planning of these interventions is often a misplaced burden of the educator. It can be argued the belief of learning styles can create an instructional paralysis due to the need of meeting each individual as a unique learner or designing instruction using the ‘middle-of-the-road’ approach with the potential of not meeting a few individual’s learning needs. Because learning styles have not been supported by an abundant amount of empirical evidence in the educational or psychology fields, it is important to follow prescribed methods reinforced by reputable research.

For example, research supporting commonalities amongst a given student population following the understanding of cognitive load and cognitive processing have demonstrated higher learning gains than those interventions designed following those dictated by learning styles (Willingham, Hughes, & Dobolyi, 2015). Strategies focusing on the utilization of memory, both long-term and short-term, are known to affect academic performance and retention of material (St Clair-Thompson, Overton, & Botton, 2010).

Swanson & Beebe-Frankenberger (2004) demonstrated working memory and short term memory each play a critical and separate role in our ability to problem solve. It is argued the tasks associated with learning and these memory systems are inherently different and require the practitioner to alter instruction. For instance, it is noted working memory draws from the executive system in contrast to the short term memory, which draws from phonological codes. Long term memory is essential in combining these two memory systems to increase processing speed and the ability to problem-solve complex scenarios. It is recommended educators in content areas requiring complex problem solving, such as math and science, need to incorporate the use of letter patterns or associations (e.g.: mnemonic devices) as a way to activate all memory systems in problem solving skills or tasks.

In one study focusing on secondary students, an interaction between working memory and cognitive styles was identified. Results offer an insight into information-processing demands on the students; for example, differences between memory retrieval were noted for a preferred cognitive style. Those students who were identified as Verbalisers, a verbal-imagery approach to instruction should be taken to increase storage and retrieval of information (Riding, Grimley, Dahraei, & Banner, 2003).

To implement CIP models into instruction, Huitt (2003) offers some helpful advice: provide significant information several times in several unique ways, tie new material to already learned or understood concepts, plan periodic assessments of learned skills, as well as present information in categories. Each of these methods will ensure information activates both the working and long-term memory storage systems.

Stamovlasis and Tsaparlis (2012) demonstrated working memory overload which supports instructional strategies connecting major concepts through direct instruction and problem solving. In a study by Troia and Graham (2002), the effectiveness of direct instruction and teacher modeling was measured by comparison of student performance scores. Those students who received the treatment of direct instruction, modeling, and provided intentional scaffolding demonstrated a significant change in measures compared to those students who did not receive the treatment. Troia and Graham found similar results to the reviewed literature in which students diagnosed with a learning disability demonstrate moderate gains in learning and performance when provided direct instruction with modeled strategies.

Another study found a strong disconnect from measured results to the predictions in performance of students diagnosed with Autism as determined by CIP models. It was demonstrated time constraints on students during tasks with increasing cognitive complexity create greater performance deficits. CIP theory suggests constraints on processing time as a single factor should be enough to increase the cognitive complexity of tasks. When compared to their peers with typical cognitive development, students with Autism responded more quickly to tasks while making significantly more performance errors (Speirs, Rinehart, Robinson, Tonge, & Yelland, 2014).

Since CIP is centered on human cognitive structures, which are biological in nature, some argue these structures and their ability to interpret information evolve over time (Van Merrienboer, & Sweller, 2005). This has spurred the exploration of new practical applications of the CIP theory into instructional practice. One such concept was proposed by Siemens (2014). This proposed new learning theory is connectivism. The principles of this new learning theory, include the reliance of non-human appliances for learning, decision-making as a process is learning, capacity to gain more knowledge is more important that what is already understood, and there are a diversity of options for learning. This new theory takes into consideration the interconnectedness of the modern human society with others as well as the reliance on multiple computing devices to augment learning. Siemens argues this new theory addresses CIP with modern learning and addresses the holes not completed by behaviorism, cognitivism, and constructivism. However, it can be argued this theory is an extension of the classic three learning theories and simply uses CIP as a connecting bridge (Duke, Harper, & Johnston, 2013).

Students with a learning disability often employ different academic strategies than their peers who do not have a learning disability. Students with a learning disability self-report using less written study strategies and utilize mnemonic strategies more often than their neurotypical peers (Heiman & Precel, 2003). These findings were echoed in a similar study which found students with a LD utilize different strategies than their non-LD peers. Students were asked to rate their learning preference using a Likert scale 1.0 through 3.0, where 1.0 is not useful/important, and 3.0 very useful/important. Results from this study indicate a learner with a LD prefers visual and hands-on learning more frequently than the students with no LD. Additionally, the learner with LD described group discussions and alternative textbooks a preferred instructional method (Black, Weinberg, & Brodwin, 2015).

Cognitive storage and retrieval of science information was examined from a cognitive load perspective in a study completed by Carlson, Chandler, & Sweller (2003). The results established the difficulty for students to process and store information into the working memory if information is presented in multiple, unique forms at one time. It is theorized the role of instructional design can reduce cognitive load to aid in the storage of learned material into the working memory through the use of diagrams, which aid in the reduction of the number of text-based elements. Additionally, both diagrammatic and text-based instructions could potentially be effective when information processing requirements have been lighted.

It has been hypothesized quicker storage and retrieval of information in a learner with a disability can be accomplished when instruction is focused on the cognitive processes of the learner. This hypothesis was generated through the observation of students needing to break the learning process into smaller, segmented pieces in order to master the academic “big picture” (Heiman, 2006).

One model that has been proposed for higher education is the implementation of universal design. This method follows grounding principles in which course content becomes accessible by everyone. For example, universal design allows for instruction of diverse student populations by developing an inclusive learning environment that promotes interactions between all participants and faculty. In addition, instruction is designed in a manner that is predictable, only necessary information is conveyed, and anticipates variation in individual student learning gains (Scott, Mcguire, & Foley, 2003). These principles are outlined in Table 1.

However, in direct contrast, King-Sears, Johnson, Berkeley, Weiss, Peters-Burton, et.al (2015) found limited evidence to support universal design. Concerns regarding the effectiveness of this framework stem from the inability to correctly implement the structure and instruction in a correct manner. Additional findings determined the measurement tools in which researchers examine the effectiveness of universal design need to be aligned properly with the guiding principles of the framework.

Table 1. Universal design for instruction as described by Black, Weinberg, & Brodwin (2015)

Principles of Universal Design for Instruction	
1. Equitable use	Instruction is designed to be useful to and accessible by people of diverse abilities.
2. Flexibility in use	Instruction provides a choice in methods of use.
3. Simple and intuitive	Instruction is straightforward eliminating unnecessary complexity
4. Perceptible information	Information is communicated effectively to the student regardless of ambient conditions or the student's sensory abilities.
5. Tolerance for error	Instruction anticipates variation in individual student learning pace and prerequisite skill.
6. Low physical effort	Instruction is designed to eliminate nonessential physical effort to allow maximum attention to learning.
7. Size and space for approach and use	Instruction is designed regardless of student's size, posture, mobility, and communication needs
8. Community of learners	Instruction and communication among students and between students and faculty is promoted
9. Instructional climate	Instructional climate is welcoming and inclusive, high expectations are promoted for all students.

It can be argued in today's modern classroom environment, the inclusion of universal design is not enough to support the learner with a disability. Due to the complex interactions between cultural and individual development of the learner, assistive technology must be integrated as a component of universal design. The inclusion of assistive technology provides an additional layer of rehearsal for the learner, which allows the architecture to store and retrieve the information (Rose, Hasselbring, Stahl, & Zabala, 2005). Despite the potential for universal design, instruction must revolve around the learner's ability to engage with the material and work directly with the cognitive process to store information.

Mayer (2011) states there are three primary cognitive processes directly related to instruction, which include 1) selecting, 2) organizing, and 3) integrating. These three processes allow the instructor to design instruction which work directly with the human architecture rather than against it.

The process of selecting requires the learner to pay attention to key words, images, and sounds to transfer the information from the sensory memory in to the working memory. From there, the learner must organize the information for it to be retained in the working memory. Organizing is the process of creating mental illustrations from the selected words, images, and sounds. Finally, the learner must integrate the information to retain it in the long-term memory. This is done by connecting the mental illustrations with prior knowledge. Figure 1 depicts this process.

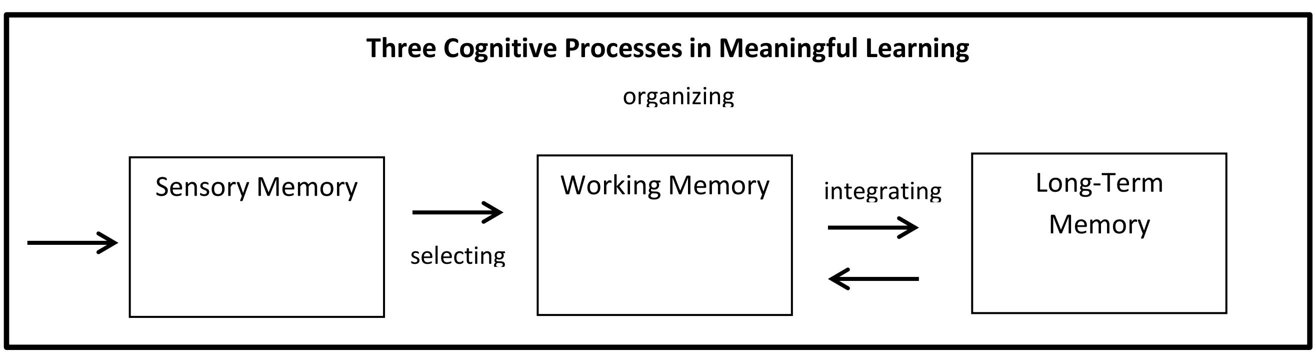

Figure 1. Mayer's (2011, p. 37) Three Cognitive Processes in Meaningful Learning

Instruction in Science Courses

There have been three main challenges to instructional design in the science content area. One of the primary challenges centers on the lack of research application in a classroom environment. This stems from inconsistent research methodology as well as the separation of the identities held by researchers and to those of classroom teachers (Hill, & Sharma, 2015). Another challenge includes the notion that this particular content area is often designed as a linear pathway with limited flexibility. This linear pathway presents challenges to designers of curriculum and instruction due to the fact students need to master basic fundamentals and subsequent skills to reach higher levels of understanding and application (Dickens & Arlett, 2008).

Singer, Nielsen and Schweingruber (2012) revealed science courses focused on the traditional discipline-of-science regularly utilize an instruction-centered model; however, when students are engaged in active learning in a student-centered learning environment, the learning gains are significantly higher. When collaborative learning is used in conjunction with lecture oriented activities, it has been documented to be more effective in increasing student performance than traditional lectures alone. It is believed this is the result of the individual learner being responsible for his own learning while rehearsing the information in a form that meets the needs of the individual (LoPresto & Slater2016).

Schroeder, Scott, Tolson, Huang, & Lee (2007) found repeating themes when it comes to the correlation of student achievement and instruction within science classrooms: highest gains in achievement came from lessons that connected the information and skills to real-world situations. Curriculum can become engaging to the student when it has been intentionally designed to connect to recognizable, everyday applications of science. Engagement can lead to a positive increase in attitudes towards science as well as demonstrate improvement in academic performance (Partin, Underwood, & Worch, 2013).

Literature suggests content alone may not be the primary factor in influencing a student's attitude towards science; rather, it is the instructional strategies (Osborne, Simon, & Collins, 2003). Learning experiences shaped by meaningful instruction foster a higher quality exposure to science (Gogolin, & Swartz, 1992). Unfortunately, the andragogy employed by the professional scientist instructing the course and the students' preferred method of accessing the content are often incompatible (Udo, Ramsey, & Mallow, 2004). When students engage in experiential and/or inquiry-based learning, they are more likely to continue the action and engage in further independent learning (Spronken-Smith, Walker, Batchelor, et al., 2012). Simply enhancing, or altering, the instructional materials had the lowest gains in increasing student achievement.

During a science course, the laboratory component may have the greatest influence over a student's perception of the content delivered, the faculty's instruction, and their overall impression of the course. Activities that do not clearly align with the lecture material make the learning convoluted and do not effectively reinforce the desired skills or knowledge. Hofstein & Lunetta (2004) found students have a difficult time perceiving the primary purpose for investigations. Many students in the laboratory setting believe their goal is to follow directions to reveal the correct answer rather than using the scientific method to investigate a given situation in which there may or may not be a correct answer. In some instances, the laboratory aspect of the general education science course is so perplexing to students it actually becomes a barrier to graduation (Son, Narguizian, Beltz, & Desharnais, 2016).

In a meta-analysis reviewing 12 published articles spanning from 1980 to 2010, three common instructional approaches utilized in science instruction were examined to determine which intervention can be considered to be the most effective for students with a learning disability. It is suggested inquiry-based instruction can be considered an effective intervention with this student population. However, those interventions containing more structure in the instruction demonstrated higher learning gains. It is hypothesized from this review there are several components required for successful science instruction interventions with this student population. These components include a focus on “big picture” concepts rather than minute details, concrete learning experiences, hands-on activities with direct instruction, formative feedback, and multiple opportunities to practice learned skills and concepts (Therrien, Taylor, Hosp, Kaldenberg, & Gorsh, 2011).

A different meta-analysis recommends direct instruction as the first priority for any learner. It is argued nearly all research on free-choice, true inquiry or self-discovery, or minimal instruction supports the utilization of direct instruction instead. In fact, there may be some evidence to support the idea that the absence of direct instruction may have multiple negative consequences, including: the loss of knowledge, formation of misconceptions, and the retention of incorrect information (Kirschner, Sweller, & Clark, 2006). It is important to note this does not mean the inclusion of practical application or experiential learning should be ignored or not implemented, rather it should be done in a manner that is guided and constructed for the learner.

Even in student-centered learning environments where a majority of the responsibility for the learning rests with the student, direct and structured instruction is necessary to ensure proper retention of the information. The uses of debriefing sessions at the end of each class session and a quick review of the previous class session have been documented to be a valuable technique in knowledge retention. In addition to knowledge retention, these review sessions have a direct positive impact on a student's confidence and satisfaction of course material (Stefaniak, & Tracey, 2015).

Many science faculty members struggle with adopting new instructional methods into practice. The preferred, and most commonly used option, is the traditional lecture. As previously stated, many faculty members struggle with the clash of personal identities in which they view themselves as a professional scientist first and an educator second. Another organizational factor influencing instructional choices made by science faculty are the pressures placed onto faculty about other job functions beyond teaching. Hora (2012) demonstrated in a study of organizational factors influencing the decision-making process regarding instruction, the department and/or institution often places a higher emphasis onto research activities rather than quality instruction. In fact, criteria for promotion and/or tenure often center on many factors except for quality instruction or positive student reviews of the faculty member's teaching style. Other factors identified by science faculty regarding limitations on implementing different instructional methods included the large class size, lack of autonomy in certain courses, lack of classroom infrastructure to support differing choices in instruction, and organizational culture.

Science Education and Learning Disabilities

Because of the unique challenges presented in designing effective instruction within the science fields for neurotypical learners, the problems associated with designing instruction for students with a learning disability increase in scope and difficulty for the designer. Each learning disability presents different obstacles to the learner and the instructional designer. Previous models of instruction and curriculum design in the science content area for students with a learning disability have focused on six principles (Grumbine, Hecker, Littlefield, Abedon, Coleman, et. al., 2005). These principles are outlined in Table 2.

Table 2. Guiding principles in science education for students with a LD

Principle	Educator Actions
Use a diagnostic approach	Identify student strengths and weaknesses; begin at the students' point of readiness; create instructional plans based on informal student assessment of mastery
Provide explicit instruction in skills and strategies	Break tasks into subskills
Create a student-centered environment	Provide opportunities for success; set clear expectations; support students in meeting expectations
Address diversity of learning styles	Create strength-based content; incorporate multiple modalities; provide alternative strategies; provide varying means of assessment to measure mastery
Instruction and assessment should have clear goals and objectives	Identify agendas and learning goals; link assessments to specific learning goals; assess the process as well as the product; hold students accountable for learning
Foster self-efficacy and self-understanding	Build reflection into the learning process; be clear and explicit about how learning takes place; tie self-understanding to use of academic strategies

Swanson and Harris (2013) echo these guiding principles in their work. They argue three critical instructional choices for teaching science to students with a learning disability center on direct instruction, cooperative learning, and curriculum-based measures. Each of these strategies have demonstrated improvement in academic performance.

In the content area of science, the material presented in the course is directly supported by explicit instruction; this is especially true when teaching students with a learning disability. In many science courses, the individual often faces challenges in their ability to plan, prioritize, manage time, and complete tasks as a direct result of their learning disability. Faculty must recognize these issues and plan instruction to enhance academic skills in addition to the material.

Literature on the effects of direct instruction on student performance demonstrate those students who were provided direct instruction to build academic skills outperformed their neurotypical peers who did not receive the same level of instruction (Grumbine & Alden, 2006). The utilization of active learning strategies creates higher student performance scores, which is a stark contrast to the traditional lecture (Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt, & Wenderoth, 2014).

For some, a reading centered learning disability may prevent a student from succeeding academically due to challenges related to the interpretation and evaluation of written text (Schneps, O'Keeffe, Heffner-Wong, & Sonnert, 2010). Many college level science courses rely on the interpretation of complex text as a central component of the course activities. As a result, a student with a language-oriented learning disability is less likely to feel successful or prepared in class. When faculty model reading skills and strategies, it demonstrates a tool for success to the learner. Structure within the instructional plan should also include visual models for the learner to replicate during reading rehearsals. In many courses, the recall of vocabulary is essential to successfully perform on assessments. When vocabulary recall is relied on in the course, faculty must include strategies on enhancing vocabulary recall using rehearsal and review skills (Grumbine & Alden, 2006).

Feedback regarding student performance is critically important to the learner. Formative feedback will allow the learner to understand progress related to overall performance in the course. In addition, formative assessment will allow faculty members to gauge student performance more frequently compared to summative assessments. Frequent feedback develops a student's self-awareness and self-efficacy related to performance in science courses (Grumbine & Alden, 2006).

Assessment practices are also called into consideration in science courses. Typically, many assessment practices in higher education courses rely on the development of large papers or completion of a complex test. Many faculty often call into question the 'fairness' of accommodations related to tests or assessment practices; however, it should be argued fairness in these situations center on providing equal opportunities for students to demonstrate learning. Therefore, strategies utilizing the principles defined in universal design allow equal opportunity for students to demonstrate learning without risking the perceived invalidity of the assessment tool (Ketterlin-Geller, 2005).

One of the most effective strategies for the acquisition of content specific knowledge by students with a learning disability focuses on the interventions which are performed outside the classroom and work in conjunction with classroom learning. For example, faculty may provide evidence-based instructional strategies, including cooperative learning, authentic assessment, and the teaching of strategies in addition to content. However, it has been demonstrated the use of strategic peer-tutoring can significantly increase student performance, especially in content specific courses (Deshler, Schumaker, Lenz, Bulgren, Hock, Knight, & Ehren, 2008).

The inclusion of embedded peer tutors has been demonstrated to increase student performance and learning gains. In addition, the utilization of embedded peer tutors in a course aided in building prosocial skills and attitudes towards science in similar student populations (Heinrich, Knight, Collins, & Spriggs, 2016). Not only does the inclusion of an embedded peer tutor aid in the development of the learners, but also helps to foster professional identity in the STEM student serving as the tutor. Nadelson and Fannigan (2014) note,

> "…the potential influence of the role of a learning assistant on the professional identity development of our participants suggest that the program may be another mechanism to promote STEM student professional identity growth…[and] the learning assistant program is likely to substantially increase the STEM profession identity development of the students who act as learning assistants."

The utilization of open lab spaces as an inclusive learning environment combined with peer mentors increases the engagement and likelihood of success in college students during their first two years of college (Rodenbusch, Hernandez, Simmons, & Dolan, 2016).

The utilization of scaffolding in education is important at any level and within any content area; however, since science curriculum has been described as a linear progression, scaffolding plays a critical role in the learner succeeding not only in the current course but also in future and concurrent courses. Scaffolding has been demonstrated to not only increase student engagement with the content, but also encourage students to practice scientific skills related to questioning, experimentation, and collaboration with others. Faculty who utilize scaffolding in their instruction are also able to equip the learner with the ability to engage in critical reflection and tasks involving metacognitive skills (Bybee, 2015).

The ability to instill the skills of systematic testing and the development of explanations supported by evidence is the cornerstone of science education. However, this can be a difficult task for students with a learning disability. The utilization of fading scaffolding has been demonstrated as an effective instructional method with this student population in science courses (McNeill, Lizotte, Krajcik, & Marx, 2006).

Scaffolding with advanced and adult learners requires the application of “fading.” This practice centers on the idea of slowly increasing learner responsibility. This may occur with a full class or an individual learner. Fading may be prescribed by faculty when a peer tutor is a central component of the instructional plan for individual learners. Curriculum and instruction may also include fading with tasks or concepts requiring long-periods of classroom involvement. In regards to learners with a learning disability, fading may occur as the learner becomes more self-reliant as a direct result of applying academic strategies taught throughout the course. As the learner becomes more confident in utilization of academic strategies, they become more responsible for their own learning in the science course (Bybee, 2015).

The use of fading demonstrated significant increases on assessment scores; however, reasoning skills were still lower than expected. This is thought to be a direct result of the altered cognitive structures (McNeill, Lizotte, Krajcik, & Marx, 2006). As a result, it is important for science faculty to not only model skills and strategies, but other techniques related to knowledge acquisition as well.

One suggested instructional approach for science faculty is to pull from the instructional strategies and philosophy demonstrated by faculty teaching in the arts. This change focuses on the inclusion of artistic expression to rehearse and demonstrate concepts presented in the course. In addition, the utilization of visual models or organizers developed either by the faculty member or the student will also aid in the rehearsal and encoding of information into the long-term memory system (Hwang & Taylor, 2016).

The utilization of this philosophy is believed to scaffold learners to engage in abstract reasoning, which is often difficult for students with learning disabilities (Hwang & Taylor, 2016). It is hypothesized this change will aid in the perception of the course and the expectations directly related to the requirements of finding the correct answer as opposed to rewarding the process of scientific questioning and reasoning. This change in instruction would require a major cultural shift for many science faculty members who often place a distinct emphasis onto the correct result as opposed to using the correct process. This is contradictory to the very nature of science; however, it does align with the performance expectations of the field valued by professional scientists.

Instructional technologies have quickly emerged as an effective means of creating personalized instruction for students. While this trend has been more popular in K-12 education, the framework of including instructional technology can be easily integrated into the post-secondary classroom. Israel, Maynard, & Williamson (2013) suggest the addition of simulations in the science course allows learners to manipulate the parameters of the learning experience by encouraging inquiry-driven learning. Simulations can also demonstrate scientific concepts and phenomena that are difficult for the learner to visualize or engage with abstract concepts. For instance, when studying cells the simulation can allow students to observe cell function and even manipulate the environment to measure changes in the cell. The same concept can be applied for Earth or space science.

The design of instruction following the universal design principles have been documented to produce positive performance outcomes in science courses for students with a learning disability. One of these design choices include the utilization of intensified curriculum. This approach lessens the amount of curricular topics presented to the students, but each topic is explored more in-depth using direct instruction. Lessons are more hands-on and encourage the student to rehearse skills related to designing and implementing a scientific investigation (Cawley, Foley, & Miller, 2003).

Summary

This chapter provided a review of literature currently available on the topics of learning disabilities, challenges facing students in higher education, and content specific issues associated with instruction design. CIP was identified as the conceptual framework for this Dissertation in Practice. CIP theory serves as the foundation for the design of data collection methodology and instruments. Chapter Five will discuss the findings of this study as they directly relate to CIP.

The Cognitive Information Processing model provides a framework of understanding to guide instruction. Each individual’s cognitive structure is unique due to behavioral, social, and environmental factors. Because the cognitive architecture in an individual with a learning disability is complex and unique compared to neurotypical learners, it requires extra consideration in choices related to instruction. Since the goal learning is to ultimately store stimuli, or information, in the long-term memory system, instructors need to employ instructional strategies to work with the altered architecture. Recognition of each individual learner's differences in ability to interpret information and work within their cognitive load is important to ensure growth in academic performance.

The rate of students with a diagnosed learning disability is on the rise. It is imperative faculty not only understand and comply with the accommodations provided to the student, but also utilize explicit instruction designed to engage learners with the content, teach academic skills, and provide regular feedback to the learner.

The conflict of the faculty member's perception of their professional role often creates a learning environment which may not be inclusive of all learners. Those faculty members which hold a professional identify of a content specialist, researcher, or professional scientist are often ill-equipped to provide the in-depth instruction necessary for students with a learning disability to succeed in an academic environment. However, faculty who view themselves as an educator or mentor, often devote professional energy into developing instructional strategies to support learning and individual learners.

The focus on developing inquiry-driven or self-directed learning experiences is often short-sighted and does not provide each learner with enough academic skills or strategies to be successful in a higher education science course. Many students are not prepared to enter the post-secondary environment and this is potentially exaggerated in those with a learning disability. The integration of explicit instruction has been demonstrated to be effective and create learning gains in all students, with larger gains in students with a learning disability.

Faculty should strive to develop system-level thinking when it comes to their instructional design. It is important to think critically regarding student performance issues and being able to intervene when necessary. The development of instruction using strategies supported by evidence is imperative in developing students. Instruction in STEM should be viewed as a computational process in which the cognitive processing of the individual learner is taken into consideration along with the physical and social learning environment.

Universal design provides a framework for instruction with the potential to aid in increasing academic performance in students. Because many higher education classrooms contain a wide-range of students with varying academic abilities, this framework can potentially provide instruction meeting the needs of all abilities and requirements. Incorporating authentic assessment in the course can potentially decrease student anxiety while increasing the faculty member's ability to measure student performance.

A misguided understanding of learning disabilities can potentially lead to a negative perception of the learner and his disability. This has the potential to create a disconnect experienced by the student and could encourage a negative connection to the institution.

CHAPTER THREE: METHODOLOGY

Introduction

The purpose of this study is to identify the instructional strategies in college science courses preferred by students with a learning disability. In addition, the relationships between preferred instructional method with learner characteristics such as declared major and learning disability were examined. This study combined both qualitative and quantitative data collection protocols along with analysis protocols in a singular study. The decision to utilize a mixed-methods approach was because neither methodology would elucidate the information sufficiently on their own to answer the research questions in a detailed manner. The combination of the two methods allow for a richness of data, which provides more information to assist in the development of instruction design for practitioners.

Participants were asked to complete an online survey in which they will be tasked with placing commonly employed instructional strategies in a rank order based upon their individual preference for the described strategy. Instructional strategies will be modified from those described by Scruggs & Mastropieri (2007). These strategies are listed in Table 3.

Table 3. Instructional Design Activities

Instructional Strategies	
Continuous feedback	Traditional lecture
Observing living wildlife in nature	In-class reading
Group discussions	Group learning tasks
Project based learning	No exams
Material connected to real-world applications	

To elaborate on the questions asked in the electronic survey, focus groups composed of current students will be included. Original questions designed by the researcher will examine student perceptions, attitudes, and opinions related to instructional practices in science courses taught at Beacon College. Students representing both science and non-science majors are included for focus group participation.

Inclusion criteria remained consistent with those described by Weis, Erickson, & Till (2016). All participants are enrolled full-time at the undergraduate level. Due to the mission of Beacon College, this ensures all participants have a diagnosed learning disability. Instead of intellectual and composite scores on tests, participants were arranged into similar groups based on learning disability as well as by major for triangulation.

Triangulation allows the researcher to learn more about a topic by recording observations from multiple perspectives. Multiple perspectives may be taken into account through varying measures, observers, theories, and/or data collection methods (Neuman, 2011). The corroboration of multiple instruments, methodology, and theories provide a deeper insight into a theme while enhancing the validity of findings (Creswell, 2013).

Statement of the Problem

Comparison of the general education competencies demonstrate students often under perform in meeting established performance criteria when compared to other courses required for graduation. Common areas of concern with student performance in science center on the synthetization of scientific principles into practice as well as examination of a problem using critical thinking and reasoning skills. In addition, approximately >20% of students earn a final semester grade of a D+ or below each semester.

It has been demonstrated students with a learning disability attempt fewer science courses and earned fewer science credits in comparison to language arts or social sciences (National Center for Special Education Research, 2011). The identification of self-reported preference of instructional strategies by students with a learning disability will aid faculty in developing instruction to ensure student success in college science courses. The literature suggests a possibility exists when instructional design uses techniques which are inclusive for all learners, there is the potential for an increase in academic performance.

Research Questions

This study will answer the following research questions:

1. Which science-specific instructional strategies are preferred by students?
2. Are there differences in preferred instructional strategies in students who have declared a science major versus those who have not?
3. Are there differences in preferred instructional strategies based upon diagnosed learning disability?

Research Methodology

An electronic survey was administered, which allowed for quantitative data collection and analysis. The electronic survey utilized questions with a closed rating scale as well as open-ended questions to gather ordinal and nominal data. This electronic questionnaire was delivered to participants via email. A copy of the tool is provided in Appendix D as well as copies of the invitation to participate in the study in Appendix B.

Semi-structured focus groups were conducted using a planned questionnaire with open response options to gather qualitative data. Focus groups lasted for approximately 35 minutes and included nine participants. The concepts presented in questions were established after review of literature. The semi-structured format allowed for the facilitator to ask follow-up probes to the primary prompts while encouraging group dialogue. A copy of the focus group questions has been provided in Appendix E. All participants were asked to provide consent before the focus group; consent to participate can be found in Appendix C.

Research Design

This study combines qualitative and quantitative data collection tools, including the use of electronic questionnaire and focus group. The combination of tools will allow for exploration of the following themes: self-report of preferred instructional strategies, identification of trends amongst diagnosed learning disabilities, identification of trends amongst students performing at an overall academic level, and differences between declared majors.

Table 4. Research questions with corresponding data and analysis

Research Question	Data Sources	Analysis
Which science-specific instructional strategies are preferred by students?	Electronic questionnaire Focus group	Descriptive statistics
Are there differences in preferred instructional strategies in students who have declared a science major versus those who have not?	Electronic questionnaire	Cross-tabs analysis (chi square) Independent Samples t-Test
Are there differences in preferred instructional strategies based upon diagnosed learning disability?	Electronic questionnaire	Cross-tabs analysis (chi square) Independent Samples t-Test

Population and Sample Selection

Inclusion criteria will remain consistent with those used by Weis, Erickson, & Till (2016). Inclusion criteria for this study include undergraduate students enrolled full-time at the College and over the age of 18. All students participating in the study must have a diagnosed learning disability. In the spring of 2017, 306 students were enrolled in courses at Beacon College (N=306). Fifty-eight percent of all enrolled students are male. Twenty-eight percent of students have declared a STEM related major. All students enrolled in Beacon College must have evidence of a learning disability, ADHD, and/or autism spectrum disorder. Student population represents a total of 38 states and eight foreign countries. Approximately 16% of Beacon College students fully participated in the electronic survey (n=48). Of these participants, 17% elected to participate in a focus group (n=8).

Instrumentation

Data was collected utilizing an electronic questionnaire as well as structured focus groups. The electronic questionnaire was comprised of six questions, one rating scale question with Likert scale response option, three open-ended responses, and one ranking question. In addition, the electronic questionnaire included four biographical questions regarding the participant's age, gender, declared major, and primary diagnosed learning disability. A copy of the electronic survey can be found in Appendix D.

Data was also collected through focus groups. These sessions contained seven open-ended questions with four planned follow-up questions. One biographical question was asked regarding participant's declared major. A copy of the focus group questionnaire can be found in Appendix E.

All questions asked were designed to answer the three research questions during analysis. The questions were designed after a review of the literature was completed. The data collection tools were designed to elucidate participant perceptions regarding instruction in college science courses.

Validity & Reliability

Creswell (2013) notes the validity of qualitative research is constructed through the reference of literature and corroboration of research methodology described in previous studies. The validity of focus group data is stronger when used a secondary tool for data collection or with triangulation of other data sets, as done in this study (Kidd and Parshall, 2000). Reliability of qualitative researcher focuses on the intercoder agreement, or the ability for multiple individuals to code transcript data. In this study, only one individual coded transcript data to ensure reliability of thematic agreements in participant responses.

The administration of an electronic survey enhances the ability to lessen the potential bias that may be created by the presence of the researcher. Since the researcher is an active faculty member, the electronic survey limited the potential for biased responses. Survey administration protocol for this study followed recommendations created by Nulty (2008). The survey was available for responses for an extended period of time and frequent reminders were sent to participants to encourage participation in the survey. In addition, the constructed survey questions allowed for multiple analysis opportunities to elucidate information from participants. Response rate to the electronic survey falls under the parameters to meet ‘stringent conditions,’ to provide 3% sampling error and a 95% confidence level in results (Nulty, 2008).

Original questions were developed for this study. However, this study modified the instructional strategies described by Scruggs & Mastropieri (2007) which anchored the development of the data collection instruments. These modifications were created by examining the instructional practices of the Beacon College science faculty and labeling the strategy in terms recognizable to the participant. Development of the data collection instrument followed the recommendations set forth by Fitzpatrick, Sanders, & Worthen (2011) to ensure the data collected could be analyzed to answer the research questions.

Data Collection

The electronic survey was distributed to the student body of Beacon College (N=306) using the college email system and was available for responses for a total of 18 days. Participants were sent a preliminary email one week before the survey was distributed to explain the purpose of the study. At the beginning of the 18 days, the survey was distributed via email to the current students of Beacon College. Throughout the 18 day period, three reminder emails were delivered to encourage participation in the survey. Verbal invitation to current students enrolled in the researcher's courses was not completed to negate any potential bias of participation.

Upon the conclusion of the 18 day period the electronic survey was available for responses, participants were recruited to participate in a focus group. Criteria for participation in the focus group included full participation in the electronic survey and the completion of a college science course. Students who were currently enrolled in a course taught by the researcher were avoided. Two focus groups were facilitated, each lasting no more than 35 minutes. The focus group was held on the campus of Beacon College in the Anthrozoology Lab.

Data Analysis

Each data collection tool was broken down by question for analysis. Analysis techniques for each question were determined based on the response type and the technique most suited to answer each research question effectively. Table 5 describes the analysis process for each of the research questions.

Table 5. Analysis methods per question

Tool	Question	Item Type	Analysis Method
Electronic survey	1	Likert scale	Descriptive statistics
	2	Open Response	Tier Coding
	3	Ranking	Descriptive statistics chi square
	4	Open Response	Tier Coding
	5	Multiple choice	Descriptive statistics
	6	Open Response	Tier Coding
Focus Groups	1-8	Open Response	Tier Coding

Responses from the electronic survey were analyzed using descriptive statistics finding the mean and standard deviation. Additionally, chi square tests of independence were used to identify potential relationships between variables and provided responses. Open-ended responses were coded a multi-stage coding procedure described by Moustakas (1994). Figure 2 provides a visual representation of this model of coding.

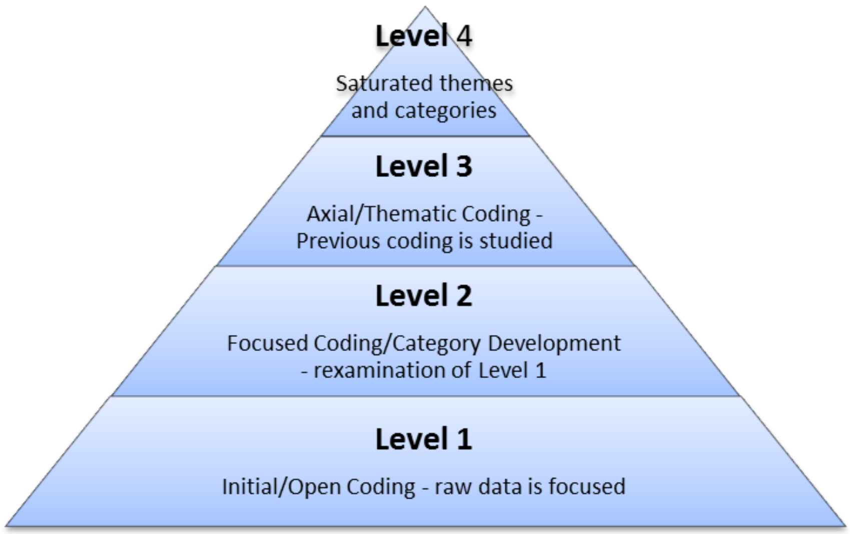

Figure 2. Modified model of coding by Moustakas

Focus group recordings were transcribed and coded using the procedure described by Moustakas (1994). A preliminary stage of coding was completed in order to gather a general outline of participant responses and the themes presented in the dialogue. Next, a more detailed stage of coding was completed, which divided participant responses into multiple segments based on participant backgrounds and attitudes towards college science courses. An emphasis was placed onto self-identified challenges to learning science at the college level. In the third stage of coding, information provided by participants regarding helpful strategies to learn science was identified. During the final stage of coding, key themes which connected participant responses in the focus group as well as the responses from the electronic survey to published literature were identified. Data from each focus group session was analyzed separately following an identical procedure.

Ethical Considerations

No ethical dilemmas have been identified with this research activity. The questionnaire and focus groups were designed in manner as to not offend, harm, provoke or stress any participant. Questions asked are non-instrusive as no personal information about names was requested. Questions asking personal information regarding gender, age, and primary diagnosed learning disability were optional and could remain unanswered.

Data collection tools and informed consents for participant clearly designated the research activities as academic research. Individual respondents may hold the belief participating in the survey would directly benefit their academic studies.

Limitations and Delimitations

The student population is unique due to the nature of the institution, which is solely dedicated to serving students diagnosed with a learning disability. The content of the general education science course is heavily influenced by environmental and life sciences. As a direct result, this student population is not reflective of most higher education classrooms. Future research activities should attempt to include a sample of heterogeneous student populations.

Students who participated in the research activity could choose not to provide information related to diagnosed learning disability, which limited analysis options and the ability to draw conclusions.

Ideal participants would not have any familiarity or attachment to the researcher. However, due to the size of the faculty and student population, this could not be avoided. Despite this, participant responses were helpful and contributed to the findings of this study.

Summary

This chapter provided a detailed explanation for the process of gathering and analyzing the data. The purpose of the study and the research questions which guided the development of the methodology were reiterated. Each of the data collection tools were outlined along with the process of analyzing the data from each tool. Methodology for this mixed-methods study were explained along with how the methodology was shaped by the research questions. In the following chapter, the results will be provided. Results are broken down by research question.

CHAPTER FOUR: ANALYSIS

Introduction

The purpose of this study is to identify the instructional strategies in college science courses preferred by students with a learning disability. In addition, the relationships between preferred instructional method with learner characteristics such as declared major and learning disability were examined. This study combined both qualitative and quantitative data collection protocols along with analysis protocols in a singular study.

To answer each research question, participants were asked to identify specific instructional methods they believed would best support them in a higher education science course. To inform the research questions, participants were asked to complete an electronic survey as well as participate in a focus group.

Each data collection instrument was designed to gather participant self-reported information regarding preferred instructional strategies. Analysis of each tool is aligned with the research questions posed in this study.

Demographics

Seventy-three (N=73) participants were recruited for participation in the electronic questionnaire. Forty-eight (n=48) students fully participated in the survey (66% completion rate) and additional three (n=3) students partially participated in the survey. The remaining 22 students consented to research activity, but did not advance past this stage of the electronic survey. Sixty-one percent of students provided demographic information (n=29); 50% identified as female (n=24) and 38% identified as male (n=18). Almost all participants were under the age of 30 (n=40); 58% stated they were 18-23 years old (n=28) and 25% stated they were 24-29 years old (n=12). Table 6 provides a breakdown of participants by age and sex.

Table 6. Electronic survey participant's age and sex

Age and Sex					
		Sex			
		Male	Female	Do Not Wish to Disclose	*Total*
Age	18-23	11	16	1	28
	24-29	6	5	1	12
	30+	0	1	0	1
	Do Not Wish to Disclose	0	2	5	7
	Total	17	24	7	48

Thirty-two percent of participants have declared a STEM related major. Sixty-eight percent of the participants (n=33) provided information regarding their primary diagnosed learning disability. Sixteen percent (n=8) of participants provided their gender but not their learning disability; two female participants and six male participants. In addition, five participants provided their learning disability, but not their gender; four auditory processing disorder along with one dyscalculia.

When asked how they would rate their overall impression of their college science courses, 67% of participants (n=32) rated their impression as Very Good or above. Only one participant rated their impression as Poor. The mean score on a five point scale for the overall impression of a college science course is 3.83 (±0.96, n=48). Overall impression of a participant's college science course was not influenced by learning disability, X^2 (24, n=48) = 21.522, *p=.141*, or by gender, X^2 (12, n=48) = 13.654, *p=.323*. Additionally, overall impression of science courses in college was not influenced by learning disability, X^2 (28, n=48) = 36.079, *p=.323*.

There were significant differences in the self-identified learning disability and the participant's gender, X^2 (18, n=48) = 31.697, *p=.024*. Table 7 provides a detailed breakdown of participant primary learning disability by gender.

Table 7. Breakdown of participant's primary learning disability

Primary Learning Disability	**Percentage of Students Self-Reporting**	**Male *(n=11)***	**Female *(n=22)***	**Do Not Wish to Disclose (n=5)**
Dyslexia	24%	6	3	0
Dysgraphia	3%	1	0	0
Dyscalculia	18%	1	5	1
Auditory Processing Disorder	34%	2	7	4
Language Processing Disorder	10%	1	3	0
Visual Processing Disorder	10%	0	4	5

There were significant differences between learning disability and the major declared, X^2 (42, n=48) = 60.843, *p=.030*. Table 8 provides a breakdown of participants by their declared major and learning disability.

Table 8. Participant major and learning disability

	Self-Identified Learning Disability						
Major	Dyslexia	Dysgraphia	Dyscalculia	Auditory Processing Disorder	Language Processing Disorder	Visual Perception Disorder	***Total***
Anthrozoology	0	0	1	6	0	0	7
Business Management	1	1	2	3	0	0	7
Computer Information Systems	2	0	1	1	1	0	5
Humanities	1	0	0	0	1	0	2
Human Services	3	0	2	1	0	4	10
Psychology	1	0	1	0	2	0	4
Studio Arts	1	0	0	1	0	0	2
Total	9	1	7	12	4	4	37

A total of 15 students were recruited for participation in the focus group. All participants had completed the electronic survey as well as one college science course. Eight students (n=8) participated in a focus group session. Sixty-six percent of the participants were female. Thirty-three percent of the participants have declared a STEM related major. Table 9 provides a breakdown of participant demographics.

Table 9. Focus group participant demographics

Participant	Gender	Major	Classification by Credits Earned
1	Female	Human Services	Sophomore
2	Male	Studio Arts	Sophomore
3	Male	Psychology	Senior
4	Male	Anthrozoology	Freshman
5	Female	Anthrozoology	Freshman
6	Female	Anthrozoology	Freshman
7	Female	Studio Arts	Sophomore
8	Female	Psychology	Junior

Challenges to Learning Science

Participants were asked to select their three primary challenges to learning science at the college level. The top three challenges identified by participants were 1) textbook is too hard or difficult to understand (52%), 2) material is difficult to remember or understand (50%), and 3) the material does not create real-world connections (45%). Additionally, thirty-three percent of students stated lectures make it difficult to be engaged.

The challenges faced by students to learn science appears to be different between male and female students. When the two groups were compared, there was a significant difference in the challenges selected by each group, X^2 (63, n=48) = 90.771, *p=.013*. However, challenges to learning content did not demonstrate a relationship to learning disability, X^2 (126, n=48) = 133.799, *p=.301*. There appears to be no relationship between the challenges faced by learners and their declared major, X^2 (147, n=48) = 149.331, *p=.431*.

The biggest challenge described by male students centers on the material connecting to their life, whereas female students reported having difficulty in reading or interpreting course text. Closely following challenges associated with reading, female students noted the content being difficult to understand or remember as well as the traditional lecture not creating a form of engagement. The challenge of difficulty in reading and interpreting text was described to be of equal challenge as the content being difficult to remember or understand after material not connecting to their own life by male students. A detailed breakdown of participant responses regarding the challenges to learning science has been provided in Table 10.

Table 10. Challenges to learning science reported by gender

Which of the following have been the biggest challenges for you to do well in a science course? (select up to three)	Male	Female	Do Not Wish to Disclose	Total
Textbook is too hard to read or understand	6	14	0	20
What we learn does not relate to my life	11	7	0	18
Lectures make it hard to be engaged	3	10	0	13
Lectures do not teach me how I prefer to be taught	2	2	2	6
What we do in lab is not connected to what we learn in lecture	1	1	1	3
What we learn is difficult to understand or remember	6	13	1	20

Table 11. Thematic categories of challenges to learning science from open-ended responses

Theme	**Key Term**	**Characteristic Response**
Text	Textbook Or Readings	"…how [textbook] was written…makes it hard for me to read." "..can't focus with a book."
Anxiety	Overwhelming Or Anxiety Or Stress	"I find the lab part of the class overwhelming." "…knowing there are no tests takes a lot of stress of me." "I get very anxious with exams and quizzes, although I know the material I blank out when it comes to exam time."
Collaborative Learning	Group Or Team	"…team based learning is the worst."

Research Question 1

This research question focused on identifying which instructional strategies commonly employed in a science course were preferred by students. When asked to order eleven different instructional methods from favorite (#1) to least favorite (#11), the most popular choice for favorite method was no exams (n=11) followed by learning outdoors (n=7). The instructional method most commonly identified as the least preferred was writing the final paper in stages or in chunks throughout the semester (n=19) and the standard lecture (n=13). Focus group participants repeatedly disclosed a dislike for the traditional lecture. One focus group participant stated "…in lectures I space out and I can't grasp [the material], I have trouble grasping what you're saying." Table 12 lists the ranking score of each described instructional method.

Table 12. Results of participant ranking of instructional methods.

Instructional Method	Mean Score (1=most favorable)	Standard Deviation	Frequency of Ordered #1	Frequency of Ordered #11
Standard lecture	8.98	2.58	1	13
Writing papers in stages or chunking	8.52	2.87	1	19
Material is connected to the real-world	7.68	2.38	1	1
Hands-on activities	5.43	2.75	5	0
Collaborative learning	7.45	2.35	0	4
No tests or quizzes	5.43	2.92	11	2
Student choice in assignments	4.91	2.17	3	0
Observation of live animals	4.52	2.54	5	0
Learning outdoors	4.23	2.86	7	2
Class discussions	4.48	2.57	6	1
Modified textbook	5.48	3.07	4	3

When participants were asked to describe why they ordered the instructional methods in the manner they did, 11 participants provided a detailed response explaining these teaching strategies aided in the reduction of stress and anxiety created by learning science. Sources of stress and anxiety, included: difficulty reading/interpreting text (n=4), working with others (n=2), and exams (n=3). There is no relationship between gender and preferred instructional method, X^2 (33, n=48) = 29.481, $p=.643$.

None of the participants placed hands-on activities or lessons as their least preferred instructional method. When participants were asked to describe their ideal science course, a total of 18 participants stated the course would be hands-on. All focus group participants (n=8) stated the utilization of hands-on activities guided by the instructor is the preferred manner to learn science in a college level course. In total, hands-on learning was mentioned 32 times as it related to a beneficial or helpful instructional process during the focus group sessions. During the focus group, nearly all of the participants were able to effectively recall a memory from their science course involving a hands-on lesson. Information provided not only included specific details about the lesson or the procedure, but also about what the participant learned from this specific activity. Table 13 provides an overview of thematic categories of ideal college science course from open-ended responses.

Table 13. Thematic categories of ideal college science course from open-ended responses

Theme	Key Term	Characteristic Response
Reduction of Anxiety / Stress	Anxiety Or Stress	"No homework or exams."
Student Access to Curriculum		"It would be a class for people who have always struggled with science…" "…let the students decide which [topics] they want to learn…" "Having the students decide what course they want first would allow them to learn [what] sounds interesting and better engage them." "I would not choose one."
Experiential Learning	Field trips OR Outdoors	"…lot of field trips." "…teach outside as much as possible."
Real-world Connecting	Real-world OR Applied	"…hands-on lessons that relate to real-life." "I'd want everything to be related to my career, stuff I would actually use in my life."
Direct instruction	Instructor <action> OR Support	"…learning games."
Hands-on Learning	Hands-on	"The work would involve hands-on learning."
Collaborative Learning	Team Or Group	"…would [avoid] group activities…"
Reading	Text Or Readings Or Textbook	"I would [have] no textbook"

In the focus group, one individual utilized the analogy of learning how to ride a bicycle to learning in the classroom. Multiple participants stated the interaction with and direct instruction provided by the faculty member creates a personal connection. The participants noted this connection with the faculty member is vital in feeling equipped to pose clarifying questions regarding learning tasks. Similarly, the connection created with the instructor as a result of the direct instruction prompted the ability for students to engage in meaningful discussions with the faculty. One participant notes, "[we] actually process information more because we got to discuss." Similarly, a participant recalled a situation where the faculty member did not use direct or explicit instruction and it created confusion regarding how to complete the task. This participant stated without the clarification, they would have been unable to successfully complete the required task. Table 14 provides an overview of thematic categories of preferred instructional method from focus group responses.

Table 14. Thematic categories of preferred instructional method from focus groups

Theme	Key Term	Characteristic Response
Q2. Here is a list of teaching methods, what have been the most helpful to you?		
Modified Text	Text OR Readings	"…been so helpful for me is modified textbook."
Experiential Learning	Field trips OR Outdoors	"…we are always stuck in a classroom and stuck sitting and then you get bored and tired…we receive information differently when you're in a classroom." "…seeing things in a natural way, as close as we can to [nature], you have something to relate [concepts] to and remember it more."
Standard Lecture	Lecture OR PowerPoint	"…I have trouble grasping what [faculty] are saying."
Real-world Connecting	Real-world OR Applied	"…[I] think of science not really as a classroom setting but as more like life."
Relationship with Faculty	Faculty or Assistance	"It's okay to ask questions." "….giving [student] assurance with wellbeing, by being firm though." "…professors who know their students…student can engage with the faculty." "…builds a bridge to understand what are the strengths and weaknesses of students…"
Q3. Tell me a time where you really enjoyed learning the content in a science class		
Direct instruction	Instructor <action> OR Support	"…it was always step-by-step."
Hands-on Learning	Hands-on	"…[faculty] brought props and let you write on the board…"
Experiential Learning	Field trips OR Outdoors	"I think one of the things I remember most from class is when we did an outside [activity]."
Real-world Connecting	Real-world OR Applied	"…we got to discuss what this actually meant, how it affects our environment." "..[faculty] teaching us about Florida and manatees [it] was fascinating."

Learning outdoors was the second most popular response for favorite instructional method. Eight participants in the electronic survey described learning outside of the traditional classroom environment, either outdoors or on field trip, as a core aspect of their ideal science course. The strategy of teaching outdoors or out of the traditional classroom was mentioned favorably as a learning strategy a total of 11 times during the focus group. The concept of being receptive to information differently while learning outdoors compared to learning in the classroom was mentioned by two focus group participants.

Collaborative or cooperative learning was among the least preferred instructional methods. In the ranking of instructional methods, ten percent of participants listed this method as their least preferred form of instruction. In addition, approximately one-third of focus group participants stated it was their least favorite method of learning. Similarly, two-thirds of focus group participants stated collaborative learning was their least favorite method of learning.

However, two focus group participants mentioned collaborative or cooperative learning as a positive teaching strategy. One example of positive cooperative learning experiences focused on peer study groups. During the discussion, study groups were described to be beneficial due to their interactive nature and the group discussions regarding the content. An additional two focus participants also described the benefits of engaging in discussions about the content. Each stating it helped them become more prepared and able to work with the content or skill.

Research Question 2

The second research question focused on identifying the differences between preferred instructional methods by students based on their declared major. When asked to rearrange a list of instructional methods commonly used by the science faculty of Beacon College, participants in the same major did not select similar preferred instructional methods. The declared major appears to have no relationship to the preferred instructional method, X^2 (77, n=48) = 82.881, *p=.303.* Table 15 provides the preferred and least preferred instructional method by major.

Table 15. Most and least preferred instructional method by declared major

Major	Number of Participants	Preferred Instructional Method	Least Preferred Instructional Method
Anthrozoology	7	Learning Outside (2.86±2.17)	Standard Lecture (10.14±0.64)
Business Management	8	Modified Textbook (3.88±2.09) No Exams (3.88±2.71)	Standard Lecture (9.25±1.64)
Computer Information Systems	7	Class Discussion (3.14±2.36)	Standard Lecture (8.29±3.19)
Humanities	1	No Exams (1.00±0.00)	Standard Lecture (11.00±0.00)
Human Services	11	Class Discussion (3.55±2.54)	Material Connected to Real World (8.91±1.54) Writing Paper in Stages (8.91±2.39)
Psychology	4	Learning Outside (2.00±1.00)	Standard Lecture (10.75±0.143)
Studio Arts	2	Learning Outside (1.50±0.50) Observing Live Animals (1.50±0.50)	Modified Textbook (9.50±0.50)

When participant explanations for the reasoning why they ordered the instructional methods the way they did, nearly half of the groupings included a statement describing hands-on learning as the preferred way to learn. In multiple open-response opportunities in the electronic survey, participants who have declared a major in computer information systems included statements regarding a preference to learn indoors rather than outdoors.

In response to designing an ideal science course, the desire to have instruction include hands on activities were provided by every declared major. The highest concentration of similar responses came from the Anthrozoology major where six of seven participants stated the course would be hands on. In addition, three of the seven responses included a statement about learning outdoors and out of the classroom environment. One participant representing a non-STEM major stated their ideal college science course would be the ability to “not choosing to take one.”

The connection of real life examples and how the content of the course can be applied to the real world was considered to be a desired trait in an ideal science course. When participant responses were grouped by similar major, four of the six response groups contained a statement focusing on the connection of the material to everyday life. Primarily participants in a non-STEM field of study expressed this sentiment. This theme was not present in the data from the focus group.

Research Question 3

The third research question focused on examining if there are differences between preferred instructional methods based on the participant’s learning disability. When asked to rearrange a list of instructional methods commonly used by the science faculty of Beacon College, participants with a similar learning disability did not select similar preferred instructional methods. The instructional method preferred by students did not demonstrate a relationship between the instructional method and the participant's learning disability, X^2 (66, n=48) = 69.544, *p=.359.* Similarly, the least preferred instructional method did not demonstrate a relationship with learning disability, X^2 (63, n=48) = 75.963, *p=.188.*

Table 16. Most and least preferred instructional method by learning disability

Learning Disability	Number of Participants	Preferred Instructional Method	Least Preferred Instructional Method
Dyslexia	9	Class Discussions (3.78±2.97)	Standard Lecture (9.11±3.11)
Dyscalculia	6	Learning Outside (2.33±1.37)	Writing Paper in Stages (10.33±1.49)
Auditory Processing Disorder	13	Observing Live Animals (3.31±1.59)	Standard Lecture (9.46±1.39)
Language Processing Disorder	3	Observing Live Animals (3.00±0.82)	Standard Lecture (11.00±0.00)
Visual Perception Disorder	4	Class Discussions (3.50±2.06) No Exams (3.50±1.50)	Standard Lecture (8.75±1.92)
Dysgraphia	0	N/A	N/A

When participants were asked how their ideal science course would be instructed, hands-on instruction was mentioned by each learning disability. Hands on instruction was mentioned by five out of six participants with dyslexia, by all participants with dyscalculia (n=3) as well as language processing disorder (n=2), and by four out of nine participants with auditory processing disorder.

CHAPTER FIVE: DISCUSSION

Introduction

The final chapter in this dissertation describes the implications for practice and recommendations for further research based on the findings presented. The purpose of this study was to identify preferred instructional strategies utilized in a college science course by those students with a learning disability.

This study employed a mix methods design to gather data from undergraduate students with a learning disability. Data collection included the use of an electronic survey as well as focus groups. Descriptive statistics were used along with chi squares to analyze the electronic survey data. Focus group data was analyzed using a tiered coding system to identify themes in participant responses.

The limited number of participants disclosing their learning disability and/or declared major in the demographic questions on the electronic survey limited the potential to draw conclusions regarding the larger population of students with a learning disability enrolled in courses at the collegiate level.

This study was limited to a single institution with a mission dedicated to serving students with a learning disability. As a result, the findings may be difficult to be representative for every higher education institution. However, experienced instructional designers may be able to apply the findings from this study.

Discussion of the Challenges Facing Students

Participants in this study self-reported their top three challenges to learning science at the college level as 1) text is too hard or difficult to understand, 2) material is difficult to remember or understand, and 3) material does not create real-world connections. While these challenges faced by students do not appear have a demonstrated relationship with their learning disability or declared major, there are noticeable differences between male and female students.

Keri (2002) suggests this may be due to male students often prefer an applied learning style whereas female students often prefer a conceptual approach to learning. These differences in cognitive processing of information by gender may influence performance in a college science course. There is an observable trend in which female students as a whole do not perform as well in math and science courses and underrepresented in STEM careers. It can be argued this may be related to a cognitive difference related to brain functioning and processing; however, the influence of societal gender stereotypes regarding professional roles and academics probably plays a much more significant role (Halpern, Benbow, Geary, Gur, Hyde, & Gernsbacher, 2007). Spelke (2005) argues gender does not play a role in the aptitude to learn math and science, only the process in which learning occurs is different between male and female learners.

While both genders described the difficulty of reading and interpreting text, it was a self-reported to be a much larger challenge for female students than male students. The utilization of complex texts is often the foundation for science courses. These texts are often used by faculty as a mean of planning curriculum and instruction for a course. Since both genders did report this challenge in a similar manner as reporting the difficulty in remembering course content, the difficulty in reading may serve as a barrier to rehearsal and encoding of information. These findings echo the findings of Schneps, O'Keeffe, Heffner-Wong, & Sonnert (2010), the ability to interpret, rehearse, and properly store the information conveyed in complex texts has been demonstrated to be a recognizable barrier for students to successfully complete college courses.

One participant in the focus group described her difficulty in encoding and recalling the information provided in the textbook by stating, "…because of my comprehension difficulties, I wasn't able to understand what they were talking about and it was harder than the [research] articles to translate." Yet, as a result of direct instruction on reading strategies to rehearse the information, she was able to interpret the information from the textbook.

Discussion of Research Question 1

This research question focused on identifying which instructional strategies commonly employed in a science course were preferred by students. Overwhelmingly, student preference was given to learning through hands-on activities and lessons. The findings presented in this study are similar to those findings by Black, Weinberg, & Brodwin (2015); students with a learning disability often self-report a preference of visual and hands-on learning more frequently than the students without a learning disability. Kirschner, Sweller, & Clark (2006) argue this form of instruction is vital to ensuring student success in college level science courses, even though this method of instruction often is underemployed by faculty. Additionally, Black, Weinberg, & Brodwin demonstrated students with a learning disability described group discussions and alternative textbooks a preferred instructional method.

The information regarding the role of hands-on, direct instruction provided by focus group participants demonstrated the direct benefits to the individual learner. Each of the focus group participants (n=8) was able to recall a specific lesson and the information presented as a result of direct instruction. Instructional designers should place a greater emphasis on the purposeful inclusion of opportunities for students to engage in hands-on learning through active movement, utilization of artifacts, creation of models, manipulatives, and investigations involving props and/or equipment.

One study examining the impacts of direct instruction on performance of elementary school learners with reading deficits as a result of autism spectrum disorder demonstrated a positive "immediate and marked change" in performance (Flores & Ganz, 2007). Etkina and Mestre (2004) note when direct instructional strategies are employed, it allows for the learner to engage with novel skills and experiences. This rehearsal period is critical to the cognitive process. Once the learner has demonstrated mastery of the skill or concept, the instructor should design assessment practices which mirror instruction so the learner may demonstrate the rehearsed skill or concept in an applied manner.

While collaborative or cooperative learning appears to be an unfavorable experience for students, it is an important instructional method for this student population. Evidence from the literature supports the claim collaborative or cooperative learning does increase academic performance in students with a learning disability (McMaster & Fuchs, 2002). It is believed the cognitive processing of information is aided through multiple rehearsals created by conversing with peers. The process of explaining information to someone else aids in the ability to retrieve and store information beyond the working memory (Slavin, Hurley, & Chamberlain, 2003). Additionally, literature supports the claim collaborative or cooperative learning when applied to students with a learning disability appears to have a positive impact on the student's resilience and the ability to work with peers (Jenkins, Antil, Wayne, & Vadasy, 2003).

Discussion of Research Question 2

The second research question focused on identifying the differences between preferred instructional methods by students based on their declared major. The declared major appears to have no relationship to the preferred instructional method.

The findings of this study, when combined with the literature, suggest if planned activities are designed to connect course material with real-world applications as well as to the student's personal life, the learner is more likely to remain motivated and engaged in learning. This can potentially increase academic performance.

This reiterates the findings of Schroeder, Scott, Tolson, Huang, & Lee (2007). A direct correlation was demonstrated between student achievement and connecting the curriculum to real-world situations and applications. When the content is directly linked to real-world application, students perform at a higher level. Osborne, Simon, & Collins (2003) suggest there is a deep disconnect between the faculty's perceived motivator for a student to learn science compared to the exact motivator of the student. It can be argued the situational interest of being required to enroll in a science course at the college level to complete general education requirements may play a role in the decreased student interest in the content. However, it is argued instruction and curriculum designers need to place a bigger emphasis onto designing activities with a perceived “true value,” which will aid in creating intrinsic motivation for learning by meeting the personal values of the learner (interest, importance, and utility of information).

Intensive or theme-based curriculum models in science education for students with a learning disability described by Cawley, Foley, & Miller (2003) demonstrates potential to move beyond a general framework for all students with a learning disability to those students who demonstrate a reduced interest in learning science. Each of these frameworks have proven to have positive performance gains in students with a mild learning disability.

Motivation, positive attitude, and engagement in academics have a demonstrated effect on a student’s success in the content areas of mathematics and science. It has been recommended curriculum and instruction designers create learning activities matching student interest (Singh, Granville, & Dika, 2002; Perkins, Adams, Pollock, Finkelstein, & Wieman, 2005). Cook and Mulvihill (2008) demonstrated when students who have declared a non-science major participate in an interdisciplinary course focusing on civic responsibility, they report a positive increase in student attitudes towards science. Keller (2002) notes the utilization of problem-based learning (PBL) can be an effective instructional strategy to engage non-science majors. PBL has been demonstrated to effectively change student attitudes towards science and the ability to learn cross-cutting concepts.

Discussion of Research Question 3

The third research question focused on examining if there is a relationship the between preferred instructional method and the participant's learning disability. The instructional methods ranked by students as the least and the most preferred did not demonstrate a relationship between the instructional method and the participant's learning disability.

While this study did not document any relationship between learning disability and the preferred method to learn, Heiman (2006) demonstrated there is a significant difference between the preferred method of learning between students with a learning disability and their neurotypical peers. Students with a learning disability often incorporate more visual and oral learning strategies compared to their neurotypical peers (Heiman & Precel, 2003). Findings from this study highlighted a similar finding through the focus groups, in which one-third of participants described the benefits of learning visually in the classroom; e.g., watching a video which restates information from the text or lecture.

Vaughn and Linan-Thompson (2003) contend students with a learning disability should be provided the same curriculum; however, the instruction should be altered. They state, "students with LD benefit from explicit and systematic instruction that is closely related to their area of instructional need." While it is not described if this statement refers directly to differing learning disabilities or between this population and neurotypical peers, similar instructional methods matching findings in this study are described. The need for direct instruction, hands-on learning opportunities, modeling of strategies, and teaching in small, collaborative groups were described to yield best results in student performance. Grumbine and Alden (2006) echo this conclusion by stating science instruction for students with a learning disability must be centered on methods involving direct instruction. Additionally, all assessment practices must be designed to mirror the instruction so the student may recall the information using rehearsed strategies.

The development of instruction following the principles of universal design may provide the best results while balancing the needs of both faculty and learner (King-Sears, 2009). Due to the unique learning environment of Beacon College, universal design may provide the best solution for instructional designers in a traditional college setting. "If curriculum designers recognize the widely diverse learners in current classrooms and build in options to support learning differences from the beginning, the curriculum as inherently designed can work for all learners" (Hitchcock, Meyer, Rose, & Jackson, 2002, p. 12). The purposeful design of instruction in higher education can move away from simply providing accommodations to learners to anticipating and meeting the needs of every learner (McGuire & Scott, 2006).

Cognitive Information Processing and Application of Findings

Ultimately, for information to be stored properly in the long-term memory, faculty must design instruction so the learner can depict information in multiple forms, solve complex problems, and repeat operations multiple times (Sarasin, 2006). This only can be achieved through the inclusion of hands-on learning experiences for students with direct instruction.

According to Grumbine and Alden (2006), strategies involving rehearsal of complex vocabulary and phrases allow students with a learning disability to properly store and retrieve information. Additionally, the faculty member should also model the skills necessary for successfully interpreting the text so it may be properly rehearsed.

CIP theory suggests when information can be connected in memory using prior knowledge or familiarity and rehearsed through personal actions, reflection, and experiences, the changes for meaningful learning (or retention of the information in the long-term memory) will increase (Morrison, Ross, & Kemp, 2007). Participants in this study ranked the inability to connect the course material to their own life as a challenge to learning science. Using CIP and this recognized barrier, it can be hypothesized when material is purposefully designed to connect course theories to everyday examples, student retention of information will increase. The design of instruction should focus on creating these concrete examples for students with a learning disability.

The findings from the first research question can be combined in this instance to support a non-STEM major with a learning disability. Etkina and Mestre (2004) argue cooperative learning strategies are particularly helpful to students who have declared a non-science major to learn science content. The process of cooperative learning engages students in rehearsal of complex information. Because all of the students possess similar motivations and previous knowledge regarding the topic, it allows each student to effectively rehearse vital skills and knowledge.

Lattuca and Stark (2009) argue the observed disconnect between faculty knowledge of instruction and their selected methods for instruction are incompatible, which may have a direct impact on the student. They highlight faculty consistently report the benefits of hands-on instruction for retention of knowledge; however, they rely on “extensive lecturing” as their primary instructional method. In particular, there is an observed inability for faculty to select the appropriate instructional method for a given learning task or outcome. Essentially, faculty are unaware of how to design instruction to allow the learner appropriate rehearsal and coding of information for proper storage and retrieval in the long-term memory. This can be attributed to the lack of training available for faculty in the areas of instruction design.

While purposeful design of active learning has been demonstrated to be successful in increasing academic performance in students, with and without learning disabilities, there have been documented barriers to including these strategies in the college classroom. The primary barriers included the lack of: 1) available time to design instruction, 2) faculty’s willingness to be inclusive of all learners, and 3) the lack of knowledge on curriculum and instruction design principles (Moriarty, 2007).

Summary of Findings

A common theme was presented throughout the findings of this study: students with a learning disability prefer direct instruction with hands-on activities in college level science courses. It appears the learning disability does not have an influence on the preferred specific instructional method. Each learning disability presents a barrier in storing and retrieving information as a result of the differing cognitive structures.

Male and female learners in this study self-identified different challenges to learning the content taught in a college level science course. However, each gender self-identified difficulties in remembering and recalling the information presented in the course. Additionally, difficulties in reading and interpreting complex texts were self-identified by participants.

Participants stated a general dislike for cooperative learning strategies, but the evidence presented in the literature demonstrates the benefits related to the cognitive processing of information, especially for students with a learning disability.

Students who have declared a non-STEM major may face additional barriers to learning science beyond those related to cognitive processes. Factors such as lowered motivation for learning science and lessened engagement as a result of a lack of interest in the material may impact the learner.

Direct or explicit instruction which includes hands-on learning has been self-identified by participants as the preferred method for learning science. These findings reiterate the findings in the reviewed literature.

Implications of the Study

The findings from this study provide the science faculty of Beacon College with the information necessary to create an instructional plan to increase student performance in science courses. These recommendations include:

- Designed Instruction should be explicit and direct,
- Topics in the curriculum should be narrowed and connected to real-world applications. In addition, the topics presented in the course should relate directly back to the learner's own life and how this information will impact them as an individual,

- The learning environment should by dynamic with a focus on experiential learning outdoors,
- Collaborative or cooperative learning strategies should be utilized strategically to increase the rehearsal and recall of complex information and/or skills,
- The inclusion of embedded peer tutors, representing science and non-science majors,
- Assessment practices should directly mirror instructional practices to allow students to recall the information in the manner in which it was rehearsed, and
- Replacement of the traditional lecture with lessons that allow students to rehearse skills and content through interactive and hands-on lessons.

Recommendations for Future Research

This study was conducted to examine the preferred instructional methods in a college level science course. The study population was students with a learning disability and represented both science and non-science majors.

It is recommended future studies examine attitudes and perceptions held by faculty and how these directly impact choices in instruction and curriculum design at a deeper level as well as the direct impact these choices have on student performance. Throughout the review of the literature, the attitudes and perceptions held by faculty appears to influence their instructional choices. Qualitative data collected during this study demonstrated the theme of being able to advocate for services and faculty not providing these accommodations or services impacting student success was presented. Focus group participant in this study stated, "…[the faculty] didn't really care too much…ultimately, [this is the] reason why I ended up not going back to college." One participant stated, "depending on what [accommodations faculty] feel should be approved or not will determine how well you do in class." Since students who have declared a non-science major as well as students with a learning disability represent distinct student populations with unique learning challenges, this presents an area of opportunity to examine how these attitudes and perceptions can directly impact student performance.

Another area should include an emphasis in examining the needs of non-science majors in college level science courses. Many higher education institutions require the completion of a science course as part of the general education requirements for graduation. These students have differing educational, instructional, and motivational needs than those students declaring a science major.

Summary

The purpose of this research was to examine the relationships between learning theories and the implementation in practice through the collection of empirical evidence and student self-reports to contribute to the general body of knowledge on this topic. Implementation of findings will guide the development of instructional plans for science courses taught at Beacon College.

A total of 48 students participated in an electronic survey and eight participants participated in a focus group. Analysis of data included the utilization of descriptive statistics as well as chi square to determine the relationship between identified variables. A tier coding system was used to analyze qualitative data provided by participants.

Study participants self-reported challenges to learning science, which include difficulty in interpreting complex texts, material difficult to remember or recall, and the material does not create connections to real-world applications. While these challenges faced by students do not appear have a demonstrated relationship with their learning disability or declared major, there are noticeable differences between male and female students.

Study participants self-reported a preference of direct instruction with hands-on learning opportunities, which may occur outside of the traditional classroom environment. The declared major as well as learning disability appears to have no relationship to the preferred or least preferred instructional method.

APPENDIX A: UCF IRB APPROVAL LETTER

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Brian W. Ogle**

Date: **December 29, 2016**

Dear Researcher:

On 12/29/2016, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Improving Higher Education Instructional Strategies for Students with a Learning Disability in a General Education Science Course
Investigator:	Brian W. Ogle
IRB Number:	SBE-16-12767
Funding Agency:	
Grant Title:	
Research ID:	N/A

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Dziegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Signature applied by Gillian Amy Mary Morien on 12/29/2016 12:48:29 PM EST

IRB Coordinator

APPENDIX B: INVITATION TO PARTICIPATE IN ELECTRONIC SURVEY

Opening Screen

You are being invited to take part in a research study because you are a current college student with a learning disability. You must be 18 years of age or older to be included in the research study.

All answers are completely anonymous.

This five-minute survey will identify preferred instructional strategies for higher education science courses preferred by students diagnosed with a learning disability.

The investigator, Brian Ogle (brian.w.ogle@ucfknights.edu or 402-708-0048), is currently enrolled as a student in the University of Central Florida Doctor of Education (Ed.D.) program and supervised by Dr. Thomas Cox, dissertation chair (Thomas.Cox@ucf.edu or 407-823-6714).

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901. You may also talk to them for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You want to get information or provide input about this research.

By clicking "Next" you agree you 1) are at least 18 years of age, 2) agree to fully participate in the survey, and 3) are providing your consent for your responses to be used.

APPENDIX C: INVITATION TO PARTICIPATE IN FOCUS GROUP

EXPLANATION OF RESEARCH

Title of Project: Improving Higher Education Instructional Strategies for Students with a Learning Disability in a General Education Science Course

Principal Investigator: Brian Ogle, doctoral candidtate, College of Education

Faculty Supervisor: Dr. Thomas Cox, College of Education

You are being invited to take part in a research study. Whether you take part is up to you.

- You are being asked to participate in a focus group with approximately 10 other indiviudals. The focus group will be held on the Beacon College campus and will last approximately 60 minutes.
- The purpose of this study is to identify preferred instructional strategies for higher education science courses preferred by students with a learning disability.
- During the focus group, you will be asked 8 main questions and potentially some follow-up questions. These questions will be about teaching strategies used in college science classes.
- Please be respectful of the other participants, their provided statements, and the views expressed by everyone involved. This is a safe space and meant to gather information related to your experiences as a learner.

You must be 18 years of age or older to take part in this research study.

Study contact for questions about the study or to report a problem: If you have questions, concerns, or complaints regarding study, please contact Brian Ogle, doctoral candidate, College of Education at brian.w.ogle@ucfknights.edu or Dr. Thomas Cox, dissertation chair by email at Thomas.Cox@ucf.edu or by phone at 407-823-6714.

IRB contact about your rights in the study or to report a complaint: Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (407) 823-2901.

APPENDIX D: ELECTRONIC SURVEY DATA COLLECTION TOOL

Screen 1 – Consent
Informed consent form and agree to participate (see separate document)

Screen 2 – Survey Questions
Question 1: What has been your overall impression with science courses in college?

1-Poor
2-Fair
3-Good
4-Very good
5-Excellent

Question 2: Why did you rate your overall impression with science courses in college the way that you have?
(open-ended response)

Question 3: Listed below are common teaching methods used in science courses at Beacon College. ***Rearrange*** them so they are in order of your most preferred (favorite) is first and your least preferred method is last:

Modified textbook
Class discussions
Learning outside
Observing live animals
Choice in assignments
No exams or quizzes
Collaborative/cooperative (team-based) learning
Hands-on lessons or activities
Material is connected to the real-world
Standard lecture / PowerPoint presentation
Writing papers in stages or chunks

Question 4: Why did you order them in this manner?
(open ended response)

Question 5: Which of the following have been the biggest challenges for you to do well in a science course? ***(select three)***

Textbook is too hard to read or understand
What we learn does not relate to my life
Lectures make it difficult to be engaged
Lectures do not teach me how I prefer to be taught
What we do in lab is not connected to what we learn in lecture
What we learn is difficult to understand or remember

Question 6: If you could design a science course just for you, how would the professor teach this course?
(open-ended response)

<u>Screen 3 – Biographical</u>
Question 7: What is your major? (select one of the following)

Anthrozoology, Business Management, Computer Information Systems, Human Services, Humanities, Psychology, Studio Arts

Question 8: What is your primary diagnosed learning disability? (select one of the following)

Dyslexia
Dysgraphia
Dyscalculia
Auditory Processing Disorder
Language Processing Disorder
Visual Perception Disorder

What is your age?

18-23
24-29
30 and up

What is your gender?

- Male
- Female
- Do not wish to disclose
- Other

<u>Screen 4 – Thank you</u>

Thank you for your participation in this survey! Your responses will help build our understanding of how to provide the best quality science education experiences as possible.

APPENDIX E: FOCUS GROUP PROMPTS AND PROBES

Question 1) Please state your major

Question 2) Here is a list of teaching methods, what have been the most helpful to you?

Question 3) Tell me a time where you really enjoyed learning the content in a science class

Probe: Did they do this more than once?

Probe: Did everyone like it or did someone complain?

Probe: Why did this stand out to you?

Question 4) Tell me about a time when the faculty did something that did not help you to learn or made you not want to learn

Question 5) Do you feel the science faculty know you as an individual? Do they teach recognizing your individual strengths or weaknesses as a learner?

Probe: Can you provide me with an example?

Question 6) Can you describe how the science and English faculty teach differently?

Question 7) If money were no object and you could learn science any way you want to, how would you want to learn science? What could the school or the faculty be doing?

Question 8) I've talk to you a lot about science and science instruction. Is there anything you want to tell me about these areas?

APPENDIX F: STUDENT FOCUS GROUP 1 TRANSCRIPT

[00:00:02] MOD: Okay, so, the very first question that I have for you guys, is for you to tell me a time where you really enjoyed learning the content of the science class?

[00:00:12] Male: I'm first.

[00:00:13] MOD: Okay, go ahead Jessy.

[00:00:15] Male: The day we were learning about predation and population control, and we played that game that you setup over by the Beacon Hall that was great.

[00:00:26] MOD: Okay.

[00:00:26] Male: I learned a lot about…

[00:00:27] Female: Yeah, I liked that too.

[00:00:28] Male: ...I had fun during it.

[00:00:29] Female: I really liked that.

[00:00:29] Female: I like that too.

[00:00:30] Male: That was a good thing.

[00:00:31] Female: That was a lot of fun, yes.

[00:00:32] MOD: Okay, so, kind of recap you really enjoyed going, what part of it was, there was the activity part?

[00:00:37] Male: I liked the interaction.

[00:00:38] MOD: Okay.

[00:00:39] Male: So, being able to go out and learn while still doing something, instead of sitting here and talking about it. It's a lot more interactive, which means it sticks better.

[00:00:50] MOD: Okay.

[00:00:51] Female: I agree with him, I liked that as well.

[00:00:53] MOD: Okay.

[00:00:53] Male: I like it because like, like what she said. It's better to just get outside, do something and interact with each other.

[00:01:01] MOD: Yeah.

[00:01:02] Male: We're humans, we're very social and we interact with each other all the time. People who have ADHD can't sit in the room for so long, at long periods of time.

[00:01:15] Female: No one can do that.

[00:01:16] Female: I also liked how it wasn't like so competitive, it was like…

[00:01:19] Female: It was just for fun.

[00:01:19] Female: …it was, it was fun.

[00:01:21] Female: It was just a fun game.

[00:01:22] MOD: Kim.

[00:01:23] Male: I guess for me when I took my class we were a little different. The class that made me interested was animal behavior, and I think it's because it was something new and I didn't know that, I guess because my major is in psychology. So, it was sort of interesting to kind of know that, there is a psychology part related to animals.

I liked the fact that when we were discussing about more than just the science, but also the psychological part. Even like social group, adaptation, I remember that was another thing. Also like, in terms of how there are certain, the way the body functions, there are certain expertise how skill and animal is.

That was another thing, and also that when we did a lot of our research paper which was the, it was a big chance for research. It was like, it was kind of it was like a variety options, where you can learn different ways.

So, we had a bunch of accommodations, so, not necessarily would just stay in the setting like you guys. But we also went out there, and I actually kind of researched and kind of learned. Not just in the research kind of base, but also kind of like the observing also.

[00:02:43] Female: Yeah.

[00:02:46] Male: So, I guess one of the things I liked in the past though was that, we were able to use present, like some sort of imaging examples and some sort of videoing as well. Because sometimes like I lost, if you're not a person that, you're like those persons who have kind of like a visual learner. It kind of gives you some sort of an imagination of what, you know what it looks like.

So, if we're discussing about certain area, about an animal. Or the anatomy, it gives you a general sense what it looks like. Sort of helps you some kind of understand, what are the functions, and so forth. So, I don't know if you have any view you guys.

[00:03:22] Female: Yeah, personally when I took your class, yeah last semester, I like manatees. When we talked about manatees, towards the end of the semester.

[00:03:32] MOD: What specifically made you like it, was it just the content, was it how it was taught?

[00:03:36] Female: I mean how you went about teaching us about the Indian, the flower mantis, I forget what it was called. But it was like the anti-Florida and how you like, yeah, it was that really cool topic about the manatee and all the cool things about it. Then you showed us those, it's called like the head of manatee and the flipper of manatee. So, we actually got to see what the head actually looked like, and what the flipper actually looks like on the inside.

[00:04:04] MOD: So, you enjoyed interacting with actual, the skull and the flipper, okay.

[00:04:07] Female: Yeah, and that was fascinating, because I love manatees. So, I thought it was really cool and that was my favorite part, like to learn about. I mean all the other stuff we went by was really cool too. But I was excited to learn that, when we found out, I found out that we were going to do that.

[00:04:23] Male: I was saying in class, I don't know if you guys are believing me or not. But I would say like in classes, the good thing it was that it was always step by step.

[00:04:29] Male: Yeah.

[00:04:30] Male: So, it was never like giving to all at once, which I think it's kind of difficult especially if you're not good at a certain thing about a certain subject. It's always better to go step by step, so you have a general sense what you're going to discuss the next class.

[00:04:48] Female: Absolutely agree.

[00:04:49] Male: I fully agree, especially with the research paper how you were giving it to us in pieces and do it.

[00:04:54] Female: Yeah, absolutely true.

[00:04:55] Male: Not necessarily even in order, but like just giving a sort of kind of like easing us into it. Because just thrown us a paper like that was completely in that sense.

[00:05:05] Female: Sure.

[00:05:05] Male: Yeah.

[00:05:06] Female: Like I wouldn't be able to do it.

[00:05:08] Female: Just people like work on it an entire semester was cool too.

[00:05:12] Male: I even like the discussion and then actually utilizing both, while we had these group projects. While we also were independently, whether there was assignments. But I feel having both things kind of help especially when you're making to transition, whatever crew you want to go into honestly.

So, it kind of makes us, in a hypothetical sense makes us mentally prepared. So, I think and this class kind of helped us, made the transition getting ready for those situations we saw.

[00:05:45] MOD: Now do you feel all your classmates feel the same way, or were there people in your classes that would disagree with this thing?

[00:05:52] Male: I want to be 100% honest, I don't pay much attention to everybody else. But I know my table, that the 4 people that sit at my table, I know it definitely helps them.

[00:06:00] Female: It helped my table, the people I had on my table that I always did a presentation with, or my partners. They were paying, they were fascinated just as much as I was, and we were good partners for the presentations.

[00:06:13] Female: My table was pretty small, it was just 3 people. I guess it helped.

[00:06:18] Male: For me it was different for every project, or for every homework assignment. Because some people like to learn by themselves, or some people liked it more with people, some people you know. Every single project, or homework assignment was different. So, they were different, like me like if it was reading I'd like help with it, like that sort of thing. If it's outside not a big group but a couple of people would be fine, group projects, love that.

[00:06:52] Male: Groups projects definitely are fantastic.

[00:06:53] Female: They were fun, I love the group projects. There was like good topics to choose from.

[00:06:58] Male: But I guess I would say, with the group project it was never the same, because everything, well, at least for the classes I took in science courses here. They were always different, and you always had a different person. But I would say, I would be with you. I guess for me I never looked, I just looked at me whether you know, how well I'm doing.

But I would say there were certain individuals that maybe you know, a lot of the issues sort of the advocating and probably has to be maybe relating to being, having some sort of anxiety. Not feeling the sense of feeling intimidated, so, but I hear because we are like a small college, small class size. It releases that stress of not feeling intimidated or anything. So, I don't know if you guys want to jump in.

[00:07:47] Male: Yeah, a little bit of that, let me see if I can formulate this into the sense. But I did find that when we did go out and actually have some sort of interaction, we were learning outside and doing things instead of sitting in a group and talking. That more people understood it, than if we were to sit here and talk about it.

[00:08:14] Male: I think one of the best things was the whole, the project that we were doing the whole semester. We didn't know what other people were doing, we knew what they were like.

[00:08:23] Male: They were researching.

[00:08:24] Male: Researching, but we didn't know everything about it. I mean at the end when we actually presented, we got to look around and see what other people were researching the whole semester. They got to come to you, and you explain to them what you were researching. Letting everybody learn different things about different research projects.

[00:08:50] Female: Yeah, I did like going outside. That was really cool, because then we like kind of had a good balance of being outside and working and then being inside and working. So, it wasn't just one, it was like both. We were out in nature, we were actually interacting with the people out there and animals out there.

[00:09:08] Male: Especially for science courses, I feel personally that that, that's very important. Just to have some sort of outdoor aspect to it.

[00:09:15] Female: Right.

[00:09:16] Male: Which is it helps you relate to kind of what you're talking about in a classroom. Because you can talk all day about apple snails, but if you've never seen an apple snail then…

[00:09:26] Female: You're never going to really truly know, or you're not going to get it as a natural feel, and I'm sincerely.

[00:09:31] MOD: All right, good. Can you guys tell me about a time when the faculty member did something that did not help you to learn, or that did not make you want to learn?

[00:09:43] Male: Here, no. I really, I haven't.

[00:09:45] Female: No, I haven't yet.

[00:09:45] Male: I haven't run into that yet.

[00:09:47] Female: I have not run into that yet.

[00:09:52] Male: But in, once I graduated high school I went into community college, and there it was all this straight lecture. The teacher didn't really care too much, and that kind of turned me off. That's actually the ultimately reason why I ended not going back to college when I came here.

[00:10:14] Male: I guess, I can say this experience fine now, but I once, for me it was different because I went to transition just going to college. Then what I did is I took out lectors outside, I went to take some lectors outside of our college. Then went to some local community college student's court.

I can say it's definitely like the, like the class sessions are different. You don't, okay, for just even like, when the class sessions are longer. They're like an hour or two, I don't know…

[00:10:45] Male: It's ridiculous.

[00:10:46] Male: It is, I don't know. For me at least I have a hard time staying at one area for so long, because especially if I'm taking notes. Then if it's like such a long time, I may lose my thoughts on it.

[00:11:04] Male: Yeah, you get lost in track and then you're like, "Oh! Man, what's going on? I can't keep up."

[00:11:11] Male: The thing is, everything is straight forward, so, there is no, there is really not a discussion really. Because it's more of I, you know, like it's more of like I discuss about the topic and then there can be very big questions. But there is never intensively like let's speak, let's talk about this issue, let's elaborate more into it.

So, I think the problem is a lot of times with the, when there is a big class size and when I say when you don't have accommodation it does create an issue with someone not performing. So, I don't know about that.

[00:11:51] Male: I totally agree with that because for me it was, it's always hard for me. But to say, like I have dyslexia. So, no matter what when I read up, it takes me 4 hours to read. So, when I get a whole bunch of reading, I'm like, "I can't do it." But that's something that I have to overcome and it's not the faculty's fault.

Like that's how they want to learn to make sure, that's the way they want to teach and they can teach their way. But yes, you can always say like, "Oh! Hey, here is an accommodation for your reading dyslexia. Go get an audio book, or have somebody read it for you." It's never the faculty's fault.

[00:12:42] Male: But here is the problem, a lot of times. Sorry, I'm just going to finish here.

[00:12:44] MOD: Go ahead.

[00:12:45] Male: I think a lot of times probably, if you go to any other university even a local. One is once if you have a diagnostic test, you prove it. It takes at least, for me when I went to the other college it took at least a week or 2, just to prove all the tram. To have the process applications you just get those accommodation.

I mean because we are in the school and we were able to do certain things during, you know for special occasions. We don't have to go through that proposes which benefits us.

[00:13:17] Male: No, we need go through that. We all went through that process before.

[00:13:20] Male: But I mean it's not to the point where it takes a week or two, just to get all that evaluative.

[00:13:25] Male: No.

[00:13:26] Male: I mean, I don't know. I'm talking about literally when you go to the class, you literally have to ask the accommodation. From then it has to be discussed with the professor, and that may take weeks or two. Depending on what they feel is approved or not, it will determine how you, honestly how you do well in class.

So, I don't know, I mean, yeah. I think, I will say that with that what you said though, I think a lot of times also students have a problem sort of advocated.

[00:14:01] Male: Yeah, I actually notice that here a lot.

[00:14:04] Male: That is big.

[00:14:05] Male: I notice that big time here.

[00:14:07] Male: I think the question now becomes how do we, how do students, I guess. How do they I guess approach things in such a way that they're comfortable?

[00:14:21] Male: That then ultimately ends up becoming personal thing.

[00:14:24] MOD: What about the faculty, is there something that faculty can do to help you sort of advocate?

[00:14:28] Male: They could if they notice someone having issues instead of saying, "Hey, go here and here and here." I'll be like, "Hey, let me see, come into my office. I've noticed you've been having issues is there anything I can help with?" Maybe not like hold their hand the whole way, but you know be a little bit nicer and be a little bit, you know, more understanding of it.

[00:14:53] Male: I think by giving them assurance by wellbeing, by being firm though. Creating such a way that they're independent creates such a way that they're learning, without having the mentality that everything is going to be handed to them.

[00:15:10] Male: It's the same way as you teach someone to ride a bicycle, you hold their back for a little bit while they pedal and then you let go. So, I guess put that in the terms as the way it works here it is, and maybe be like, "Hey, let's go with your learning specialist. Your learning specialist can then work with you to get to these places." I just feel once you get that communication going, I feel that and things will pick up.

[00:15:34] Male: I think the, another thing is also encouragement. Because even though that may not seem like it, that has such an act. A lot of times you may not notice, but a lot of times it can play a factor on someone, how they're going to perform.

[00:15:54]

Male: Actually I have the right instance for that. I used to think I was a terrible writer, like God awful. Recently in Mr. Robert's class, I'm actually performing really well. Each time he ends up writing my paper, he like comments wonderful things and it just gets to my writing even better and better. Because I can believe in myself now.

[00:16:15] Female: Yeah, I used to think my reading was horrible.

[00:16:22] Male: But then again I would say no, it also depends on the student how they approach things. Because let's say, there are some students who know they're motivated. They have the attitude, they have the desire and they are just some who unfortunately may not see that way. They have a different perspective, and all those sorts of things. So, I mean we all probably met some people, so yeah.

[00:16:49] MOD: Kind of building off of that last question, do you feel the science faculty know you as an individual? Do they teach to you recognizing your individual strengths and weaknesses?

[00:16:59] Male: I think there is no way...

[00:17:00] Male: Well, absolutely.

[00:17:01] Male: I think it is more yeah, accurately process. I think it only takes a few classes for a teacher to really figure out a student, especially in these small class. Where it's, if you get individualize work, you definitely do it and you get to know the teachers.

[00:17:19] MOD: Can you provide me an example of this?

[00:17:22] Male: Yeah, when I came to you the other day, and I was talking to you about what kind of path I wanted to go through down. You were talking and we had a conversation about the herpetology, and how that's what I wanted to get out. Right after that I applied for my major.

[00:17:40] Male: I can give you an example, like when I took animal behavior. When we were learning about, because there were so many things about the animal behavior and change of subjects. But I remember there were certain discussions I didn't understand well. Then you were making sure like, "Hey, does everyone understand? Is there any question? If you need to ask questions after class I can do so."

I remember you kind of sat down with me, kind of making sure that step by step I understand the material. Then I was able to conduct the assignment, so, that kind of helped I guess for me. Kind of having this sort of, kind of this approach like it's okay to asks questions, and have a way to get some sort of assistance or.

[00:18:31] Female: Yeah, I like that too, like that's what science it really helped me. When I can't after, or when I started late and I still came and I actually found out, so, it did help. Because most teachers they're like, "Oh! How did you not understand this?" But you didn't do that, you just went step by step and I just understood it.

[00:18:53] Male: Coming to you about the paper, the research paper.

[00:18:57] Male: Yeah, yes that's a good...

[00:18:57] Male: There were some parts that I didn't understand, and I came to you and you explained on. Even then I feel like can you say it in a different way. You rephrase it and then it would just click, and I'd be able to finish the research paper. Or the part of the research paper we were working on that week or that month.

[00:18:53] Male: I would say first, unlike other colleges. Like you said, since we are a small school. Most professors know their students and the way they learned, and how they articulate things. I would even say like, I guess usually because we are, I wouldn't even say like a friend. We're more of a, in a way it's like an orthodox way. Because it's more of, almost like a family setting wise.

How, I guess how students with other students and professors interact such a different way. It's not this kind of individualistic culture, it's more of a collectivism culture if you're getting what I'm saying.

[00:20:02] Male: Yeah, we're not too big to just like, everybody knows everybody in a small school.

[00:20:09] Male: Yeah, you can't speak to someone under the table here.

[00:20:10] Male: Exactly.

[00:20:11] Male: Basically no one is a number and so, in that regard no one has as sort of mentality. When you go hearing this, everyone will at least know somebody. Whether its classes or work and so forth, these are professors who know their students. They would know probably, when you have a small class that means most likely you can engage with the student as well as the student can engage with the faculty.

So, it's like this option where you're limited that you're basically, it's like you kind of have to kind of come together. So, there is no in between well, we can't do this and that. So, and honestly it kind of builds a bridge to kind of understand what are the strengths and weaknesses of students, and so.

[00:20:57] Male: I totally agree.

[00:21:00] MOD: Now can you describe how the science faculty teach different than other faculty members that are here. Is there a different, do they use different instructional approaches or are they all pretty similar?

[00:21:12] Male: I don't think I can answer that properly, it's a little bit different with the semester.

[00:21:15] Male: Could you repeat that question?

[00:21:16] MOD: Yeah, sorry.

[00:21:16] Female: Yeah, I forgot that, can you repeat it?

[00:21:18] Male: So, does your, do you feel that the science faculty, so, those that teach the science classes. Do they teach differently, do they use different ways of teaching that maybe different than other ones?

[00:21:29] Female: Yeah.

[00:21:29] Male: Well, I could say you're the only teacher that is actually taken us outside and had interaction. Like naturally just because it's outside, just you're the only teacher I've had that has actually done hands-on work, and I love that.

[00:21:42] Male: But I think, I don't know because maybe I'm a little, I think I have a different opinion. I think though, I think in the classes here I guess. I always used to think that there is, we always use this different types of learning skills. I know a lot of times we either do some listing on the board. That's well, some students are visualizing.

We have to kind of say that's the explained group projects going outside, and then we have auditoriums as well. We have videos where sometimes like certain students learn that way as a way to hear, understand, identify key important words that may help them in terms of understanding the subject.

So, I don't know, I think our professor try to utilize different skills. I mean again everyone at the same time, we had to consider that all students work in a different pace. So, it's never going to be everyone in the same level. So, I don't know, it really depends on how the class setting is as well as the students' performance.

[00:22:53] MOD: Cool, so, up on the board there is a list of different teaching methods. Which includes the use of a modified textbook, interactive activities are guided by an instructor. Interactive or hands-on activities are not guided by an instructor.

Group discussions, working in small groups like the group teach assignment, or independent work such as working on a worksheet or out of a book during class. The one other one that can be included up there is the not using test or exams. Which one of those methods had been…?

[00:23:26] Male: Do you mean examples from like textbooks?

[00:23:28] MOD: So, like how your book is a packet with all the questions and interactive components side of it, versus a traditional text book.

[00:23:37] Male: Okay.

[00:23:38] MOD: So, which one of those do you feel like are probably the most beneficial to you as a learner?

[00:23:44] Male: Interactive activities guided by an instructor.

[00:23:46] MOD: Okay.

[00:23:49] Male: I think with having an instructor guide you, is a better way of understanding.

[00:23:54] MOD: So, that's the general consensus as the activities.

[00:23:57] Male: Because it's also hands-on but it's also, you have someone talking to you.

[00:24:02] Female: You can ask questions.

[00:24:03] Male: Yeah, you can ask questions.

[00:24:05] Female: If you're confused, ask the instructor.

[00:24:08] MOD: Okay.

[00:24:09] Male: Definitely the interactive activities guided by the instructor, but I would also say the modified textbook.

[00:24:15] Male: I can say that also, I just I was actually…

[00:24:17] Male: Because that's actually really helpful.

[00:24:19] Male: Then I do occasionally like doing work, just having a piece of paper that I can write on, and actually fill out things. That's occasionally helpful as well.

[00:24:29] MOD: Do you guys do…?

[00:24:30] Male: Because writing stuff down…

[00:24:31] Male: You almost like fill in the blank.

[00:24:31] Male: ...helps my memory.

[00:24:33] Male: I always thought you can always use all of this, is just the way how you, how well do you.

[00:24:37] Male: Yeah, agreed.

[00:24:39] Male: I think it's more of how to approach it, how to plan this out. Honestly I would say the benefit would be really interactive activity guides by the instructor. Because a lot of times if you're doing independence here, a lot of times you can misinterpret in the instructions. When really that's not what your professor is really asking.

So, a lot of times when you go, when someone is doing assignments they always wondering, "Well, what just happened?" "I thought that's what you asked." Then a lot of times it's the way they write, or the way they thought of how the class was conducting in such a way like we have to learn.

[00:25:17] MOD: Do you have any of this listed up there, one that you feel is not beneficial? Or one that you, it made no impact when you're learning?

[00:25:27] Male: None of them are not beneficial.

[00:25:28] Male: Honestly or well interactive activities are none of the redefying instructions, but can surely just be a dicking around activity. But I mean obviously some people I know here will just screw it up, but like I feel it could be potentially not as beneficial as all of the rest.

[00:25:48] MOD: Okay.

[00:25:48] Male: Let's say we were doing a game outside, and like the instructor gave you instructions on a piece of paper and this is the instruction.

[00:25:57] Male: That's instructed by an instructor actually.

[00:25:58] Male: Well, that would be instructed by, well, okay.

[00:26:01] MOD: Okay.

[00:26:02] Female: I see where you're trying to go.

[00:26:04] Male: I was trying to go, I was starting to go where I want to go.

[00:26:06] Male: What I was getting at is just teacher goes as, “Go read this.” Its activity but that’s, no, this is, then it’s like…

[00:26:15] Male: That’s enforced by an instructor.

[00:26:17] Male: True, I guess. What would you, what would an example of an interactive activity not guided by an instructor?

[00:26:24] MOD: So, there would be kind of like you get a packet that you, it’s all self-discovery based. So, you would have to follow the instructions, you would have to come up with a solution too on your own. It would be all determined by you, and you would have to figure that out on your own.

[00:26:42] Male: So, kind of like at the beginning.

[00:26:43] Male: I’d say if it wasn’t, I think if it wasn’t graded then it could be a potential. But it could be, it can fly away.

[00:26:54] Male: It’s sort of like the beginning worksheet.

[00:26:55] Male: Yeah.

[00:26:56] Male: Like when we went around the room and seeing different things, and writing it down in the packet for the questions. Like what verdicts this type of saying, “Okay, to get through.” But you go into that in the poster, and you look at it.

[00:27:10] Male: Yeah.

[00:27:12] MOD: Now, if money were no object at all and you could design or you can learn science anyway you want to, how would you learn science? What would that…?

[00:27:22] Male: Completely hands-on.

[00:27:23] MOD: Completely hands-on.

[00:27:24] Male: Completely hands-on.

[00:27:25] MOD: What could the school or the faculty be doing? So, what kind of things, if money was no object at all?

[00:27:31] Male: I think trips to like maybe zoos, aquariums, large national parks, somewhere where …

[00:27:39] Male: Sanctuaries.

[00:27:40] Male: A nature sanctuaries, somewhere where we can actually be in nature learning about nature.

[00:27:48] Male: Unless we’re one of those people that is in text learning.

[00:27:52] Male: Right.

[00:27:54] Female: With your hands-on.

[00:27:55] Male: Hands-on, your visuals.

[00:27:56] Female: Then you'll like field trips then often more.

[00:27:58] Male: Maybe more videos in class that can balance out.

[00:28:04] Female: For maybe text with people.

[00:28:07] MOD: What about the physical lab space itself, how would that physical lab space be designed?

[00:28:13] Male: I mean I think this is pretty nice, I do think it could get, it could get better.

[00:28:19] MOD: How, like what would you improve if the money was no object what would you make a different?

[00:28:21] Male: We can have those lab tables and then actually do experiments in the lab.

[00:28:27] Male: Yes.

[00:28:30] Male: Even like if we say, well a bit of scope things in terms of…

[00:28:35] MOD: Microscopes?

[00:28:36] Male: Microscopes, yeah. Get some microscopes, maybe look at some…

[00:28:40] Male: We also have to consider that this isn't, that will answer zoology doesn't deal with.

[00:28:46] Male: But if you like, just trying to explain like say you're doing an apple snail. You want to try and explain a little more like what the shell is made of, how is it made?

[00:29:01] Male: Okay, yeah, I can just do that but I think more tools.

[00:29:04] Male: What does it look like?

[00:29:05] Male: More tools would definitely be helpful and I think a better lab environment.

[00:29:15] Male: Even, maybe even possible, like as for example…

[00:29:17] Female: More like a science class.

[00:29:19] Male: We have animals but for some animals that say around here are endangered or, like even put some in here and then we release some into the wild sometimes. I think you have barbed wires.

[00:29:38] Male: Maybe we started catch or release program.

[00:29:40] Male: Catch or release program.

[00:29:41] Male: Or we name it, I don't know. One of the projects could be, you go work with an adoption agency or.

[00:29:50] Male: Absolutely.

[00:29:53] Male: You could work with local organizations and go help them and kind of just make it a school project. Not a project but just a little of a daily assignment. We go out there and figure out the percentage of trash that's been thrown out there, or something like that.

[00:30:14] MOD: Okay, so, I've asked you a lot of questions about science and science instruction. Is there anything you want to tell me about that, about how you would prefer to learn science? Or how you would prefer to be taught science that we've haven't discussed yet?

[00:30:28] Male: That we've not discussed yet, no, not really. I think we've touched on a lot this stuff.

[00:30:34] Male: Yeah, like hands-on is a base…

[00:30:35] Male: Like hands-on for me is very good.

[00:30:39] Female: Hands-on, because I just would take science and read it, and there were times where I didn't like it because it mostly textbooks. But I think I enjoyed it more like I could have called my dad asking him about science stuff.

[00:30:52] Male: When, like hands-on when we went to the snake sanctuary.

[00:30:57] Male: You go snake sanctuary?

[00:30:58] Male: Oh! Yeah, it was fun. Rattlesnakes, indigos.

[00:31:04] Male: Those are very gorgeous.

[00:31:06] Male: Oh! Honestly, like we got to see them up close and they're not and he, well, he didn't take up the dangerous parts. But like we got to hold, we got to even hold and feel how they move like that's all hands-on works.

[00:31:20] Male: The different textures of the snake's scales.

[00:31:22] Male: When it first came up I was like, "Oh! I'm kind of scared of this because I've never actually," I've held one big snake before and kind of scared, I was a little though. But now I'm like all into snakes, I want to see more snakes, I want to own a snake. I talked to everybody about what I did there, and I wasn't even supposed to be there. It was for an extra credit assignment for, what class what it? I don't remember what…

[00:31:55] Male: I mean like cool field trips that, like I think we should do more field trips.

[00:31:59] Male: Also volunteer work.

[00:32:00] Male: Yes, volunteer work is good.

[00:32:01] Male: Volunteer work is what I did.

[00:32:02] Male: Things like extra credit volunteer work, it doesn't necessarily have to be part of class. Like we can all sign up on certain and go after class to a local sanctuary, or something and clean up. Or plant trees or do some fun cool stuff that helps the environment, but we could learn about it while we're doing it.

[00:32:24] Male: Yes.

[00:32:24] Female: Yeah.

[00:32:26] Male: Absolutely.

[00:32:28] MOD: Is there anything you want to add? What are your thoughts on not using, like not having tests in the class, tests or quizzes or not doing dissection, what are your thoughts in that?

[00:32:39] Male: I actually was a little sad when we heard we weren't in dissections, because that was pretty, I loved doing that in high school. But it's something I can do without.

[00:32:47] MOD: Okay, what is it that made you like it, the hands-on part of it?

[00:32:50] Male: The hands-on part of it, just like being able to go in and see everything. That fit of it is just, it was fun.

[00:32:59] Male: For some animals that would be okay, but like in my high school they had to bisect a cat. To me I can't, one I can't stand the smell.

[00:33:14] Male: The smell behind.

[00:33:14] Male: Yes, overall. But say frogs, frogs would be okay if they're already dead.

[00:33:24] MOD: What about not having test or quizzes, what are your thoughts in that?

[00:33:26] Male: Test or quizzes, I've never really been like just. I'm okay with the testral quizzes, like if we do like major middle ones like little 10 question quizzes that might go over what we talked about this week. That's cool, that's fine, that just reminds me about what we did.

[00:33:46] Female: I enjoy like if you do different notes.

[00:33:49] Male: Yeah, notes but if you feel…

[00:33:51] MOD: Do you feel like, because we don't do a trial-midterm, or trial-final in any other science courses. Do you feel that helps reduce anxiety or made you learn better?

[00:33:59] Male: Yes.

[00:34:00] Female: Yeah.

[00:34:00] Male: 100%.

[00:34:02] Male: But also as an instructor or teacher, or coach anything, you got to make sure their students are actually learning.

[00:34:11] Male: Right, so, to be knowledge, it's more like a knowledge check.

[00:34:12] Male: So, one like if you have some random, if you have some random question in class and nobody can answer it. Then they'll be like, "Okay."

[00:34:22] Male: We need to go back and look at this again.

[00:34:23] Male: "We need to look back at this," maybe even take the 10 question quiz.

[00:34:28] Male: Question knowledge test.

[00:34:29] Male: Make sure you guys are still learning at the same time as having fun.

[00:34:33] Male: I mean you don't even have to call them quizzes or tests, you call them knowledge check.

[00:34:38] Male: Knowledge, I like that.

[00:34:39] Male: Then and all these just trying to figure out what you like for the week.

[00:34:43] Female: Or assessment.

[00:34:44] Male: No, because assessment sounds bad.

[00:34:47] Female: Oh! Great.

[00:34:47] Male: I really look at those ones.

[00:34:48] Male: Knowledge check.

[00:34:48] Male: Knowledge check, how didn't I write that down.

[00:34:53] MOD: All Right, anything else you want to add? All right.

APPENDIX G: STUDENT FOCUS GROUP 2 TRANSCRIPT

[00:00:00] MOD: Thank you again for providing your verbal consent and we are ready to go. So, what I'm going to do is ask you a series of questions and again just respond you know and be honest provide your background your experiences that you've had or specific examples that you can remember from your sciences classes, okay?

So, the first one is tell me a time where you really enjoyed learning like the content in a science class. Keep it all centered on college, Okay? So, these are all centered around your college experiences. So, tell me a time where you really enjoyed learning the content of your science class?

[00:00:34] Female: I think it was when it was hands-on I learned the most like when we went out to the Nation Guard or we discussed hands-on things in class like the group conversation not just lecturing. Because in lectures I space out and I can't grasp, I have trouble grasping what you're saying. When you've handed the information and we need to discuss it and then or we go over it in some sort of hands-on activity is what I do.

[00:00:58] Female: Hands-on activity is a lot more easier for me, when we do lectures. I mean yeah I take notes and make sure I'm more focused but I can't like grasp it very greatly.

[00:01:14] Female: I struggle with writing and like people talk and I can't do both at the same time. So, and I struggle with auditory processing. So, it makes it even harder for me. So when it's hands-on I think that I remember the information a lot more so.

[00:01:30] Female: Yeah it's kind of like…

[00:01:33 Female: Yeah I like the videos are really helpful.

[00:01:35] Female: The videos are very helpful.

[00:01:35] Female: Visualization.

[00:01:41] Female: Something to picture like what's going on.

[00:01:42] Female: Yeah.

[00:01:41] MOD: Do you have any kind of recollection of bit or a memory of being in your science classes and people or your classmates saying similar things that they would prefer to learn this way or that they didn't like a certain activity or they liked a certain activity that was done in the class?

[00:02:00] Female: Well in my class we didn't have a problem. I mean everybody you know, because we had all different type of styles of learning and everything that, how you taught us, taught us like all the same way.

[00:02:14] Female: Yeah everyone is different. Everyone has different processing disorder and different things that the reason why they are here where. So, yeah it's what I'm going to say.

[00:02:30] Female: I struggle with group activities but I know that's needed for in science because you work a lot of times in a group. When you have a member that they don't do as much or just sit there it kind of makes the balance in the group hard to finish a project. I don't always understand what I'm reading in a project, but I like when we did our papers so it was broken in parts because it wasn't as overwhelming and I understood it more, we discussed it more.

[00:03:05] Female: Yeah, group projects like if, when the teacher says in science class that now let's go in a group of each table I can't that's so hard for me. Working in groups don't go well with me.

[00:03:22] Female: Sometimes it's good, it depends on the, I think depends on the assignment. I like it when we're outside, I think one of the things I remember most from class is when we did an outside thing we were showed why we have with resources in deer and shelter like why we, some of the things we did to our environment and the effects of it and stuff. I learned a lot of information to that and I use it, like just the other day in a conversation and they were talking about hunting and what not. So, it was really helpful.

[00:03:54] Female: It helps more when we do everything in class concerning because like kind of share the papers everything was broken down and started like getting time to do it in class and stuff. So, that helps do work together in class. You get to know everybody and there I get to feel comfortable with everybody. If we do have to work on something more outside the class then everybody feels comfortable because everybody knows each other.

[00:04:20] Female: Yeah if it was from a book that's where I struggle deeply because I don't understand what I'm reading most times and it takes me such a long time to translate everything. I do little margin notes that I most of the times don't understand what they are asking me especially if it's not a direct question. It's like, wants you to infer things, because I struggle with inferring and what it means, I can't pick between the lines, in a conversation, I still have some of those conversational skills I don't quite have though it's the same with writing.

[00:04:54] Female: Yeah when a teacher especially in science class, when the teacher tells everyone to read something for the next class it's hard for me to inference it also. Because sometimes I don't really understand what it means and sometimes I don't understand what it's trying to ask me.

[00:05:19] Female: I like though when we did watch videos like you brought up that we discuss what happen in videos, we got to ask questions about videos because I feel like we didn't just watch a video and you weren't waiting to fall asleep you actually learned and you actually process information more because we got to discuss what this actually meant, how it affects our environment.

[00:05:37] Female: Oh! You write the when you watch the video you got to watch the 10 stuff that you learned from the videos or what you've heard and took details.

[00:05:45] Female: I think the video finally like not a human sought of a while but I get that all the time so.

[00:05:52] MOD: Can you provide me a time that you remember when a science faculty member did something that did not help you learn or want to learn?

[00:06:01] Female: Yes, when once especially well in college yes. That teacher didn't explain this assignment very well and I had no idea what I was doing for this assignment. So, I had to like go back to his office after class and say that I don't understand this assignment could you please explain it to me? Basically.

[00:06:38] Female: I get frustrated with that when it's not, it goes like fast and I have to make notes to remember things that I don't usually write when we discuss over it. If we discuss over it if it doesn't happen and they tell me I need to like to read, it's in the, they wrote down in the paper, they handed out to you but I'm not understanding what's in the paper handed out to me. So, I needed it reworded.

I don't want things done for me, I want to know it myself but sometimes I just don't understand what I'm reading and if it's explained to me and I can jot it down in my own words underneath then I'm better off because then I know what to do.

[00:07:16] MOD: Do you two have anything you want to add?

[00:07:16] Female: No.

[00:07:19] MOD: Okay.

[00:07:19] Female: Not referring to the college science because I came here straight after high school and stuff.

[00:07:25] Female: Yeah I did the same.

[00:07:27] MOD: Did you take any science classes at your college before this one?

[00:07:32] Female: I didn't take science I took a history class.

[00:07:38] MOD: Okay. Do you feel that the science…

[00:07:37] Female: I took psychology but I don't think that counts.

[00:07:44] MOD: Do you feel that the science faculty know you as an individual and do they teach recognizing your individual strengths and weakness as a learner?

[00:07:53] Female: Yes for me definitely. All my teachers do an excellent job with that.

[00:08:02] Female: They don't know my personality and stuff. Just you could tell when I was slipping just call me back.

[00:08:12] Female: I don't if people know my personality unless they tell me. Like I know the art teachers know my personality because they deal with me constantly and I've only had one class, science class here so far. But I'm pretty sure they'll know my personality once I take more classes. But I feel, I think I was intimidated, a lot of the times, I'm easily intimidated by teachers until I get to know them more.

So, I think this is the same way probably for them. I'm getting to know me if they talked more. Yeah because when I'm intimidated I'm sometimes scared to ask questions.

[00:08:47] Female: Yeah I agree with you on that one.

[00:08:50] MOD: Now up on the board there is a couple of different teachings methods that are commonly used. So, there is the modified textbook which is kind of like, there is a traditional text book and then there is the new style textbook which is a packet that's given to you that has questions built into it and it's structured differently it's more paraphrased passages compared to a traditional textbook the texts are a little bit bigger.

The interactive activities or hands-on activities that are guided by the instructor as well as hands-on or interactive activities that are not guided by the instructor or the instructor kind of turns you lose and let you do them on your own. The group discussions working in small groups collaboratively like the group teacher assignment or an independent work where you work on your worksheet or out of the book by yourself in class.

So, looking at these ones up here are there any teaching style or teaching methods that have been the most helpful to you in your science class?

[00:09:50] Female: For me that has been so helpful for me is modified textbook introductive activities guided by the instructor, groups discussions, no hold on one second.

[00:10:06] MOD: So, let's talk about the modified textbook really quick, why is the modified textbook very helpful to you?

[00:10:12] Female: What did you say the modified text book was?

[00:10:13] MOD: So, like how you have the packet…

[00:10:18] Female: Oh! And the questions.

[00:10:18] MOD: …yeah instead of a traditional textbook why do you feel, find that very helpful?

[00:10:23] Female: Because it lets you think about those questions. You have those questions in front of you. You can go back in that textbook, well go back into the guided areas of reading like in our workbook. You can look back and forth to find the answer.

[00:10:48] MOD: Okay.

[00:10:52] Female: The independent worksheet or out of the book, works well good for me.

[00:11:00] MOD: Why is that?

[00:11:00] Female: Because I like working by myself, I don't like working in groups at all.

[00:11:05] Female: I didn't have the modified textbook I had the old text book I didn't understand anything that I read in those books.

[00:11:16] MOD: What made the book difficult for you to understand?

[00:11:15] Female: It was really like how it was written was I don't know how to explain what makes it hard for me to read. I think it was the wording and it was very, I don't want to say upper class but higher up reading, than where I'm at and I'm kind of behind where I should be in the reading skill but it's also because my comprehension difficulties.

So, I wasn't able to understand what they were talking about and it was harder than the articles for the paper to translate. So, I had a good, have it explained to me after reading it with somebody.

[00:11:56] Female: I have a question, I didn't have the modifier, we didn't have to modified we had the old one.

[00:12:00] MOD: No your group had the traditional textbook.

[00:12:02] Female: Yeah.

[00:12:05] MOD: Yeah would you have found a modified text to be more beneficial?

[00:12:06] Female: Yeah because, yeah I would because, in other class and I mean it has questions and then after you read and it sums it up and it asks you questions and stuff like that. I did like the group discussions, I mean all of them are very helpful in a way I will pick the one that I will say that I'm going to turn the negative into a positive which is the interactive activities not guided by the instructor.

[00:12:43] MOD: Okay.

[00:12:46] Female: Because it would show us more responsibility and it will help us push ourselves just not to use our disability as a crutch and try to say you know I'm not going to let this hold me back today and try to push ourselves. That's what I would say but the one that was most helpful was, the group discussions in that interacted these group guided by an instructor because it helps us see that the instructor is engaged with us so, it's not so bad after all.

But sometimes you, our instructor gave us stuff and it doesn't matter if they, it's just their job but they don't seem as engaged because you love animals and like made this place. You know very more out there and stuff like that so yeah.

[00:13:47] Female: I like the both interactive things, one for the same reason as her, I liked the instructor when it's interacted by the instructor because it shows that they want to be engaged with us. It shows that they care about not just about what they are teaching but about us as students and that they enjoy. So, they really want us to understand and interact with us on a personal level which is in a way an interesting aspect and it's easier to learn that way because it's not just like you're being lectured to but more like you're being talked to.

When the interactive activity is not, I find like you're having to work, you're not being guided by the instructor shows more response, like you said I find those because they are more interactive, kind of more hands-on and I'm very hands-on and kinesthetic. So, the more I do with my hands and stuff, the more I write whatever I take in more. I like the group discussions because it's not like a lecture.

It's more like we are discussing in a group like we're having a conversation. So, we're receiving the information not just like we have to listen to recording which it just goes over our heads.

[00:15:02] Female: Yeah both of those instructive activities I just like to add instructive activities and guided by an instructor helps me also a lot but I can't explain why.

[00:15:13] Female: I think I would have liked modified text book because maybe if I understood what I was reading I would have been more, I wouldn't have been like oh! I have to read this. I would have been more interested into it because I like science, when I don't understand things like I can't read and stuff when I struggle to read something I tend to not want to read it.

[00:15:35-4] Ptcpt: But it helps that, because you did read we went over it in class. So, you had a questions so we had the little group discussions or the small group activities with the preset study groups.

[00:15:47] Female: I did like study groups though for science. It helped me understand a lot I think I like studying groups and the same thing I find lately because I'm taking history now that it has a lot of things that are similar to science and the fact of study group and how we some of the ways of teaching sometimes is a little bit similar because its kind of more interactive in a way because we have a group discussion and I like the group discussion not just the lecture.

[00:16:15] MOD: Is there anything out there that you find kind of like how she mentioned before that one of them was tougher as a learner but you found values or one of them that you would say does not work for you or that is tough for you to learn?

[00:16:28] Female: Group discussions and working in smaller groups very hard for me, extremely hard actually for me to learn something. I learn so much better with an instructor than in groups.

[00:16:44-6] Female: Well I think group discussions a lot of times we had the teacher with us, he was discussing with us, so it wasn't just like a group discussion for the students. It was also a group discussion later on with the teacher.

[00:16:56] Female: Yeah, that true.

[00:16:54] Female: The working in small groups can be very challenging between like who is in your group and you can't just say like oh! You can't be in my group because that's rude. We try to incorporate everybody but sometimes it's really hard when the same people choose you and it's the same people that's not doing anything. You don't know how to do everything yourself but they are putting all that pressure on you.

[00:17:19] Female: Yeah exactly.

[00:17:20] Female: I get really stressed out on myself. So, when I do independent work I like doing stuff on my own but it helps me but a lot of times if I don't know what I'm doing or if it's a lot of work or really stressing me out then then it's harder and then I want to work with somebody. I think it depends on the assignment too.

[00:17:35] Female: Yeah that's true.

[00:17:37] MOD: Okay. Can you describe how the science faculty teach differently than some of the other faculty that you've seen? Are there similarities are there differences?

[00:17:48] Female: I think that science faculty is more hands-on than other faculty and that's what I think.

[00:17:58] MOD: Okay.

[00:18:00] Female: I think okay, can I say Doctor Ross is like a science teacher, she is kind of a science teacher.

[00:18:09] MOD: Anthropology, sometimes yeah, social science.

[00:18:12] Female: Because she taught and I love the way she taught because it was very hands-on in class. Even if inside of class it was hands-on she brought props and she let you write on the board and then everybody is quite till we wrote down our notes and everything was just calmer, it wasn't so stressful. I like the hands-on, I liked that we got a chance to write our information down and then we just group, talk to her as a group she told us what it was about and then we got to ask questions and that was great.

Science teachers also we got to go outside and I think it's very important for students to see outside because we are always stuck in a classroom and stuck in sitting and then you get bored and tired. Whereas you're outside you're more open and I think you're more awake and you're more, I think we receive information differently than when you're stocked up in a classroom.

[00:19:00] Female: Oh! yeah I agree.

[00:19:01] Female: It also helps that science was not an hour and half or an hour the long days and it was the labs instead because the labs. I am not going to say they weren't fair or just been draining but you have more time to see the animals in their habitat and stuff like that to go out.

The 50 minutes for the science class wasn't boring as well. Like we did stay interactive during our lecture. You didn't just stand there and just go through a lot of slides so it is kind of different because you don't go through slides a lot of time. Your PowerPoint are not just draining with a lot of points.

[00:19:45] Female: You got experience things, you got to do things and it was not, I forgot what I was going to say, I had a way of wording it, you're good I like what you said, I agree. I like because it didn't feel like we're stuck here waiting for class to end and it made it more exiting when you're hands-on. I feel like it also takes more responsibility and it helps your body.

I feel like one big thing that helps learning is when just like how writing this is about I think it was going towards technology which is good but in effect bad, because writing is one of the biggest ways to send information to your brain even if you're not reading it, it sends information to your brain.

So, when you're hands-on with things a lot of times if you're moving your body, you're keeping your brain active even if you're not just sitting there and thinking and thinking, you're exercising your brain in a different way than you would sitting down. You're using more of your brain and feeling, I don't know, I feel I've learned more.

[00:20:53] Female: I get what you're saying, I agree to both of those statements.

[00:20:55] Female: Yeah.

[00:20:57] MOD: All right. If money were no object and you could learn science anywhere you want to, how would you want to learn science? If money was no object at all and we could design the perfect course, what would that course look like? Or what would we do in that course?

[00:21:15] Female: Visually ish we had like a bigger building like [Inaudible] [00:21:21] which I wish I would be excited it was really bigger and also not just learn about animals but just other things too. We could dissect something.

[00:21:30] Female: I like more plants science, I love animal science probably just as much as plant science but I feel like plants are just equally as important because they make a big part of ecosystem without plants we don't have animals. It's partnership and I feel like learning about plants and learning about animals and learning how they work together would be really important but I like, I want the bigger space so we can get more animals more activities more things we can do and a bigger space outside.

I think it will be more helpful because then we'd have more and give us a little bit more responsibilities in the classroom. I like how some of the people get responsibility to take care of animals so you get that practicing.

[00:22:19] Female: Well if you have animal at home we could bring our animal here just for a semester like Emily did, she brought her animal, an iguana here for the class and stuff.

[00:22:30] Female: Yeah I agree to both of those statements yes I think that we need a bigger science lab. I think we should go outside more and play like the game that we played before like we should play some games that will help us remember. Because in lectures sometimes students don't listen they just goes into ear and comes out the next.

[00:23:00] Female: I feel like the game was really helpful.

[00:23:02] Female: Oh! yeah.

[00:23:03] Female: Because I think I wouldn't have understood it as much if we did it on paper or just talked about it. We became the deer or became the resources. It makes you understand things differently.

[00:23:16] Female: Yeah, one activity that I did like I don't know if he does it know like, they did do it but we went on break, onto the science work [Inaudible] [00:23:25] so for spring break, we went home and we had to do an assignment at home with our family member just talk about what we learned and what type of birds we learned about and stuff like that. See they will react to us teaching them about the type of science that we learned at school I really think that activity.

[00:23:48] Female: Sorry. I like that my problem was I really like that, because they were really excited to know that. Most I was lucky that spring break to actually have family but most of the time I have to kind of bombard people spring breaks and Thanksgivings because I can't afford to go home.

I can't afford to stay on campus either because it cost more than even going home. But so, a lot of times I'm with other people that I don't know their family or anything. So, I don't feel comfortable asking them questions and my friends are like I don't want to do homework so.

[00:24:20] Female: Yeah and also, I think that we should have a big science lab but also they should have like a fence in the yard and have some animals roaming on that yard, so we could have you show us, actually show us, what you're talking about.

[00:24:48] Female: With training animals?

[00:24:50] Female: Yeah.

[00:24:52] MOD: Then…

[00:24:52] Female: If you could see people training animals, if we could see people doing the things that we're talking about. It helps us understand more than just talking about it or watching a video. It's more interactive and you get more experience like when I train people at a factory that's not exciting. But they'd understand what I was talking about if I did it. But once I've explained it and then to show them and then have them try, they understood more once they got to try it after I explained it.

[00:25:24] MOD: All 3 of you mentioned a bigger space and a different space. What would that, like when you say you want a bigger space or a different space what would that space look like? What would that learning space look like to you?

[00:25:39] Female: I feel like not like a classroom size but I picture a long gated building kind of like the seed shop. Well then you have like your animals a section for your animals or even in different sections and you have, if you want maybe a classrooms type things, but I want it to feel not like a classroom.

[00:26:01] Female: Yeah like interactive, interaction.

[00:26:07] Female: Because I feel like science isn't really, I like to think to think of science not really as a classroom setting but as more like a life. Because I feel like especially since this is an animal science, animals are classrooms, animals are outside, animals are in life in the world and I want to be able to see them in the way are and I want to feel more open I don't want to feel claustrophobic. I want to be able to move around and hands-on on in the activities.

[00:26:35] Female: Yeah.

[00:26:35] Female: So, I do like to sit down during the movies of course.

[00:26:38] Female: But anyways yeah, like the more bigger space, and then get to the writing center.

[00:26:45] Female: I want to see the animals have more space.

[00:26:49] Female: Yeah, definitely

[00:26:50] Female: I feel like we're all crammed in here I mean it's cute and I love it and I love this room but we can only have so many animals and they are usually small animals. I feel like not make the classroom size bigger because our class is bigger because we have a bigger room but just make it so we can do more activities, more games. Maybe have a yard outside these space do things maybe or like a small homemade pod or something that you have some sort of like animal and that you can see different types of things.

I don't know because I never designed it.

[00:27:28] Female: Yeah well I'm thinking is that, maybe you should, I mean maybe they should have like a science building for its own purpose. So, you guys can have small animals on one side. Then classroom stuff and tables and white board and anything for the teacher or another side. Then when you go outside, there'd be a yard where we can play games and some animals out there. So, when you want to interact with, so, when you want to show us what you are actually telling us, we can see it in visualization.

[00:28:18] Female: Like long tables, you know like a big I don't know, like long tables and straight open.

[00:28:25] Female: Makes you feel like you are in a big group conversation, instead of split mode conversation. So this table is like long and everybody is on the side, so it might hard to hear that way.

I like when it's kind of oval, like in a U because learning you, you're not being closed off you're not, you feel a lot more open and everybody can see each other and all talking to each other. So, you're not all separate and segregated but does come in handy sometimes for groups you are already in a group.

[00:28:54] MOD: All right so I've asked you a few questions about science and science instruction, is there anything you want me or want to tell me that we did not discuss about science or learning science that you feel like we've not discussed yet.

[00:29:11] Female: I know I struggle with, I like having a calendar it's like inside, it's like having a rubric but I also like to be reminded ahead of time that you are in class because I don't always have the time, you don't back in my rubric or in calendar and it's easier if I'm reminded in class if it's written in board because I'll write down what's written on the board in my planner every day. So, I have it as a daily, like a reminder.

So, I don't forget it and be like oh! It was in your calendar and like oh! I miss it because I didn't write it down because that was a struggle for me when I was in class.

[00:29:48] Female: I just need to always be reminded. I have calendars in our binders I know that.

[00:29:56] Female: [Inaudible] [00:29:58]

[00:29:58] Female: So especially me, I have to be reminded repeatedly so I don't forget.

[00:30:07] Female: I will write in my planner especially if it's written on the board or something or like the Dr. Huff told us a reminder out loud, whereas Dr. Ross put it right on the board, even though it on rubric she goes you can always refer back to your rubric or calendar. Like if I know what it's coming up by the teacher saying it, it feels different and gives me a different impression then we're just supposed to look at our rubrics and we know when everything is going to happen.

Because I feel like it's more personal and more real because on the calendar or in a piece of paper it's just paper. Whereas if you just tell it in the class it feels more real. I have to do it like it's in important.

[00:30:52] Female: Also like the field trips.

[00:30:57] Female: Yeah field trips.

[00:30:55] Female: Remember we had the hike and then I don't know if you all went this year but when I took science they were going to Animal Kingdom and were going to see the animals and stuff and we talked about that, I think that was nice. If money was not an object then that would be done more often.

[00:31:20] MOD: More field trips.

[00:31:21] Female: Yeah more field trips yeah.

[00:31:24] Female: To Animal Kingdom and stuff like that because everybody don't have the money, even though it's like we get the lower rate but still it would be more better.

[00:31:32] Female: Yeah I feel like more field trips, sorry go ahead.

[00:31:32] Female: It's fine, I feel like interrupted you, I feel more field trips are good. I like the hiking I didn't do the Animal Kingdom thing but I think for you to see more of the animals we're discussing, more of the things and do, I feel like field trips are very hands-on things.

[00:31:46] Female: Oh yeah.

[00:31:48] Female: You are very outside, everything is excited and I feel like you've always learned things on field trips. Because everybody is excited to do it, excited to hear. It's not like saying oh! We are going to go to a business lecture and you are like but we are going outside experience. Liked hiking because we discussed things that the teacher did previously. We discussed about like the park about the land about the plants that are there and the animals are there, what's needed to hear, what's not.

We got to test water and see it change color.

[00:32:19] Female: Yeah that's pretty cool. Yeah definitely I agree with what all that.

[00:32:24] Female: Plus you got some exercise, hiking is always fun.

[00:32:27] Female: Yeah definitely field trips are very hands-on and it will especially help me, I don't know about other students but especially.

[00:32:39] Female: I think field trips, if you would go have a field trip where money is no option to like Animal Kingdom and they discussed like what they do, to do for the animals. How they operate with their animals there and what they do to take care of them and stuff. Or that even at an aquarium and zoo I feel like it might be different for Animal Kingdom because they are showing animals and they have to drive through a terrain and it's different than when zoos are kept in captivity but.

[00:33:05] Female: They tell you about the ranch like through the drive through.

[00:33:06] Female: In Animal Kingdom it's a floorly thing where you are writing vehicular, this drives through the animal's right?

[00:33:16] MOD: Yeah the Safari ride?

[00:33:15] Female: The safari ride.

[00:33:17] Female: Okay that was the first thing my uncle had me do. I went there the same day as him and I didn't know it.

[00:33:26] Female: Oh okay.

[00:33:24] Female: He's on the same ride too.

[00:33:28] Female: Sweet.

[00:33:28] Female: You know I think it was a different ride though. One time I've been there but I think that, it'd be good to see what's like at a zoo or different places that this major is associated with. If we go to see what not just talk about the jobs but that would be really important but associate it by seeing it and see what they do and know what it is it'd be a lot more helpful.

But I know that's a lot on us for internship and stuff. But just like go a zoo or an aquarium or something and see how it is, what they do to take care of the animals and discuss their jobs and I think that's really interesting and they could talk to us about animals that we don't see on a normal basis that we don't know anything about. Like [Ms. Dager] [00:34:09] and her snakes.

We don't know a lot about all the snakes but we got to learn more because she discussed things. She discussed like it would have been cool to do a night tour I really want to do that owl like night bird watch thing. Because I saw an owl the other day on the road, it scared me. Flew out in front of me, did not see it coming because it was dark. But didn't notice I was down here.

But there I think going to the zoo at night it would be really cool because a lot of animals are nocturnal. When you go to the zoo a lot of them are asleep or out back and I know they change different animals from the day time and at night. But it would be really cool to see the animals when they're active and especially at a time that they're normally active.

[00:35:03] Female: Yeah.

[00:35:04] Female: So, I think just seeing things in a natural way, as close as we can in the natural ways and discussing more about these animals and when we see them, you have something to relate them too and remember it more. I like those things. I like when we go to things and we have somebody to give us a tour and discuss with us about the animals like [Ms. Dager] [00:35:22] did and she told us about the animals and I found that really cool.

I like those private tour things, I like one on one with the person who works there and it's just not like a normal tour that you're going to pay for this tour.

[00:35:34] Female: So many people.

[00:35:35 Female: It's more like hands-on I feel.

[00:35:38] Female: I agree with everything that you said.

[00:35:40] Female: I like those things yeah.

[00:35:43] MOD: Well thank you very much guys I appreciate it and I appreciate all your feedback.

REFERENCES

Artiles, A. J., Kozleski, E. B., Trent, S. C., Osher, D., & Ortiz, A. (2010). Justifying and explaining disproportionality, 1968–2008: A critique of underlying views of culture. *Exceptional Children*, *76*(3), 279-299.

Basham, J. J., & Marino, M. T. (2010). Introduction to the topical issue: Shaping STEM education for all students. *Journal of Special Education Technology*, *25*(3), 1-2.

Beacon at a glance. (n.d.). Retrieved from http://www.beaconcollege.edu/beacon-at-a-glance/

Black, D. R., Weinberg, L. A., & Brodwin, M. G. (2015). Universal design for learning and instruction: Perspectives of students with disabilities in higher education. *Exceptionality Education International*, *25*(2), 1.

Blumberg, P. (2016). Assessing implementation of learner-centered teaching while providing faculty development. *College Teaching*, *64*(4), 194-203.

Bolman, L and Deal, T. (2013). *Reframing organizations 5th edition*. San Francisco, California: Josesey-Bass.

Brigham, F. J., Scruggs, T. E., & Mastropieri, M. A. (2011). Science education and students with learning disabilities. *Learning Disabilities Research & Practice*, *26*(4), 223-232.

Bybee, R. (2015). Scientific literacy. *Encyclopedia of Science Education*, 944-947.

Carlson, R., Chandler, P., & Sweller, J. (2003). Learning and understanding science instructional material. *Journal of educational psychology*, *95*(3), 629.

Cawley, J. F., Foley, T. E., & Miller, J. (2003). Science and students with mild disabilities: Principles of universal design. *Intervention in School and Clinic*, *38*(3), 160-71.

Cook, M., & Mulvihill, T. M. (2008). Examining US college students' attitudes towards science: Learning from non-science majors. *Educational Research and Reviews*, *3*(1), 38.

Cooper, J. T., Lingo, A. S., Whitney, T., & Slaton, D. B. (2011). The effects of instruction in a paired associates learning strategy as an intervention for college students with Learning disabilities. *Journal of Postsecondary Education and Disability*, *24*(2), 133-145.

Cortiella, C., & Horowitz, S. (2014). *The state of learning disabilities: Facts, trends, and emerging issues, 3rd edition.* New York, NY.

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Denhart, H. (2008). Deconstructing barriers perceptions of students labeled with learning disabilities in higher education. *Journal of Learning Disabilities*, *41*(6), 483-497.

Deshler, D. D., Schumaker, J. B., Lenz, B. K., Bulgren, J. A., Hock, M. F., Knight, J., & Ehren, B. J. (2008). Ensuring content-area learning by secondary students with learning disabilities. *Journal of education, 189.*

Dickens, J., & Arlett, C. (2008). Key aspects of teaching and learning in engineering. In Fry, Ketteridge, & Marshall (Eds.), *A handbook for teaching and learning in higher education: Enhancing academic practice, 3rd edition* (264-281). New York, NY: Routledge.

Duke, B., Harper, G., & Johnston, M. (2013). Connectivism as a digital age learning theory. *The International HETL Review*, 4-13.

Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, cognitivism, constructivism: Comparing critical features from an instructional design perspective. *Performance Improvement Quarterly*, *26*(2), 43-71. doi:10.1002/piq.21143

Etkina, E., & Mestre, J. P. (2004). Implications of learning research for teaching science to non-science majors. *SENCER Backgrounder*, 1-25.

Feldon, D. F. (2007). Cognitive load and classroom teaching: The double-edged sword of automaticity. *Educational Psychologist*, *42*(3), 123-137.

Flavell, J., Miller, P., & Miller, S. (2002). *Cognitive development (4th ed.)*. Upper Saddle River, NJ: Prentice-Hall.

Flores, M. M., & Ganz, J. B. (2007). Effectiveness of direct instruction for teaching statement inference, use of facts, and analogies to students with developmental disabilities and reading delays. *Focus on Autism and Other Developmental Disabilities*, *22*(4), 244-251.

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, *111*(23), 8410-8415.

Georgiou, G. K., & Das, J. P. (2015). University Students With Poor Reading Comprehension. *Journal Of Learning Disabilities*, *48*(5), 535-545.

Gogolin, L., & Swartz, F. (1992). A quantitative and qualitative inquiry into the attitudes toward science of nonscience college students. *Journal of Research in Science Teaching*, *29*(5), 487-504.

Gredler, M. (2009). *Learning and instruction: Theory into practice.* (6th ed.). Upper Saddle River, NJ: Pearson Education, Inc.

Grumbine, R., & Alden, P. B. (2006). Teaching science to students with learning disabilities. *The Science Teacher*, *73*(3), 26.

Grumbine, R. A., Hecker, L., Littlefield, A. P., Abedon, B., Coleman, K. D., Hinckley, T. R., ... & Whittemore, S. (2005). *Biology success!: Teaching diverse learners, a resource manual for biology educators*. National Institute at Landmark College.

Harwell, J. M., & Jackson, R. W. (2014). *The complete learning disabilities handbook: Ready-to-use strategies and activities for teaching students with learning disabilities*. John Wiley & Sons.

Hedrick, B. b., Dizén, M. d., Collins, K. k., Evans, J. j., & Grayson, T. t. (2010). Perceptions of college students with and without disabilities and effects of STEM and non-STEM enrollment on student engagement and institutional involvement. *Journal Of Postsecondary Education & Disability*, *23*(2), 129-136.

Heiman, T. (2006). Assessing learning styles among students with and without learning disabilities at a distance-learning university. *Learning Disability Quarterly*, *29*(1), 55-63.

Heiman, T., & Precel, K. (2003). Students with learning disabilities in higher education academic strategies profile. *Journal of learning disabilities*, *36*(3), 248-258.

Heinrich, S., Knight, V., Collins, B. C., & Spriggs, A. D. (2016). Embedded simultaneous prompting procedure to teach STEM content to high school students with moderate disabilities in an inclusive setting. *Education and Training in Autism and Developmental Disabilities*, *51*(1), 41.

Hill, M., & Sharma, M. (2015). Research-based worksheets on using multiple representations in science classrooms. *Teaching Science: The Journal Of The Australian Science Teachers Association*, *61*(3), 37-46.

Hofstein, A., & Lunetta, V. (2004). The laboratory in science education: Foundations for the twenty-first century. *Science Education, 88*, 28-54. doi: 10.1002/sce.10106

Hora, M. -. (2012). Organizational factors and instructional decision-making: A cognitive perspective. *The Review of Higher Education*, (2), 207.

Huitt, W. (2003). The information processing approach to cognition. *Educational Psychology Interactive*, *3*(2), 53-67.

Hwang, J., & Taylor, J. C. (2016). Stemming on STEM: A STEM education framework for students with disabilities. *Journal of Science Education for Students with Disabilities*, *19*(1), 4.

Israel, M., Maynard, K., & Williamson, P. (2013). Promoting literacy-embedded, authentic STEM instruction for students with disabilities and other struggling learners. *Teaching Exceptional Children*, *45*(4), 18-25.

Jarrett, D. (1999). *The inclusive classroom: Mathematics and science instruction for students with learning disabilities. It's just good teaching*. Portland, OR: Northwest Regional Educational Lab.

Jenkins, J. R., Antil, L. R., Wayne, S. K., & Vadasy, P. F. (2003). How cooperative learning works for special education and remedial students. *Exceptional children*, *69*(3), 279-292.

Johnson, E. S., Humphrey, M., Mellard, D. F., Woods, K., & Swanson, H. L. (2010). Cognitive processing deficits and students with specific learning disabilities: A selective meta-analysis of the literature. *Learning Disability Quarterly, 33*(1), 3-18.

Kandarakis, A. G., & Poulos, M. S. (2008). Teaching implications of information processing theory and evaluation approach of learning strategies using LVQ neural network. *Advances in Engineering Education*, *5*(3), 111-119.

Kayhan, N., Sen, M., & Akcamete, G. (2015). Opinions of university students with disabilities on current regulations and adaptations at higher education institutions. *Procedia-Social and Behavioral Sciences*, *197*, 635-639. doi: 10.1016/j.sbspro.2015.07.050

Keller III, G. E. (2002). Using problem-based and active learning in an interdisciplinary science course for non-science majors. *The Journal of General Education, 51*(4), 272-281.

Keri, G. (2002). Male and female college students' learning styles differ: An opportunity for instructional diversification. *College Student Journal*, *36*(3), 433.

Ketterlin-Geller, L. R. (2005). Knowing what all students know: Procedures for developing universal design for assessment. *The Journal of Technology, Learning and Assessment*, *4*(2).

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.

Kidd, P. S., & Parshall, M. B. (2000). Getting the focus and the group: enhancing analytical rigor in focus group research. *Qualitative Health Research*, *10*(3), 293-308.

King-Sears, M. (2009). Universal design for learning: Technology and pedagogy. *Learning Disability Quarterly*, *32*(4), 199-201.

King-Sears, M. E., Johnson, T. M., Berkeley, S., Weiss, M. P., Peters-Burton, E. E., Evmenova, A. S., & ... Hursh, J. C. (2015). An exploratory study of universal design for teaching chemistry to students with and without disabilities. *Learning Disability Quarterly*, *38*(2), 84-96.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75-86.

Kuh, G., Cruce, T., Shoup, R., & Kinzie, J. (2008). Unmasking the effects of student engagement on first-year college grades and persistence. *The Journal of Higher Education*, *79(5)*, 540-653.

Lattuca, L.R., & Stark, J.S. (2009). *Shaping the college curriculum: Academic plans in context (2nd ed.)*. San Francisco, CA: Jossey-Bass.

Learning & memory. (n.d.). Retrieved June 02, 2016, from http://www.apa.org/topics/learning/

LoPresto, M. C., & Slater, T. F. (2016). A new comparison of active learning strategies to traditional lectures for teaching college astronomy. *Journal of Astronomy & Earth Sciences Education*, *3*(1), 59-76.

Lucentini, D. F., & Gudwin, R. R. (2015). A comparison among cognitive architectures: A theoretical analysis. *Procedia Computer Science*, *71*56. doi:10.1016/j.procs.2015.12.198

Lutz, S., & Huitt, W. (2003). Information processing and memory: Theory and applications. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University.

Mayer, R. E. (2011). *Applying the sciences of learning*. Boston, MA: Pearson.

McGuire, J. M., & Scott, S. S. (2006). Universal design for instruction: Extending the universal design paradigm to college instruction. *Journal of Postsecondary Education and Disability*, *19*(2), 124-134.

McLeod, S. (2008). *Information procession*. Retrieved from http://www.simplypsychology.org/information-processing.html

McMaster, K. N., & Fuchs, D. (2002). Effects of cooperative learning on the academic achievement of students with learning disabilities: An update of Tateyama-Sniezek's review. *Learning Disabilities Research & Practice*, *17*(2), 107-117.

McNeill, K. L., Lizotte, D. J., Krajcik, J., & Marx, R. W. (2006). Supporting students' construction of scientific explanations by fading scaffolds in instructional materials. *The Journal of the Learning Sciences*, *15*(2), 153-191.

Miller, G.A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 63, 81-97.

Mintz, S. (2016, March 28). Designing next-generation universities. Retrieved from https://www.insidehighered.com/blogs/higher-ed-beta/designing-next-generation-universities-0

Mission statement. (2016, May). Retrieved from http://www.beaconcollege.edu/about-beacon-college/mission-statement/

Monahan, M., & Shah, A. (2011). Having the right tools: The leadership frames of university presidents. *The Coastal Business Journal, 10*(1), 14-29.

Mooney, J., & Cole, D. (2014). *Learning outside the lines: Two ivy league students with learning disabilities and adhd give you the tools for academic success and educational revolution*. Simon and Schuster.

Moriarty, M. A. (2007). Inclusive pedagogy: Teaching methodologies to reach diverse learners in science instruction. *Equity & Excellence in Education*, *40*(3), 252-265.

Morrison, G.R., Ross, S.M., & Kemp, J.E. (2007). *Designing effective instruction (5th ed.).* Hoboken, NJ: John Wiley & Sons, Inc.

Moustakas, C. (1994). *Phenomenological research methods*. Thousand Oaks, CA: Sage.

Nadelson, L. S., & Fannigan, J. (2014). A path less traveled: Fostering STEM majors' professional identity development through engagement as STEM learning assistants. *Journal of Higher Education Theory and Practice*, *14*(5), 29.

National Center for Special Education Research. (2011). *Secondary school programs and performance of students with disabilities: A special topic report of findings from the national longitudinal transition study-2 (nlts2)*. Washington, DC: Buckley, J.

Neuman, L.W. (2011). *Social research methods: Qualitative and quantitative approaches (7th ed.)*. Boston, MA: Pearson.

Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: What can be done?. *Assessment & Evaluation in Higher Education*, *33*(3), 301-314.

Ofiesh, N. S. (2007). Math, science, and foreign language: Evidence-based accommodation decision making at the postsecondary level. *Learning Disabilities Research & Practice, 22*(4), 237-245. doi: 10.1111/j.1540-5826.2007.00252.x

Okano, H., Hirano, T., & Balaban, E. (2000). Learning and memory. *Proceedings of the National Academy of Sciences*, *97*(23), 12403-12404.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, *25*(9), 1049-1079.

Paas, F., Renkl, A., & Sweller, J. (2003). Cognitive load theory and instructional design: Recent developments. *Educational psychologist*, *38*(1), 1-4.

Partin, M. L., Underwood, E. M., & Worch, E. A. (2013). Research and teaching: Factors related to college students' understanding of the nature of science: Comparison of science majors and nonscience Majors. *Journal of College Science Teaching*, *42*(6), 89-99.

Pathamathamakul, C. (2016). Challenges of transforming introductory science classes to learner-centered teaching. *Pertanika Journal of Social Sciences & Humanities*, *24*33-42.

Perkins, K. K., Adams, W. K., Pollock, S. J., Finkelstein, N. D., & Wieman, C. E. (2005, September). Correlating student beliefs with student learning using the Colorado Learning Attitudes about Science Survey. In J. Marx, P. Heron, & S. Franklin (Eds.), *AIP Conference Proceedings* (Vol. 790, No. 1, pp. 61-64). AIP.

Quaye, S. J., & Harper, S. R. (2009). *Student engagement in higher education : theoretical perspectives and practical approaches for diverse populations*. New York, NY : Routledge, 2009.

Quinlan, M. M., Bates, B. R., & Angell, M. E. (2012). 'What can I do to help?': Postsecondary students with learning disabilities' perceptions of instructors' classroom accommodations. *Journal of Research In Special Educational Needs*, *12*(4), 224-233. doi:10.1111/j.1471-3802.2011.01225.x

Rao, S. (2004). Faculty attitudes and students with disabilities in higher education: A literature review. *College Student Journal*, *38*(2), 191.

Riding, R. J., Grimley, M., Dahraei, H., & Banner, G. (2003). Cognitive style, working memory and learning behaviour and attainment in school subjects. *British Journal of Educational Psychology*, *73*(2), 149-169.

Rodenbusch, S. E., Hernandez, P. R., Simmons, S. L., & Dolan, E. L. (2016). Early engagement in course-based research increases graduation rates and completion of science, engineering, and mathematics degrees. *CBE-Life Sciences Education*, *15*(2), ar20.

Rose, D. H., Hasselbring, T. S., Stahl, S., & Zabala, J. (2005). Assistive technology and universal design for learning: Two sides of the same coin. *Handbook of special education technology research and practice*, 507-518.

Sarasin, L.C. (2006). *Learning styles perspectives: Impact in the classroom*. Madison, WI: Atwood Publishing.

Schneps, M. m., O'Keeffe, J. K., Heffner-Wong, A., & Sonnert, G. (2010). Using Technology to Support STEM Reading. *Journal of Special Education Technology*, *25*(3), 21-33.

Schroeder, C., Scott, T., Tolson, H., Huang, T., & Lee, Y. (2007). A meta-analysis of national research: Effects of teaching strategies on student achievement in science in the United States. *Journal of Research in Science Teaching, 44(10)*, 1436-1460.

Schunk, D. H. (1996). *Learning Theories (2nd ed.)*. Englewood Cliffs, New Jersey: Merrill, an imprint of Prentice Hall.

Scott, S. S., Mcguire, J. M., & Foley, T. E. (2003). Universal design for instruction: A framework for anticipating and responding to disability and other diverse learning needs in the college classroom. *Equity & Excellence in Education*, *36*(1), 40-49.

Scruggs, T. E., Brigham, F. J., & Mastropieri, M. A. (2013). Common core science standards: Implications for students with learning disabilities. *Learning Disabilities Research & Practice*, *28*(1), 49-57. doi: 10.1111/ldrp.12002

Scruggs, T. E., & Mastropieri, M. A. (2007). Science learning in special education: The case for constructed versus instructed learning. *Exceptionality*, *15*(2), 57-74.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research*, *95*(6), 323-332.

Singer, S. R., Nielsen, N. R., & Schweingruber, H. A. (Eds.). (2012). Discipline-based education research: Understanding and improving learning in undergraduate science and engineering. Washington, DC: National Academies Press. http://www.nap.edu/catalog/13362/

Slavin, R., Hurley, R., Chamberlain, A. (2003). Cooperative learning and achievement: Theory and research. In Reynolds & Miller (Eds.), *Handbook of Psychology volume 7, Educational Psychology* (177-198). Hoboken, New Jersey: John Wiley & Sons, Inc.

Son, J. j., Narguizian, P., Beltz, D., & Desharnais, R. A. (2016). Comparing physical, virtual, and hybrid flipped labs for general education biology. *Online Learning*, *20*(3), 228-243.

Sparks, R. L., & Lovett, B. J. (2009). College students with learning disability diagnoses who are they and how do they perform?. *Journal of Learning Disabilities*, *42*(6), 494-510. doi: 10.1177/0022219409338746

Speirs, S. J., Rinehart, N. J., Robinson, S. R., Tonge, B. J., & Yelland, G. W. (2014). Efficacy of cognitive processes in young people with high-functioning autism spectrum disorder using a novel visual information-processing task. *Journal of Autism And Developmental Disorders*, *44*(11), 2809-2819.

Spelke, E. S. (2005). Sex differences in intrinsic aptitude for mathematics and science?: a critical review. *American Psychologist*, *60*(9), 950.

Sproken-Smith, R., Walker, R., Batchelor, J., O'Steen, B., & Angelo, T. (2012) Evaluating student perceptions of learning processes and intended learning outcomes under inquiry approaches. *Assessment & Evaluation in Higher Education, 37(1),* 57-72.

Stamovlasis, D., & Tsaparlis, G. (2012). Applying catastrophe theory to an information-processing model of problem solving in science education. *Science Education*, *96*(3), 392-410.

St Clair-Thompson, H., Overton, T., & Botton, C. (2010). Information processing: A Review of implications of johnstone's model for science education. *Research in Science & Technological Education*, *28*(2), 131-148.

Stefaniak, J. E., & Tracey, M. W. (2015). An exploration of student experiences with learner-centered instructional strategies. *Contemporary Educational Technology*, *6*(2), 95-112.

Sunal, D., Hodges, J., Sunal, C., Whitaker, K., Freeman, M., Edwards, L., Johnston, R., & Odell, M. (2001). Teaching science in higher education: Faculty professional development and barriers to change. *School Science and Mathematics*, *101*(5), 246-257.

Swanson, H. L., & Beebe-Frankenberger, M. (2004). The relationship between working memory and mathematical problem solving in children at risk and not at risk for serious math difficulties. *Journal of Educational Psychology*, *96*(3), 471. DOI: 10.1037/0022-0663.96.3.471

Swanson, H. L., & Harris, K. R. (Eds.). (2013). *Handbook of learning disabilities*. Guilford Press.

Therrien, W. J., Taylor, J. C., Hosp, J. L., Kaldenberg, E. R., & Gorsh, J. (2011). Science instruction for students with learning disabilities: A meta-analysis. *Learning Disabilities Research & Practice*, *26*(4), 188-203. doi: 10.1111/j.1540-5826.2011.00340.x

Tierney, W. (1998). Organizational culture in higher education: Defining the essentials. *Journal of Higher Education, 59*(1), 2-21. doi: 10.2307/1981868

Tremaine Foundation. (2010). *Measuring Progress in Public & Parental Understanding of Learning Disabilities*. New Haven, CT: Roper Public Affairs & Corporate Communications.

Troia, G. A., & Graham, S. (2002). The effectiveness of a highly explicit, teacher-directed strategy instruction routine: Changing the writing performance of students with learning disabilities. *Journal Of Learning Disabilities*, *35*(4), 290-305. doi:10.1177/00222194020350040101

Udo, M. K., Ramsey, G. P., & Mallow, J. V. (2004). Science anxiety and gender in students taking general education science courses. *Journal of Science Education and Technology*, *13*(4), 435-446.doi: 10.1080/09362830701294144

Van Merrienboer, J. J., & Sweller, J. (2005). Cognitive load theory and complex learning: Recent developments and future directions. *Educational Psychology Review*, *17*(2), 147-177.

Vaughn, S., & Linan-Thompson, S. (2003). What is special about special education for students with learning disabilities?. *The Journal of Special Education*, *37*(3), 140-147.

Wagner, M., Newman, L., Cameto, R., Garza, N., & Levine, P. (2005). After high school: A first look at the postschool experiences of youth with disabilities. A Report from the National Longitudinal Transition Study-2 (NLTS2). *Online submission*.

Weimer, M. (2015, Sept 18). The names we give to our instructional strategies. Retrieved from http://www.facultyfocus.com/articles/instructional-design/the-names-we-give-to-our-instructional-strategies/

Weis, R., Erickson, C. P., & Till, C. H. (2016). When average is not good enough: Students with learning disabilities at selective, private colleges. *Journal of Learning Disabilities*, 1-17. doi: 10.1177/0022219416646706

Willingham, D. T., Hughes, E. M., & Dobolyi, D. G. (2015). The scientific status of learning styles theories. *Teaching of Psychology*, *42*(3), 266-271.

Zundans-Fraser, L., & Auhl, G. (2016). A theory-driven approach to subject design in teacher education. *Australian Journal of Teacher Education*, *41*(3).