Special Education and STEM Education Teacher Credentials and Instructional Preparedness for Inclusive STEM Education

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ABSTRACT

In an effort to meet the demands of industry within society, STEM (Science, Technology, Engineering, and Mathematics) education has been a major push for the United States Government resulting in public school system reform. As STEM education begins to become integrated across disciplines and special areas of public schools, and the population of inclusive classrooms containing Students with Disabilities continues to rise, a very important question must be fully investigated and answered. We must ask: Do first year Secondary STEM Education and Special Education teachers have the instructional preparedness to effectively teach all populations of students within their classrooms? And do STEM education and Special Education teachers have the appropriate content credentials to effectively support the diverse needs of students and curriculum in an inclusive STEM education class?

This dissertation consists of two research studies that examine Special Education and STEM Education teachers’ preparedness (coursework and professional development) and content credentials to educate Students with Disabilities within an inclusive STEM Education classroom. This study will be utilizing a secondary analysis of the 2011-2012 School and Staffing Survey Teacher Questionnaire (SASS TQ) datasets to conduct national analysis of how Special Education and STEM Education teachers’ degrees, state-level certification areas, and professional development participation reflect potential indicators of preparedness to educate in an inclusive STEM education classroom.

The first study focuses on well-known approaches for the instruction of STEM Education and Special Education. This study will utilize differentiated instruction, behavior management, and data to drive instruction as best classroom approaches to instruction to determine their identifiable differences in instructional preparedness among first year STEM educators and first year Special Education teachers.

The second study utilizes the 2011-2012 SASS TQ datasets to analyze Special Educators credentials to teach STEM compared to STEM educator’s credentials to teach Special Education. This study will analyze and compare credentials and backgrounds of STEM educators and Special Educators in search of indicators for preparedness for Inclusive STEM education.
GENERAL ABSTRACT

Society has and continues to rely on STEM (Science, Technology, Engineering, and Mathematics) research and applications to solve many of its novel problems and push the boundaries for innovations which seek the betterment of humanity. This has led to recent educational focuses on STEM content and concepts which has resulted in reforms throughout the United States school systems. While STEM education has become a major focus within our school systems there has also been a reported increase in the number of special education students attending STEM education coursework.

This educational shift towards STEM subjects combined with the increase of students with disabilities has led to an unprecedented amount of STEM classrooms containing students with disabilities. Since students with disabilities require unique programming and teaching strategies to be successful there increase in population has not only changed the roles and responsibilities for educators but has also created new challenges for both regular and special education teachers. This has raised the importance of evaluating both STEM and special education teacher’s instructional preparedness and content expertise to teach STEM subjects to all students, including students with disabilities.

The two research studies reported within this dissertation use a national data set to examine special education and STEM education teachers’ coursework, professional development and content credentials to identify their preparedness to educate Students with Disabilities within a STEM Education classroom containing students with disabilities. These studies conducted a secondary analysis to determine how special education and STEM education teachers’ degrees, state-level certification areas, and professional development participation reflect as potential indicators of preparedness to educate in a STEM education classroom containing students with disabilities.
Dedication

“Here's to the crazy ones, the misfits, the rebels, the troublemakers, the round pegs in the square holes... the ones who see things differently -- they're not fond of rules... You can quote them, disagree with them, glorify or vilify them, but the only thing you can't do is ignore them because they change things... they push the human race forward, and while some may see them as the crazy ones, we see genius, because the ones who are crazy enough to think that they can change the world, are the ones who do.” -Steve Jobs

I dedicate this work to my wife Tara who has shown unwavering supported in my mission and journey to reach and exceed my dreams and self-expectations. You push me to be the best version of myself. You have always set the bar high through example, and have never, ever let me down. You have taken on so much for me to do this and I am forever grateful for your support.

I also dedicate this work to my two crazy kids Louis IV and Rocco Rossi. You have provided me clarity and motivation to make an impact in a universe in which you will participate and no doubtable will make a dent in. Don’t ever let anyone put you in a box and set parameters for what is possible. You CAN do anything you put your mind to, no matter how hard and “impossible”.

This work is also dedicated to my parents, Phyllis and Louis Rossi. You created a fighter with a hard work ethic and a kind heart. You taught me invaluable lessons regarding life, grit, perseverance and the importance of family. All of which I am hopeful to pass down to my children.
I also would like to dedicate this work to my other set of parents, Chris and Anne Towers. You welcomed a troubled juvenile into your home and trusted me with one of your most prized possessions, Tara. You taught me the importance of giving a child a chance to prove themselves, and not only relying on hearsay and reputations. You have also taught me much about the importance of family.

Last but not least, I would like to dedicate this work to every child who doesn't fit the mold of school and may be feeling lost. You will find your way. You are different and later in life you will find out that this is an asset, not a setback. Trust your instincts and figure out who you really are. Don't let your intelligence be merely defined by a grade, an assignment or a teacher's comment. Maybe it's not that you need to be better at school, maybe it's that school needs to be better at you. It's likely that you are the square peg in the round hole my friend, and there are great things awaiting you. Work hard, stay focused, and envision yourself where you want to be. Then go hard, and don't let anyone or anything get in your way. Faith is a strange thing. Have it.
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Chapter 1. Introduction to the Dissertation

Background

In the past, the common practice and expectation for general education teachers regardless of a student’s learning capacity and ability was to instruct all students whom were assigned to their classroom. Over time this expectation began to shift as classrooms became more diverse with the increase of students becoming classified as having learning disabilities. To accommodate this newly identified population within the confines of public education many schools across the United States began to create new environments specifically designed for special education students. This shift in approach to address the learning needs of these students led to the 1975 passing of Public Law 94-142, which was referred to as the Education of All Handicapped Children Act. With this newly signed act, all students with disabilities became eligible to a free and appropriate education in the least restrictive environment.

This led to a variety of new placements and instructional options for students with disabilities. These included the construction of segregated facilities that were designed for students with more severe disabilities based on the assumption that these facilities provided the least restricted environment for students whom had not previously been afforded an education in their district. In other cases, special education students were served in separate schools and not permitted in the general education setting. Some public-school systems developed specialized programs which were housed within the general education school but detached from the general education population. As Gerber (1996) reported, many times special education students received instruction in a “pull out” or resource room program. At the time the belief was that this was the best way for avoiding conflicts in learning environments, while at the same time implementing specialized instruction for students with disabilities (Gerber, 1996). In many cases
special education students would receive their content-based instruction in the general education classroom, and then move to the resource room for strategy-based or specialized instruction from a special education teacher whom would assist them with their classwork. Another common practice was to move the special education students to a quieter resource room for testing purposes. Self-contained were also an option for special education students. These were classrooms in which students would receive all instruction from the special education teacher on the specific content area, such as reading or mathematics (Bakken, 2016). This placement had lower teacher-student ratios, specially trained teachers, increased individualized instruction, and an increased curricular emphasis on social and vocational goals (Johnson, 1962). Regarding all these placement options it was left up to the individualized education program (IEP) team to decide the most effective setting for the student with disabilities. This team often based their decisions on student disabilities, content gaps, and knowledge/skills.

The inclusion model gained additional acceptance as a best practice in 2002 when President George Bush signed the No Child Left Behind Act (NCLB) into law. This law was created to make sure that “all students will have a better chance to learn, to excel, and to live out their dreams” (www.whitehouse.gov/infocus/achievement/chap12.html). NCLB states that all teachers are to be highly qualified in the core subjects in their classrooms, utilize research-based instructional strategies for students, and provide opportune information and options for parents.

Under NCLB states began working to close the student achievement gap and ensure that all students, including special education students, achieve academic proficiency. This enactment was aimed to ensure that educators in all classrooms and subjects are effectively teaching and accommodating all students (U.S. Department of Education, 2007). With these new requirements in place the United States had an increase in the number of schools moving towards educating
students utilizing an inclusion model. It has also been reported that STEM classrooms in the United States are becoming increasingly inclusive (Ernst et al., 2014). These classrooms contain a variety of students comprised of both regular education and special education students and require teachers to make accommodations in both their delivery and assessment (Ernst et al., 2014).

The combination of NCLB requirements and accommodations in delivery and assessments required for students with disabilities has created a unique and challenging environment for teachers. It has been reported that the background of the general education teachers for knowing how to make these accommodations, as well as teach to the high standards of NCLB can be an issue (Martel, 2009). If a teacher is not equipped to make appropriate and effective accommodations to their instructional strategies and assessments, struggling students can fall behind academically and may exhibit behavior problems which can lead to teachers becoming overwhelmed and more reactive to arising issues. In 2005, Baker reported that reactive and adverse teaching methods result in teacher frustration and can cause teachers to withdraw from their position as an educator. In turn, teachers who are properly equipped to use a variety of research-based teaching methods, both instructional and behavioral, are better prepared to educate in diverse learning environments (Baker, 2005).

Since the signing of the NCLB, much has changed regarding student placements and academic experiences in the United States’ educational system. This is evident for both the general education classroom population and curriculum (Bakken, 2016). An example of these changes is the time spent in different placements within the educational environment. From 1988 to 1989, approximately 30% of students with disabilities spent more than 80% of their time in general education classroom setting receiving instruction on the general education curriculum
(Bakken, 2016). This is much different than the statistics in 2013 when the number of students with disabilities served in the general education classrooms had more than doubled since 1989, with a reported 61% being served in this environment (U.S. Department of Education, National Center for Education Statistics, 2016).

The inclusion shift’s focus on including students with disabilities in their least restrictive environment (LRE) has always been the mission of special education. However, in the past many special education students were pulled out of the general education environment due to the thought at the time that these students could not be successful in this environment due to their need for an individualized instructional requirement.

Recently, there has been much debate regarding the decline of education for all student populations in the USA, as well as our global status in key academic areas such as Mathematics and Science for all students. Understanding the fundamental causes of these declines has proven to be complex and elusive. Many researchers and teachers alike investigate, analyze, and ponder whether it is the complex Common Core-based standards, Standardized Testing, School Funding or Educational Policies that are creating this downward shift. But could the answer be much more obvious and right in front of us as educators and researchers? Could it be our direct sources of output data for these rankings that perpetuates these studies, our teachers and increasingly diverse student populations? This study aims to:

To determine if STEM educators are properly prepared to teach in today’s classrooms which are comprised of 1 out of every 8 students having some level of a learning disability it is imperative to analyze whether they have the instructional tools and credentials to serve all student abilities in their classroom as they enter the teaching profession. These instructional
approaches include differentiated instruction, classroom management, and data to inform instruction.

Credentials regarding teacher certification will be reported for Science, Mathematics and Technology education. To determine if Special Education teachers are properly prepared to teach in STEM classrooms that require a distinct content knowledge and credentials, it is imperative to analyze the importance of preparedness, and whether these teachers are entering the profession with the proper content knowledge and credentials to serve all of their Special Education students in an inclusive STEM education context.
Chapter 2. Literature Review

Teacher Quality and Preparedness

Over the past two decades, it has reported that teacher quality is the most effective predictor of student achievement in public schools (McCray & Chen, 2012; National Commission on Teaching and America’s Future, 1996; Rice 2003; Wright, Horn, & Sanders, 1997). Teacher preparedness and content expertise are also reported as an essential role of an educator to properly facilitate learning within the classroom. In fact, Darling-Hammond (2000) and Ferguson (1991) found that teachers expertise, specifically qualifications accounted for more increase in student achievement than that of socioeconomic status. In 2002, Podgursky reported that teachers with appropriate credentials, professional development, and classroom practices could counterbalance the impact that socioeconomic disadvantage has on student learning.

In addition, teacher education proponents have reported that positive connections exist between teacher certification status and student achievement (Darling-Hammond, 1999, 2000; Felter, 1999; Laczko-Kerr & Berliner, 2002). In 1999, Darling-Hammond reported that states with the highest amounts of certified teachers, also had the highest student results on the National Assessment of Educational Progress. In 2002, Laczko-Kerr and Berliner reported that students whom received instruction by highly qualified certified teachers performed significantly better on state assessment in the areas of language arts (including reading) than those taught by teachers whom lacked credentials. As reported in 2005 by Mary T. Browell, Dorene D. Ross, Elayne P. Colón, and Cynthia L. McCallum, the importance of teacher certification, and teacher quality directly related to teacher preparation have been reported since the 1980’s. These include such reports as A Nation at Risk (National Commission on Excellence in Education, 1983), A Nation Prepared (Carnegie Task Force on Teaching as a Profession, 1986), Tomorrow’s Schools
of Education (Holmes Group, 1995), A Call for Change in Teacher Education (National Commission on Excellence in Teacher Education, 1985), and What Matters Most: Teaching and America’s Future (National Commission on Teaching and America’s Future, 1996). In Valli and Rennert-Ariev’s (2000) review of nine of these reports, they reported the strongest consensus was the importance of disciplinary preparation (content) and multicultural emphasis. In 2002, the U.S. Secretary of Education, (U.S. Department of Education, 2002), claimed that a teacher’s subject matter knowledge is a key factor in improving student achievement. As the importance of teacher preparedness and content credentials has been established within the research community, we must look to those whom will receive instruction to ensure that educators understand their content and their instructional audience. We must also determine if educators have adapted to the changes that have taken place over the past decade from a content, pedagogical, and special education context. In recent years, the data suggests, that more student with disabilities are now receiving instruction in an inclusive education setting than ever before. To understand the inclusion model and how prepared educators are to teach in this context, it is imperative to understand its history, trends and current usage in today’s public schools.

Defining Inclusion

Ferguson (1996) defined inclusion as a movement aiming to create schools that have the capability to meet the individualized needs of all students by establishing learning communities that contain students with and without disabilities. He also emphasized that these students should be educated together in age-appropriate general education classrooms. The main goal of inclusion is to ensure that students with special needs are appropriately integrated into the general education setting for as much time as possible, given them with the individualized supports and strategies necessary to be successful. Some of the more implemented strategies that
are used in the inclusion model are co-teaching, consultative services, paraprofessional support, modifications to curriculum or testing, and individualized accommodations for specific disabilities. These strategies have the end goal of providing special education students with access to the district curriculum in a general education classroom.

The necessary considerations when determining the appropriate placement of a special education student into an inclusive environment include matching the student’s ability, required modifications, and Least Restrictive Environment. The Inclusive environment will not always be appropriate for all students with disabilities. To ensure the success of a specific special education student, available pedagogical and behavioral services are critical to consider prior to an official placement. An example of a pedagogical service is differentiation. This is a critically important pedagogy to help children with disabilities succeed in an inclusive classroom. Since the inclusive classroom often contains students with varied abilities, differentiation affords various levels of activities, while at the same time employing a variety of strategies to meet the needs of all students with different abilities.

Teacher training is also an important component for the success of students with disabilities in an inclusive environment (Bakken, 2016). Prior to a placement of a special education student into an inclusive classroom, Bakken suggests that the IEP team needs to answer the following questions: What training does a general education teacher have working with students with disabilities? How might the special education teacher support the general education teacher and the student with disabilities? He emphasizes that “for inclusion to be successful, special educators and general educators need to work closely together and compromise. It definitely requires that teachers have training and support to overcome the challenges together.” (Bakken, 2016, p.13)
Legislation and the inclusion shift has relocated children from self-contained to inclusive classrooms. This shift “has had a serious impact on the roles and responsibilities of teachers. General educators are responsible for the performance of growing numbers of diverse students in their classroom” (Green & Casale-Ciannola, 2011, p.12). Teachers in inclusive settings mostly support the amount of student access to learning experiences that inclusion requires; however, teachers characteristically identify themselves as unprepared to deliver educational concepts to students with disabilities. (Bender, 2008; Bender, 2002; Bender & Shores, 2007). When placement is appropriate, and teachers are skilled, inclusion is an educational model that can positively impact all students and ability levels within a general education setting. Over the course of the past 10-15 years, inclusion research “has produced positive benefits academically and socially for students with and without disabilities, but the key is that teachers need to be prepared (through education and training) and have time to (Co)plan” (Bakken, 2016). With the current state of education’s focus on STEM education, and with the inclusion model in full swing, it is important to understand STEM education’s history, trends and status to better analyze STEM education teacher’s preparedness in their content area and instructional abilities for students with disabilities in an inclusive context.

STEM Education

Since its conception, education has traditionally been subject to change and redevelopment. Factors that have contributed to the continuously changing systemic and classroom landscape include the rise in population of students with disabilities, multicultural diversity, recognition of different learning preferences and diverse intelligences, as well as rapid societal and technological changes (Gregory & Chapman, 2002). Over the past decade, one such educational-based systemic and pedagogical shift is the move away from the traditional approach
to education where subjects are taught independently to a focus on implementing STEM education as an integrated approach to teaching Science, Technology, Engineering, and Mathematics subjects. The combination of the increase of Children with Disabilities and shift towards STEM education within our current educational system has given rise to an unprecedented number of inclusive classrooms within the STEM disciplines. To understand the full breadth of STEM education’s role in educational reform it is important to understand the history of STEM education and the major systemic events since its conception.

In the past there have been many reports constructed and delivered by the scientific community regarding educational reform and new instructional approaches. Many of these have received formal consideration in the creation of legislation, and some were even incorporated into proposals that were eventually passed by congress. Regarding STEM education policy, much of the scientific contributions have dealt with five key areas: “improving elementary and secondary preparation in math and science, recruiting new elementary and secondary math and science teachers, retooling current math and science teachers, increasing the number of undergraduate STEM degrees awarded, and supporting graduate and early-career research” (Kuenzi, 2008, p. 30).

As the United States Administration’s comprehensive effort to improve STEM education becomes more explicit and of priority, so do the initiatives to support these efforts. One major instigator for these changes comes from the passing of the America COMPETES Act Reauthorization in 2010 which outlined and put into action five articles devoted to STEM disciples and included one specific to STEM Education support programs. This act was the driving force behind the legislations that followed. In the February 2012 report titled *Coordinating Federal Science, Technology, Engineering, and Mathematics (STEM) Education*
Investments: Progress Report, the Federal Coordination in STEM Education Task Force Committee reacts to the passage of the America COMPETES Act Reauthorization of 2010 by creating the National Science and Technology Council Committee on STEM Education (CoSTEM) which was assigned to create a five-year widespread governmental strategic plan. Prior to this passage it was reported by researchers and acknowledged that the U.S. government lacked a strategic plan to implement STEM education into our current systems. As this document describes early stages of this plan, it outlines its first steps of accounting for all Federal investments in STEM education, identified overlap in agencies STEM education goals, and outlined goals and tactics to organize Federal investments in STEM education around these goals. The main purpose of this publication was to outline a plan for the overall future direction of STEM education in the United States.

Another reaction to the America COMPETES Act Reauthorization of 2010 was the February 2012 Report to the President titled Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics. As the America Competes Act stressed the importance in “Development of recommendations on the following: (i) How the United States should invest in human capital. (ii) How the United States should facilitate entrepreneurship and innovation. (iii) How best to develop opportunities for locally and regionally driven innovation by providing Federal support.” (America Competes Act, 2010, p. 57) This Report to the President “provides a strategy for improving STEM education during the first two years of college that we believe is responsive to both the challenges and the opportunities that this crucial stage in the STEM education pathway presents.” (Report to the President, February 2012, p.7) Therefore making these called upon recommendations regarding human capital that are both locally and regionally driven by innovation.
In reaction to the America COMPETES Act of 2010, it was stated that the Federal Coordination in STEM Education Task Force Committee on STEM Education would have a completed five-year strategic plan by spring 2012 (Coordinating Federal Science, Technology, Engineering, and Mathematics (STEM) Education Investments: Progress Report, 2012, p.12). The purpose of this report was to provide a five-year plan to congress with an overview of the importance of STEM education in the areas of scientific discovery, innovation, job preparedness, and overall citizen STEM-literacies. It outlined a roadmap for five key areas that the federal government can employ a strategy to lead major improvement over the course of five years. The five key areas identified by the document where to: “1.) Improve STEM Instruction 2.) Increase and sustain youth and public engagement in STEM 3.) Enhance STEM experience of undergraduate students 4.) Better serve groups historically underrepresented in STEM fields 5.) Design graduate education for tomorrow’s STEM workforce” (5-Year Strategic Plan, 2013, p. 9-11). All of these key areas identified by the task force were reflective of the calls made for investing in human capital by the America COMPETES Act of 2010 as well as the scientific (research) contributions identified by Jeffrey J. Kuenzi in his 2008 CRS Report for Congress. Approximately one year later the Next Generation Science Standards (NGSS) (NGSS Lead States, 2014a) were published and required the integration of engineering design concepts within the science curricula. As of December of 2016, 18 states adopted these as standards to teach in their states, and engineering and design process became a formal part of science education.

All of these previous events and reports led to the “Every Student Succeeds Act” of 2015. The purpose of this Act was to provide the appropriate funding to support previous plans and identified priorities. They approved reform in school leadership through the passing of Title II-Preparing, Training, and Recruiting High Quality Teachers, Principals, or Other School Leaders.
This created provisions to increase alternate route teachers coming from industry, increase
differential pay to recruit and retain teachers in high-need academic subjects (STEM disciplines),
and develop and provide professional development to promote high quality instruction and
leadership in STEM and computer sciences subjects. This act also created federal funded support
for the advancement of STEM education and created a STEM Master Teacher Corps. This aimed
to support and federally fund the development of a state-wide STEM Master Teacher Corps for
state educational agencies and non-profit organizations in partnership with state educational
agencies such as “Change the Equation” whose aim is to connect industry and education. This
act also called for a “Well-Rounded education” which accounts for all disciplines, including
STEM disciplines. The call for investing in human capital is also explicit throughout this
document.

In the September 2015 Report to the President titled Prepare and Inspire the committee
sought to identify the most precarious priorities, which require fast action. They provided two
conclusions. 1.) “To improve STEM education, we must focus on both preparation and
inspiration. 2.) The Federal Government has historically lacked a coherent strategy and sufficient
leadership capacity for K-12 STEM education” (p.12). These conclusions call for the need to
prepare and inspire all students including girls and minorities to pursue STEM careers, and to
have a federal government with a coherent vision and funding commitment to scale proven
programs. This committee calls for shared standards in math and science, the recruitment of
100,000 great STEM teachers, rewards for the top 5% of STEM teachers, the use of educational
technology to drive student innovation, inspiration of STEM outside the classroom, creation of
1000 STEM-focused schools, and to ensure strong and strategic national leadership. The result of
these recommendations is clearly related to a STEM literate society through investment in
human capital by means of education.

In response to the 2015 Report to the President, Congress passed the STEM Education Act of 2015. This Act sought to provide a definition of STEM Education to include computer science as well as to include the use of federal funds (NSF) to support specifics mentioned in the previous report. Under this definition, grants could now support research and development of out-of-school STEM learning and informal STEM education. Use of funds for the research and development of learning and engagement in informal STEM education, innovative STEM learning models, increased engagement of K-12 students, teachers, and the general public, scalability of successful models and programs. Based on this decade long history of STEM education, and its mandated role in our education system, this initiative has had, and is going to continue to have an impact on how we approach instruction in STEM content areas for all student abilities.

STEM Education and Special Education

It is clear that over the past decade there has been an increased priority on STEM subjects within schools. There has also been an explicit shift from traditional subjects being taught independently of each other to a more interdisciplinary approach focusing on science, technology, engineering, and mathematics (STEM) instruction for all students, including those students with disabilities. Given this shift in focus one would expect that student performance would be rising in these areas for all student populations. In the general education population of students, we have not seen much of an increase in performance for STEM subject areas, and research shows that students with disabilities are still having much difficulty mastering STEM content (Basham, & Marino, 2013). In fact, in 2010 it was reported that Students with Disabilities are performing lower than their peers without disabilities in these academic areas.
which is leading them to become discouraged with STEM content as early as middle school (Marino, 2010). This is concerning as students with disabilities make up approximately one out of every eight public-school students in the United States with a graduation rate that is nearly 20 points lower than the average graduation rate for all students (Civic Enterprise, 2014). This makes students with disabilities with the second lowest graduation rate of all groups.

This is problematic from a societal perspective as it has been reported that there is an influx of STEM related jobs, and an increase in the number of science, technology, engineering, and mathematics jobs in the US specifically designed for students with disabilities (Basham, & Marino, 2013). Although many of the students with disabilities are highly capable to perform these jobs and their required tasks, many of the eligible students do not take the initiative to follow the STEM careers after high and college (Basham, & Marino, 2013). To ensure that students with disabilities are successful in STEM education and are better prepared to engage in the STEM-based work force, it is important to understand the research-based best practices and learning environments for STEM education to better understand how they align to the learning environments of an inclusion model.

**Best Practices for STEM Education**

The United States Department of Education (USDOE) published a 2016 report titled: *STEM 2026, A Vision for Innovation in STEM Education* which outlines interconnected components of an effective STEM education learning environments. In 2017, Ernst et al. provided a list of best practices to be used in Technology Education which has transferability to a STEM Education environment. The following examples were described by STEM 2026 and Ernst et al. as best practices for facilitating and conducting lessons in a STEM education and Technology education context.
1. Each lesson should utilize a variety of instructional delivery methods and should go beyond direct instruction. In a lecture format, teachers simply provide students with the pertinent information that they should know and “limit a students’ ability to predict, analyze, synthesize, and evaluate ideas and concepts (Ernst et al., 2017). To implement effective and integrated STEM education learning opportunities for students, they must be engaged in the lesson or concept being taught. Utilizing various instructional delivery methods an educator can increase student engagement. This multi-instructional approach allows educators to help students positively anticipate learning and teacher expectations and has been reported to increase pride in workmanship and active learning engagement (Ernst et al., 2017).

2. Prior to each lesson, teachers should make explicit connections between prior and subsequent learning by questioning students in the classroom. This can also be done by conducting a pretest to determine and connect prior knowledge with the concept they will learn.

3. According to STEM 2026 (2016), and Ernst et al. (2017) the promotion of higher-order thinking, and problem-solving skills is another best practice of STEM Educators. The STEM 2026 report lists “developing critical thinking skills” as a major outcome of its “Innovative Measures of Learning” component which encourages the assessment of students in a way that “provide insight into the mindsets and habits associated with academic and postsecondary outcomes, including those that can be drawn from observations, evaluation of portfolios of student work, and student demonstrations and presentations” (STEM 2026, 2016). Ernst et al. suggests that the promotion of higher order thinking and problem solving can be accomplished through providing students with active learning experiences and tasks. These tasks include analysis, synthesis, and evaluation. When students are actively engaged they “study ideas, solve problems, apply concepts, construct hypotheses, and make decisions” and “discover meaning and
organize experiences while bridging the gap between real-life work and school (Ernst et al., 2017, p.5).

4. Due to its integrated nature, it is a STEM education best practice to assess student knowledge before, during, and after the lesson, and can be multi-disciplinary as necessary. This has been reported to benefit both the students and teachers (Ernst et al., 2017). Depending on the context, varied assessment can be utilized ranging from informal to more comprehensive.

5. As in any classroom, it is best practice on the first day to communicate expectations for course requirements regarding quality/completion of work/assignments and should be reinforced with each task. This allows the students to understand not only teacher expectations, but also how detailed they need to be, assignment duration, and the format for what they need to submit.

6. In a STEM education classroom Differentiating instruction is a best practice and is essential for all students to be successful. “Differentiating instruction is essential to the classroom climate and the success of all students” as they are “uniquely different and complex (Ernst et al., 2017, p.5). To differentiate instruction effectively teachers must constantly tailor the curriculum in different ways to meet the needs of all learners. Ernst reports that differentiated instruction allows students to “utilize their strengths, learning styles, back-ground knowledge, and set individual learning goals (2017).

7. A critical best practice for STEM education is the act of integrating curricula. This can be accomplished by not teaching the content areas in isolation. Research shows that integrative approaches improve students’ interest and learning in STEM (Becker and Park, 2011). The STEM 2026 report includes the component of providing educational experiences that comprise of interdisciplinary approaches to solving challenges as a means of accomplishing the facilitation of an integrated curricula. Ernst et al. (2017) reports that although students may be highly
engaged in the building of structures, they would gain few, if any transferable skills and new knowledge without the act of applying intellectual effort and applying knowledge gained therein. An integrated curriculum allows students to be both actively engaged in the process to achieve concept mastery and utilize their skills from other disciplines. “When students integrate curricula, they can refine their technology skills, develop research skills, realize the connectivity and interaction among disciplines, actively learn, and assume authentic responsibility” (Ernst et al., 2017, p.4).

8. Active learning is a best practice in STEM education classrooms due to its ability to help establish content-based personal learning goals (Smith et al., 1992) while engaged in hands-on activities rather than passively receiving knowledge. Due to the hands-on nature of STEM education, these classrooms are naturally collaborative and lend themselves to providing active learning opportunities for students. STEM education lessons are intentionally created to facilitate student use of background knowledge to build meaning from new ideas and concepts. Active learning experiences come in many forms but include higher-order thinking tasks such as analysis, synthesis, and evaluation whereas students study a multitude of ideas, solve a variety of problems, apply new and old concepts, construct new hypotheses, and make informed decisions. “Active learning opportunities allow students to discover meaning and organize experiences while bridging the gap between real-life work and school” and “hands-on activities engage, reinforce, and extend the learning process” (Ernst et al., 2017, p.6). Active learning can be facilitated through the STEM 2026 reported component of “flexible and inclusive learning spaces” which are described as “adaptable to the learning activity and invite creativity, collaboration, co-discovery, and experimentation in accessible and unintimidating instructor-guided environments” (STEM 2026, 2016, p.8). Active learning has been reported to increase
examination performance by just under half of a SD and lecturing has been reported to increase failure by 55% (Freeman et al., 2014).

9. As STEM education is often unstructured and involves the use of potentially dangerous tools, classroom management is reported as a best practice and critical to student wellbeing, success, and setting a positive tone for the classroom community. In 2013, Love reported that “Safety and liability will continue to be an issue for STEM educators. The hands-on design-based learning nature of these courses will carry increased liability compared to many other content areas. This design-based learning methodology that defines STEM education must remain the crux of its pedagogical practices” (p.38). To accomplish student wellbeing, success, and setting a positive tone for the classroom community research suggests establishing and posting explicit rules and procedures for instructional expectations, safety, materials / equipment, and behavior with consideration of student input on the first day of class (Ernst et al., 2017). These rules should be enforced consistently with previously determined consequences. Proximity is reported as a multipurpose classroom management tool for use with a variation of problematic situations (Ernst et al., 2017). The establishment of proper classroom management increases learner satisfaction and leads to a positive learning environment. A positive learning environment is necessary in a STEM education classroom as it creates a classroom community in which students feel comfortable and confident while actively learning.

10. Ensuring learner satisfaction is a best practice for STEM education classrooms and is reported to be critical to both students and educators. Ernst (2017) reports that when engaging in STEM education pedagogies, students should feel satisfied that they are learning the concepts and getting value out of the course. He also highlights that a learning environment that is low-stress makes for more satisfied learners, and satisfied learners are more engaged and successful.
This is reaffirmed by the STEM 2026 report which highlights the importance of STEM-themed play, in which a student’s interest to design and create instigates curiosity in STEM fields. The process of exploration and discovery allows students to see that STEM is everywhere, that they have something to contribute, and the utility of solving real-world problems and challenges as a team (STEM 2026, 2016).

11. Collaboration is a critical best practice of STEM education (Smith et al., 1992) and has been found to increase critical thinking (Gokhale, 1995). The idea behind previous and current legislation regarding STEM education is to prepare our students for the STEM industry, which is collaborative in nature (STEM 2026, 2016). Ernst (2017) suggests that a teacher should create and facilitate collaborative learning opportunities for students on a daily basis and that this experience for students will “ensure that students are exposed to this necessary 21st Century Skill; permit more in-depth projects that require more time; and give students more opportunities to apply and enhance classroom learning” (p.5). According to STEM 2026, collaborative networks of STEM learning incubate the skills and growth mindsets across all learners that lead to lifelong learning and opportunities for postsecondary and industry success (STEM 2026, 2016).

12. One of the best ways to enhance students’ transferability of skills, and to create sustainable learning within a STEM education classroom is to ensure that they are actively engaged in their own learning process. Technology and STEM educators utilize best practices to help shape students into active and engaged learners who are well equipped in critical thinking, problem solving, and are proficient in transferring classroom concepts and knowledge to beyond the lesson. Research reports that students who are equipped at transferring skills to new experiences are more likely to become lifelong learners (Ernst et al., 2017).
In 2017, Ernst et al provided a guideline that Technology and STEM educators can utilize to see if they are successfully implementing best practice-based classrooms. STEM education best practices are in place when:

1. Instruction is varied and interesting.
2. Teacher is connecting students’ prior and subsequent knowledge.
3. Students demonstrate the ability to analyze, synthesize, evaluate, and apply concepts.
4. Learners are able to make predictions, problem solve, and think critically.
5. Assessment collected before, during, and after learning takes place.
6. Students understand expectations.
7. All levels of learners achieve success. Differentiated content, process, and product.
8. Integration of multiple relevant curricula into learning.
10. Classroom is designed with clear rules, consequences, and expectations.
11. Relevance exists between course concepts, real-world applications, and student interest.
12. Students are skillful and successful collaborators.
13. Actively engaged students in their learning process.

STEM education best practices should steer the environments in which they will be deployed. In understanding the big picture of STEM from a pedagogical perspective it is critical to analyze the research-based learning environments that host the learning of both regular and special education students. Although these learning environments are conducive for STEM education best practices, we must understand whether they are conducive for an inclusive STEM education context.
STEM Education Learning

STEM Education can mean many different things depending on its context and purpose. STEM Education as a learning object is defined “as a course, unit, or lesson that integrates two or more of the STEM areas (Ernst et al., 2017). In 2009, similar to Ernst’s definition, Merrill defined STEM Education as “A standards-based, meta-discipline residing at the school level where all teachers, especially science, technology, engineering, and mathematics (STEM) teachers, teach an integrated approach to teaching and learning, where discipline-specific content is not divided, but addressed and treated as one dynamic, fluid study” (Merrill, 2009). This definition depicts an optimal implementation in which a course is utilized to facilitate an integrative approach to STEM content. Although an Integrated Curriculum in STEM education can take many forms (Jacobs, 1989., Lake, 1994., Fogarty, 1991) research has reported that STEM Education learning environments should clearly contain the components of Learning Goals and Objectives, Theme and Essential Questions, Real-World Context and Authentic Problem, Purposeful Inclusion of Content, Purposeful Partnerships, Support of Critical Thinking and Problem Solving, and Performance Assessment (2010; Lake, 1994, Ernst et al., 2017). Below is a summary for each element as presented by the above-mentioned researchers:

**Learning Goals / Objectives:**

Research has reported the need for all curricula to be led by explicit learning goals or objectives. In this context, learning goals and objectives are statements that should be written which describe the knowledge and skills that students should be able to demonstrate at the completion of instruction. When creating these the teacher should design them to be focused on learning outcomes that are both actionable, and measurable.
Theme/Essential Question:
At the beginning of an integrated lesson it is important that a STEM education environment incorporates a purposeful theme or essential question. When the integrated lesson is united with STEM, it is suggested that the curriculum is developed around a theme or essential question, whereas the topic is the central focus of the integrated curricula.

Real-World Context/Authentic Problem:
STEM education environments should exuberate themes which are both relevant and provide students with a "real-world" context and authentic problem. Authenticity and real-world problems can be difficult to apply in a more traditional or singular discipline approach. Ernst (2017) reported that problems are more difficult for students to solve in fragmented or "siloed" courses because few real-world problems use only math, science, or technology. Using authentic problems is a method of engaging students and making learning more meaningful but requires an educator to consider the prerequisite knowledge that is essential for students to be successful. This approach also facilitates the “technology as values” approach where students learn about social impacts of technology and investigate ethical questions regarding technology and humans (de Vries, 2012).

Purposeful Inclusion of Content:
Research reports that when teachers provide inclusive STEM-focused experiences in an integrated fashion, students apprehend the significance and value in education which leads to a positive learning culture (Behrend, et al., 2014; Kearney- Rich, 2014). Therefore a STEM environment must be conducive for an integrated curriculum, therefore “must include content from more than one content area and/or discipline” (Ernst et al., 2017). Ernst reports that inclusion of content alone is not adequate for effective implementation and that content areas
must be intentionally included and facilitated with a high-level of integrity. In this case, the “content should be taught so that students see the specific interactions and connectedness between content areas and disciplines” (Ernst et al., 2017, p.3).

**Purposeful Partnerships:**

Partnerships are an important element of a STEM environment which uses an integrated curriculum. In many cases, educators are trained as content and pedagogy experts in only one discipline, therefore they often do not have the expertise necessary to facilitate learning in multiple content areas. According to Ernst et al., the act of partnering teachers with differing discipline expertise for the purposes of co-teaching or content/pedagogy mentoring is highly valuable and desired (2017).

**Supports Critical Thinking and Problem Solving:**

According to Ernst, a STEM education environment should use an integrated curriculum that engages learners in practices that encourage both critical thinking and problem solving. In 2013, the Next Generation Science Standards identified eight science and engineering practices (Achieve, 2013) that require the questioning and solving of authentic questions and require students to think in innovative ways. To accomplish this, Ernst suggests that the curriculum “must be designed to allow students to do that kind of work” and “students cannot be critical thinkers if they are not given opportunities to think critically about the content they are learning” (Ernst, 2017, p.5).

**Performance Assessment:**

Research reports that assessment in a STEM Education environment should be designed to measure a student’s understanding of authentic multi-disciplinary themes. In this approach to
assessment, Ernst (2017) suggests that learners should be assessed in a way in which they use the content knowledge and skills that they have developed. He emphasizes the idea that these assessments should be focused on performance. Examples include: demonstrations, technical drawings, prototypes, or portfolios. It was also noted that students should be provided with consistent and constructive feedback or formative assessment. According to Marzano in 2006, frequently used formative assessments are effective as it affords sound feedback, is encouraging, and shows student progress (Marzano, 2006).

To determine whether first year STEM educators are prepared to facilitate STEM education and inclusion-based best practices it is important to understand STEM educator’s characteristics, educational backgrounds, credentialing process and professional development participation.

**Teacher Education and Credentials for STEM Education**

The 2010 Association of Public and Land-Grant Universities report titled: *Improving State Need Assessments of Secondary Science and Mathematics Teachers: Challenges, Possibilities, and Recommendations* describes the current state of the United States licensure and credentialing process. In this publication, Allen reports that the credentialing and certification processes are similar in each state for Secondary Science, Math, and Technology. These processes are intended to specifically serve as an indication that an educator has fulfilled at the very least, the minimal requirements for content knowledge and teaching readiness that each individually state deems appropriate. These “endorsements” or “credentials” provide a confirmation that educators who have met a particular states requirement are authorized to teach specific subjects, and it serves as a quality control mechanism which assumes that educators without the designated endorsement lack the content background necessary to teach the subjects the endorsement allows. Therefore ‘licensure and certification would seem to offer precisely the
kind of ready signal of teachers’ core teaching competencies that is appropriate to a statewide assessment of teacher supply and demand” (Allen, 2010., p.3).

Allen (2010) also reports that the reality of licensure is “somewhat messier than the promise” (p.2). This is due to the lack of ability in licensure to accurately identify whether a teacher has the necessary knowledge and skill set to teach their credentialed subjects is compromised by the “relaxation of licensure standards in some states and by complexities – such as validity issues with licensure examinations – that plague the licensure process’ (p.2). This has led to strong and often justified criticisms of licensure practices in the United States. For licensure examinations, this means ensuring the assessments are valid and reliable while establishing and maintaining a passing score or “cut score” that is high enough to indicate appropriate intellectual and academic proficiency and adequate mastery of the subjects tested (Mitchell, 2001).

In terms of concern, Allen (2010) reports that in spite of these limitations and criticisms the Association of Public and Land-Grant Universities believe it should only become concerning if; 1.) a significant number of science and mathematics teachers in a state or in district are responsible for providing instruction for classes for which they lack proper credentials in all subjects they teach. 2.) if there is a substantial discrepancy in the number of questionably endorsed teachers between one school district and another. Allen (2010) reports that the Association of Public and Land-Grant Universities believe teacher licensure offers satisfactory potential for providing the quality dimension for a state assessment of teacher supply and demand to justify the detailed discussion of licensure and its challenges.

In terms of level of education, certification status, route, and qualification status, Ernst and Williams (2015) reported that “technology and engineering education teachers are less likely
to have a master’s degree and more likely to have a “bachelor’s degree or less” than that of all other teacher groups” (p.3). They concluded that technology and engineering education teachers “are less likely to hold a regular or standard state teaching certificate (85.6% vs. 91.3%), more likely to receive certification through an alternative certification program (21.6% vs. 14.5%) and are less likely to be highly qualified in all subjects taught (59.3% vs. 72.9%) than the category all other teachers” (p.5). This study also reported on the caseloads of technology and engineering education teachers specifically regarding the total amount of students served, learners with an Individualized Education Program (IEP), learners who are recognized as limited in English proficiency, and total service load of students with IEPs within their classroom environments. Ernst and Williams (2015) reported that technology and engineering education teachers had a statistically significantly larger caseload, categorical student load, and service load than “all other” educators. In fact, it was found that “technology and engineering education teachers have a caseload of approximately 92 students and the category “all other teachers” had a caseload of approximately 52 students” (2015) In regard to special education, “technology and engineering education teachers also teach more students with disabilities and have a higher service load than the category “all other teachers.”

The disproportionate amount of STEM alternate route placements and increased caseloads of special education students can be concerning from both a content and pedagogical perspective. It is important to analyze whether these STEM educators seek special education best practices offered outside of the standard coursework that many traditional route teachers are required to attend. Professional development offers a wealth of knowledge into the best practices of special education and can be attended by any subject area teacher who is looking to gain insight into student learning of special education students.
Special Education Professional Development for STEM Educators

In a 2015, Li conducted a professional development (PD) based secondary analysis of 3,385,170 valid cases from the 2011-2012 SASS TQ dataset administered by the NCES. She reported that Science, Technology, and Mathematics (STM teachers), especially science and technology teachers, had larger chance to teach students with disabilities yet only 30.52% participated in practice-oriented PD regarding students with disabilities. This is much lower compared to 38.78% of non-STM teachers. Li also reported that among the teachers who participated in the SASS TQ surveys, technology educators (TE) had the highest service load regarding students with disabilities. TE educators also were reported to have the highest percentage for participating in students with disabilities-based professional development (33 or more hours). Although this percentage was approximately three-times that of mathematics and science teachers, only 20.36% and 45.11% of TE reported that the PD was very useful. Science educators also reported high service loads of students with disabilities yet reported the usefulness of the PD lower than that of non-STM teachers. As schools in the USA are becoming increasingly inclusive (Ernst et al. 2014) and focused on STEM education, it is reasonable to suggest the importance of special education student’s ability to effectively participate in STEM learning opportunities. However, if students with learning disabilities are not effectively instructed it may prevent their participation in both STEM learning and future career endeavors.

To ensure special education student participation and meaningful learning in a STEM education context, teachers should be prepared to implement research-based instructional strategies and behavior management techniques. STEM educators should participate in special education-based PD as it has been reported that PD aligned with practice assists teachers in achieving student learning objectives and addressing misconceptions (Penuel et al. 2007). It is
not enough for STEM teachers to participate in a few workshops throughout their teaching career. In fact, in order for educators to make considerable change in their practice they need to participate in a significant amount of professional development in their targeted area (Wei et al. 2009). The fact that STM teachers tend to engage in fewer PD opportunities regarding students with categorical disabilities then the remainder of the teaching population (Li, 2015) is problematic. This poor attendance may be due to the quality and structure of special education PD offerings. In 2010, Wei et al. reported that national investments in teacher learning regarding teaching special education appear to be trending more towards ineffective short-term workshops, rather than more effective and routine-based workshops.

When the inclusive and integrative nature of STEM education is paired with the absence of required PD, it is reasonable to assume that students with disabilities are not being served at full capacity in STEM learning environments. Especially given that these classrooms are being led by STEM educators with a disproportionate credential process in Alternate Route and low attendance in special education PD. In order to ensure that special educators are equipped to (co)teach in a STEM education environment that is steered by STEM education best practice it is important to understand best practices that first year special educators have gained throughout coursework and are employing in the classroom.

**Special Education Instructional Approaches**

Among the popular instructional strategies that Special Education teachers possess as a result of teacher preparation programs are co-teaching, differentiated instruction, behavior management and the use of data to inform instruction. These have been proven over time to support the learning process of the inclusion of students with disabilities in general education settings.
Co-teaching Model

According to Friend and Cook, co-teaching “involves two or more certified professionals who contract to share instructional responsibility for a single group of students primarily in a single classroom or workspace for specific content or objectives with mutual ownership, pooled resources and joint accountability” (2003, p. 18). If implemented and used effectively, it’s purpose is to potentially bring the best qualities of both teachers together to increase learning for all students. The co-teaching model is utilized as an alternative to other special education placements such as resource room or pull-out instructional models. In this model the general education teacher uses their formal training regarding the classroom structure, academic content, and pacing of curriculum while the special education teachers can utilize their formal training to identify individual learning needs of students and tailor the curriculum and instruction to suit these needs (Zigmond & Magiera, 2001).

According to Martel (2009), there are three core objectives of co-teaching. The first objective is to “include a wider range of instructional alternatives”. This impacts student learning by utilizing both general education and special education strategies and styles to afford students within the co-teaching classroom an increased opportunity to understand academic concepts and content information presented in the classroom. Second, the co-teaching model is envisioned to “enhance the participation” of students with disabilities within the general education classroom. The third objective is the aim to “improve performance outcomes for special education students”. As the co-teaching model requires both teachers to work in sync to deliver academic instruction within one classroom, the determination of instructional responsibilities is decided by both the general and special education teachers. This joint decision approach to instructional responsibilities is critical in avoiding misunderstandings or conflicts between teachers and students alike. In 1996,
Walther-Thomas, Bryant, and Land reported that co-teachers should volunteer for this assignment and that effective co-teaching requires both teachers to have one opportunity per week to plan. The also reported that the appropriate distribution of responsibilities regarding instruction is imperative for successful co-teaching outcomes.

The Individuals with Disabilities Education Act (IDEA) of 2008 mandated that special education teachers that teach in a resource room placement are required to be highly qualified in core content areas (Council for Exceptional Children, 2008). However, the co-teaching or inclusion setting is an option that can be conducted without the requirement that every special educator be certified in multiple core content areas. This model affords general education students the opportunity to work with students on different ability levels and provides them with a better understanding of students whom possess various ability levels. Dover (1994) reported that the co-teaching model provides general education students with more opportunities to develop leadership skills, academic growth as well as enhance their sense of responsibility. From a pedagogy perspective, Friend and Hurley-Chamberlain (2007) reported when teachers in a co-teaching placement combine their knowledge in content, learning strategies, and classroom management, more learners can accomplish higher levels of proficiency. Co-teaching can also increase the social development and reading achievement of both at-risk students and students with disabilities, but general education students as well (Vaughn, Elbaum, Schumm, and Hughes, 1998). A major factor contributing to these reported increases is that students in a co-taught classroom benefit from having a second teacher whom can assist and offer support in the learning of all students. The co-teaching model is most frequently utilized for facilitating the inclusion of students with mild mental retardation, behavior disorders, and learning disabilities.
Although the co-teaching model is utilized by all grade levels k-12, it is mostly recommended for grades k-6 (Zigmond & Magiera, 2001).

Implementing Co-Teaching:

When implementing co-teaching, the State Education Resource Center (SERC) reports six common approaches which can be used throughout grade levels and disciplines. They report these six approaches as 1.) One Teach, One Observe, 2.) One Teach, One Observe, 3.) Parallel Teaching, 4.) Station Teaching, 5.) Alternative Teaching and 6.) Team Teaching.

The One Teach, One Observe model is comprised of one teacher delivering the instruction while the second teacher is observing student learning habits and concept understanding. This approach leverages having two teachers in a single classroom by intentionally having one teacher performing detailed observation of students whom are engaged in the learning process. In this model the co-teachers decide in advance the type of specific observational information to gather during the lesson, agree on a system for gathering the data, and a way to transfer and analyze observational data together afterwards.

In the second approach, One Teach, One Assist, one teacher takes primary ownership for teaching while the other teacher continuously circulates the classroom while unobtrusively aiding students on an as needed basis.

The third approach is Parallel Teaching and runs on the overall assumption that on occasion, student learning would be increased if students had more teacher supervision and more opportunity to respond to classroom questions and the presentation of academic concepts. In this model teachers share the responsibilities of both planning and instruction. Throughout the lesson
the teachers both cover the same academic information, but they divide the class into two groups and teach simultaneously.

The fourth co-teaching approach is known as Station Teaching. In this approach the teachers divide both the content and students. In small groups, each teacher teaches the content to one group and then repeats the instruction for the other group. The students rotate between the two teachers, who repeat instruction using various methods of learning. The planning and teaching responsibilities are shared. This approach can be enhanced if deemed necessary by the addition of a third station could which could provide students an opportunity to work independently.

The fifth co-teaching approach, known as Alternative Teaching is utilized when the occasion arises in which multiple students need specialized or individualized devotion. In alternative teaching, one teacher takes primary accountability for the instruction of the class while the other works with a smaller group or individual student for pre-teaching, enrichment, re-teaching, or other individualized instruction. Although this co-teaching approach allows for highly individualized instruction to be offered, teachers should be careful not to pull the same students routinely.

In the final co-teaching approach, Team Teaching, both teachers are delivering the same instruction at the same time and work as a team to introduce new content. They work together on developing skills, clarify information, and facilitate learning and classroom management. This approach is most dependent on teachers' styles. This approach requires mutual trust and respect between teachers and requires that they be able to network their teaching styles.

When using any of the presented approaches to co-teaching, teachers should consider students’ grade level, ability level, significance of disabilities represented, climate of the educational
setting, and administrative support. It is also very important to consider the instructional settings, modifications, support activities, and available assistive technologies. It is also important to note that all strategies and teaching models can be used as a singular tool aimed to improve student success in the classroom, or in combination with other strategies.

Regardless of which co-teaching model is adopted by both the regular and special education teacher, it important that differentiated instruction and behavior management is effectively utilized to meet class learning goals and create a positive classroom environment. First year special educators have completed coursework involving data informed instruction, differentiated instruction and behavior management (CEC, 2012). To understand the importance of these concepts for special education student learning, it is crucial to refer to the research community to identify trends and best practices for each.

Differentiated Instruction

To maximize achievement of general curriculum standards for students with disabilities it is critical to increase efforts to differentiate instruction in an inclusive classroom setting (Lawrence-Brown, 2004). Inclusive education does not separate students with disabilities whom are unable to keep pace with general education students without substantial support. This mixed ability setting makes differentiated instructional (DI) strategies a necessity, especially given the concurrent push for all students to achieve high standards (Lawrence-Brown, 2004). The push for high standards (NCLB, 2001) and the abundance of research documenting the importance of high expectations has raised the importance of teachers to maintain a high learning standard for special education students. Utilizing DI enables students with disabilities to access both the content and demonstrate what they've learned (King-Sears, 2001). The connection of high expectations and instructional support has been associated with success for students at risk of
failure (Lee & Smith, 1999). With DI and appropriate supports, intended benefits of inclusion for students with disabilities can be realized (Lawrence-Brown, 2004).

Students with Disabilities have learning needs that vary from individual to individual and can be quite drastic from their classmates in an inclusive classroom environment. In today’s educational system providing DI to meet these student’s learning needs is more challenging than ever due to the sheer fact that the population of students with disabilities is rapidly increasing. DI is defined by Dombek and Conner (2012) and Tomlinson (1999) as an educational plan that encompasses a variety of lessons plans and tailored curriculum selection that meets students’ readiness, language skills, comprehension abilities, academic skills, and cultural differences. The goal is to maximize each student's development and individual accomplishments by meeting his or her learning needs and fostering further academic growth (Dombek & Conner, 2012; Tomlinson, 1999). To effectively utilize Differentiated Instruction as an approach inside the classroom, students need to be able to demonstrate autonomy and self-direct their learning. According to Andrew Rotherham and Daniel Willingham (2010), “We don’t yet know how to teach self-direction, collaboration, creativity, and innovation the way we know how to teach long division” (p. 19). These authors suggest that educators’ understanding of curriculum, content, and assessment must improve before they can better implement differentiated instruction. The authors also emphasize that knowledge and skills are interconnected. They conclude that if we do not connect knowledge and skills, the 21st century skills movement may become another fad that ultimately changes little or results in setbacks to the mission of creating more powerful schools.

Many teachers struggle to provide every student with learning opportunities that are individually designed due to the fact that what works for some students will not work for others
(Berliner & Biddle, 1995). As teachers attempt to adopt new instructional approaches to adapt to a shifting educational landscape and rising diverse population, it is becoming increasingly difficult for them to excel in their teaching responsibilities, utilization of best practice, and in meeting the diverse needs of their students. Many schools in the United States currently utilize mixed ability grouping of students which combine all types of abilities and diversities into a single classroom. This model can be overwhelming and perplexing for teachers in their mission to meet the academic needs of all students in their classroom. This mission can be even more cumbersome when aiming to reach students with disabilities in a mixed-ability STEM-based inclusive setting.

The Individuals with Disabilities Act (IDEA, 2004) asserts the school’s duty to ensure that students with disabilities have access to the core curriculum of general education in the least restrictive environment. Although IDEA aims to assist special needs students in their educational journey, teachers may have students in the same class whom have been identified as exceptional learners whom expect and require an academically demanding and stimulating setting to stay engaged, motivated, and to grow academically. Given current practices and tools for differentiation in a mixed-ability setting, many teachers succumb to the time consuming high demands necessary to provide individualized learning opportunities for such a diverse and distinct group of learners. Differentiated Instruction is reactive, as it is intentionally developed and implemented to meet unique individual student needs across grade levels, subject areas and student populations. To employ DI effectively teachers not only must consider, and tailor differentiated content and assessments to the ability levels concerning diversity, exceptional learners, students with disabilities, and students at grade-level, but they also must employ a strategy to facilitate this process. Given the mixed-ability element within an inclusive classroom,
it is reasonable to suggest the importance for students with disabilities to be able to make use of their tailored content in an effective and meaningful way.

Self-Directed Learning (SDL) is one strategy to facilitate DI within an Inclusive educational setting within a Public-School structure given its focus on the child taking ownership of their learning. One of the most accepted definitions of SDL was presented in by Malcom Knowles (1975), where he describes SDL as “a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes” (p. 18). In spite of the emphasis on the word “self” Knowles (1975) proposed that SDL often involved others such as teacher, mentors, and even friends as supporters in the learning process. It is critical to ensure that the strategic plan is versatile and appropriate for the student and that they can be successful without direct facilitation of the concepts. SDL is a theoretical perspective that attempts to explain how people can address their own learning needs and takes steps towards meeting those needs. Teaching SDL has many challenges in today’s classrooms as it” appears the advent of state organized and supported schools with their increasing structure and emphasis on teacher-directed instruction did much to weaken the idea of learner responsibility” (Long, 1996, p. 1).

Teacher-directed learning and whole-class instruction may lead many students with disabilities to feel isolated, disengaged and frustrated. In 2013, the national average graduation rate for students with disabilities hit 61.9 percent, nearly 20 points lower than the average graduation rate for all students (Civic Enterprise, 2014). Of all student subgroups measured by the National Center for Education Statistics, students with disabilities have the second lowest graduation rate. This drop-out rate could be a result of the fact that research studies have reported
that general education teachers almost exclusively rely on whole class instruction (Avramidis, Bayliss, & Burden, 2010; Clampit, Holifield, & Nichols, 2004; Santoli, Sachs, Romey, & McClurg, 2008; Scruggs, Mastropieri, & McDuffie, 2007), which has been found to be an ineffective approach for engaging many students with disabilities. These reports also indicate that teachers have not been trained in differentiation strategies.

Schools and teachers are also faced with relatively new challenges related to the rapid increase in the use of technology outside of school, new technological tools for learning, the ever-widening varied ability levels of learners, and the sheer increase in special education students (Ernst, 2015). It has now become more important than ever to consider these factors when determining the best way to employ differentiated instruction aimed to meet these diverse learners and to provide them with a unique and academically tailored experience. Since 1996, much has changed in terms of what is known to be best practice within our schools, but many schools are still teaching content in the same way. These schools are still practicing direct instruction in a race to perform on standardized testing. Given the abundance of resources now available online, is it time for these schools to pass the torch of content knowledge delivery to search engines such as Google and media outlets such as YouTube, and provide our students with a process to Self-Direct their own learning?

The shift to adapt to the information age has required rapid social and technological changes, and consequently, people now more than ever before need to be able to direct their own learning. To provide learners with experiences for directing their own learning, schools will need to move away from teacher-directed learning. This would likely help schools provide students with the skills and knowledge they require to be successful, thereby helping to affirm schools’ importance in the role of preparing people to be productive members of society. It is necessary
for students to continually update their own knowledge and skills in order to meet the demands of today’s schools and industries. This type of “lifelong” learning is important during the technologically complex information age, a time during which our economies will no longer rest on agriculture, industry, and manufacturing, and our mental capabilities will be the focus (Reigeluth, 1997). People must be able to adapt to current societal changes and be able to self-direct the process of developing their own knowledge and skills as “the ability to be a self-directed learner is a requirement for all adults in a rapidly changing, technologically-complex society” (Oddi, 1987, p. 21).

Today’s digital society has information expanding in an ongoing information bang resulting in the birth of technologically well-equipped digital natives with diverse learning needs. In this setting, learning assistance and collaboration is more likely than ever before to involve not only individuals within our proximity but also individuals from around the world. This includes both Internet connected teachers and students alike. Online collaboration has already become a natural phenomenon for learners of all levels whereas assistance of digital and connected partners who may sit on another continent cannot be ignored or undervalued. Utilizing connective collaboration via social net-works such as EdMODO, facebook, LinkedIn, Twitter, and production tools such as YouTube, Flickr, iMovie and Prezi, learners in all age groups have the ability to collaborate, create and share content, share ideas and establish new social learning platforms such as on Wikispace or blogs. Bryan (2015) reported that ‘the collaboration in the digital world does not take away the benefits of self-direction; rather it heightens the need for individuals to succeed together” (p.43). He suggests that connected collaboration ironically increases the need that learners become self-directed because they can utilize gained collaboration tools and skills such as accumulated knowledge, experience, making meaning of
what they learn, working in a team to better seek their own knowledge. This provides them with a distinct perspective on learning as they begin to make sense of the world through interpersonal social lenses (Bryan, 2015).

Tomlinson (2001) reports that differentiated instruction can occur when a teacher or facilitator focuses on four major components of instruction. These include the process by which students learn, the products or demonstrations of their learning, the environment in which they learn, or the content they are learning. Taylor (2015) identified three components of Differentiated Instruction. These three include Content, Process, and Product. She defined Differentiated Content as “a teacher’s ability to vary the level of complexity of content” (p.14), Differentiated Process as “a strategy in which teachers can vary the learning activities based on the students' interests or learning styles” (p.14), and Differentiated Product as “a strategy in which teachers provide students with a choice in how they demonstrate what they have learned (Taylor, p.14).”

In both cases, it is important to note that differentiating the process by which students learn, the products or demonstrations of their learning, the environment in which they learn, or the content they are learning are not independent of each other, rather they are interrelated and interdependent. Tomlinson (2001) states that these components could, and indeed sometimes should, affect one another. The concept behind the importance of these relationships comes from the fact that children bring a range of valuable cultural and linguistic experiences to school that may be similar or dissimilar to those of the teacher or other children in the classroom and no particular style of learning should not be considered more important than others (Terry & Connor, 2012).
DI gained much focus and momentum for exception learners with the reauthorization of the Individuals with Disabilities Education Act (IDEA, 2004) and its introduction to the Response to Intervention (RTI). IDEA reported RTI as a strategy to implement differentiated instruction by capitalizing on a student's' abilities by acting strategically responsive to specific student needs. RTI assumes that teachers differentiate as a matter of course, within both the context of the general classroom and within the context of more specialized and targeted instruction and intervention such as the case when working with exceptional learners. Differentiated instruction and its component Differentiated Content is used as a tool in the process of providing and facilitating a RTI approach (IDEA, 2004).

The driver of differentiated instruction is that because every child learns differently, and every child is different, the most effective instruction is designed to fit each learner (Connor et al., 2011). When taking on this perspective of differentiation, it is critical to understand the role of the teacher as an informed decision maker and creator of differentiated learning. Effective differentiation is not found in a boxed program. Rather it is found in the strategic and intentional decisions teachers make inside their classrooms. These decisions should be based on teachers understanding of the learning process, in-depth knowledge of their students and their abilities, consideration of a variety of effective pedagogies supported by research, and the ability to select and deliver appropriate content, materials, and methods to suit specific students as they engage in particular learning activities.

Due to the fact that every student is different, deciding on a differentiation strategy can be challenging. Strategies can include modifying the process, the materials, the content, the environment, the product, changing the knowledge exchange process between the teacher and the student (Direct Instruction vs Self Directed Learning) or a combination of all of these. When
utilizing these strategies, it is critical to offer a range of opportunities for learning and materials that best suited the strengths, learning abilities, level of understanding, needs, and interests of groups of students. The process of facilitating differentiated instruction is not a single strategy, but rather a unique approach to teaching that involves a variety of strategies.

Although there are many ways to implement differentiated instruction effectively, there are some major considerations to consider when planning to utilize this approach. They include assessing the student carefully and routinely (data informed instruction), deciding on differentiation strategy, organization of learning and students (behavior management), matching ability to content level, and gradual release of responsibility (behavior management). Assessing students carefully and regularly using a variety of formative and informative assessment tools, then analyze resulting data to determine patterns of need and group them accordingly. This can be incorporated through running records, record keeping, and conferencing with students. These are all attempts to not only get know your student both on a personal and academic level including their interests and learning styles, but also to understand their skill level in a particular concept. This information is valuable and can used to motivate a learner, match differentiated content to learning style, and intentionally design an instructional plan.

**Classroom Management and Classroom Discipline**

As much research has indicated over the course of the last decade, students with disabilities who lack on-task skills frequently struggle in inclusive classrooms which are not geared to accommodate individual behavioral and learning needs. It has been reported that these students can find success when teachers implement behavior management techniques such as self-monitoring (Clampit, Holifield, & Nichols, 2004; Kilanowski-Press, Foote, & Rinaldo,
Attention deficit hyperactivity disorder (ADHD) can impede a student’s ability to stay on task and attain new skills presented in an educational environment (Barkley, 2006; Dunlap, 2009; Heward, 2013; Mesibov & Shea, 1996) as well as include disruptive behaviors that frequently cause educators to separate students whom exhibit them (Salend & Duhaney, 1999; Santoli, Sachs, Romey, & McClurg, 2008). Students whom have been classified with ADHD regularly struggle staying on-task due to disabilities related to processing sensory stimuli, integrating academic concepts with their daily relevancies, and adapting to unpredictable schedules (Heward, 2013; Mesibov & Shea, 1996). Difficulties with attention span, impulsivity, disorganization, and distraction are all characteristics of students with ADHD that have the most impact on their ability to stay on-task in a classroom (Barkley, 2006; Carbone, 2001; Reiber & McLaughlin, 2004).

One way to increase on-task behaviors for students with disabilities is to employ common behavior management strategy self-monitoring. Self-monitoring is a common behavior management strategy used by special education teachers. Mitchum, Young, West, and Benyo (2001) reported self-monitoring as being an effective strategy for helping students with disabilities increase their academic performance and attention behaviors. This strategy is student-centered and can be used to positively impact on-task behavior of students by encouraging them to monitor their own behavior. Students whom exhibit behavioral and academic difficulties in many cases also have inadequate awareness and understanding of not only their own behavior, but also its impacts on others in the classroom. Research has reported that self-monitoring interventions provide students with the ability to identify and keep track of their own behavior.
(Hoff & DuPaul, 1998; Rhode, Morgan, & Young, 1983). When students are implementing self-monitoring, they can learn to identify and increase positive, pro-social behaviors. In 2001, it was reported that self-monitoring interventions are amongst the most versatile, useful, and effective strategies for students with academic and behavioral disabilities (Mitchum, et al., 2001). The main premise surrounding self-monitoring is that it strategically encourages students to become more independent, which allows students with disabilities to rely less on prompts from teachers (Koegel, Koegel, Harrower, & Carter, 1999).

**Background**

Maag (2004) reported that self-monitoring can be successfully utilized with special education students, including autism, cognitive impairments, learning disabilities, and attention deficit hyperactivity disorder and is effective in facilitating an increase in both academic and social behaviors. The versatility of self-monitoring is that it extends itself to general education teachers as well. Ganz and Sigafoos (2005) reported that self-monitoring has been utilized successfully in both general and special education contexts and has been found to improve behaviors in individuals with both mild and severe disabilities. A 2006 study conducted by Peterson, Young, Salzberg, West, and Hill analyzed and reported the impacts of self-management. They reported that all students involved in the study demonstrated an increase in their usage of targeted social skills and a decrease in their off-task behavior post the implementation of self-management.

When implemented with proper preparation and intentionality, self-monitoring techniques can reduce teacher frustration and will insure greater academic achievement of students. According to the Center for Disease Control and Prevention, “in 2011-2012, approximately 237,000 children 2-5 years of age had an ADHD diagnosis, based on parent
report. This is about 57% higher than the estimate for 2007-2008. Among these children, only about 50% received behavioral treatment for their ADHD” (Danielson M. et al., 2017). The sheer magnitude of the ADHD population and trend suggests that inclusive classrooms have seen an increase in ADHD students within the United States educational system. Students with this classification may work at slower rates compared to their general education classmates, present work that is below their level of ability, and/or demonstrate the inability to stay on task. This is not due to lower brain functioning rather a result of student difficulties with inhibitory control. Multiple studies have reported a connection between academic performance and behavior management strategies such as self-monitoring for students with ADHD. In fact, it was reported that eighty percent of students with ADHD academic performance issues were due to the lack of their self-monitoring ability (Barkley, 1990; Davies & Witte, 2000; Frick, Kamphaus, Lahey, Loeber, Christ, Hart, 1991; Reif, 1993). These reports also indicate that when teachers properly implement student-centered self-monitoring strategies, student academic performance rates and appropriate behavior increase significantly. Students with attention disorders function better when presented with feedback (Barkley, 1990). At the height of a successful self-monitoring strategy students are able to independently provide themselves with feedback. This removes negative attention from teachers and provides more attention for positive behavior.

**Implementation of Self-Monitoring: Behavior Management**

The best method of implementing and structuring a self-monitoring strategy can differ from researcher to researcher as it has been reported that there are many ways to structure self-monitoring interventions (Vanderbilt, 2005). For this study I have adopted the structure of Lane et al. (2009) whom presented the field of education with five steps necessary to properly implement a self-monitoring program. I chose this structure due to its emphasis on the balance
between “scientific rigor and feasibility within the classroom context” (Lane et al., 2009). The five steps as described by Lane et al. are detailed below.

Step 1: Identify and Operationally Define the Behavior of Concern

Identifying the target behavior is the first step in setting up any successful self-monitoring intervention. In this step, the teacher and student discuss and may perform a roleplay activity for what the behavior looks like to ensure that both parties agree on the description of the behavior. Once the target behavior is agreed upon, it is recommended that the teachers and students role-play the appropriate replacement behavior. When evaluating a target behavior for use in a self-monitoring program it is critical to first identify if the behavior occurs as a result of an acquisition deficit or performance deficit. If the student cannot understand and perform the desired behavior, this is considered an acquisition deficit. A performance deficit is when a student knows how to perform a behavior but does not do so. In the case that the target behavior selected is the outcome of an acquisition deficit, the student must first be taught a new skill to replace the target behavior, and then learn how to self-monitor the use of the skill (Project REACH, 2008). In regard to managing behaviors in a classroom, it is recommended that teachers not solely focus on problem behaviors but also focus on improving academic performance as it has been reported that students whom are academically engaged and learning meaningful skills will be less likely to engage in undesirable behaviors to avoid both simple and challenging tasks (Lane, 2004; Umbreit, Lane, & Dejud, 2004). In 1992, Smith et al reported that a self-monitoring procedure can positively affect not only classroom behavior, but also the quality and quantity of students’ work (Smith et al., 1992).

Step 2: Design the Self-Monitoring Procedures, Including a Monitoring Form
The creation of a simple self-recording data sheet which indicates the chunks of time to be monitored is recommended as the next step. Lane reports some of the benefits of breaking the day up into smaller chunks is that it makes the tasks less daunting for both the student and teacher, enhanced ability to reward the student in at least one of the time periods and affords the teacher with information about when the behavior is most likely to occur. These benefits ultimately enable the educator to better support the student with prompts or reminders.

Step 3: Teach the Student the Self-Monitoring Procedures

For the student to effectively facilitate self-monitoring they will need instruction on how to complete the teacher created form. To accomplish this, researchers have suggested the use of modeling, coaching, and roleplay when explaining the process to students (Lane, Weisenbach, Little, Phillips, & Wehby, 2006). To keep the target behavior at the forefront of a student’s mind it is suggested that teachers remind students at the start of each time-period. Teachers and students should work together to set a goal and select the reinforcement. Once the reinforcement is co-selected, teachers can redirect the student when necessary by providing a gentle reminder of what a student is working for. When selecting reinforcers, it is important to consider the function that is being served for the target behavior (e.g., avoiding tests or quizzes). Then, for maximum effectiveness the teacher is suggested to address that same function with reinforcement when the desired behavior occurs (Umbreit et al., 2007).

Step 4: Monitor Student Progress

Monitoring the students’ progress utilizing the data collected before and during the self-monitoring process is reported by Lane to critical in tracking student progress. Prior to intervention, utilizing the record forms created specifically for the targeted behavior, the teacher needs to identify the student’s baseline status. In doing this the teacher can have a clear view of
the magnitude of the problem. Throughout the implementation, it is suggested that the teacher use the form, report the target behaviors, and compare it to the student’s completed form to check and reward accuracy (McLaughlin, Burgess, & Sackvill-West, 1981). Monitoring and analyzing this data unveils parts of the plan that may need to be modified (Vanderbilt, 2005). Having the students track their own progress and see progress in a concrete fashion has been reported to promote intrinsic reinforcement for improvement (Carr & Punzo, 1993). If a student is found to be misrepresenting their behavior the teacher is suggested to speak directly to the student regarding the importance of accuracy, double check their forms, and readjust the reinforcements.

Step 5: Maintenance and Follow-Up

The main goal of self-monitoring is for the student to significantly decrease or remove the target behavior altogether and become independent of a form. Once the student has successfully improved academic and/or behavioral performance through self-monitoring on a daily basis, researchers suggest that self-monitoring should be gradually faded (Vanderbilt, 2005). The fading out of self-monitoring will be different for each child. Common fading strategies are lengthening self-monitoring intervals, matching less frequently, self-monitoring for fewer periods, or removing it altogether (McLaughlin et al., 1981). Intermittent, specific verbal praise and some reinforcement is still suggested by Lane after self-monitoring is phased out.

Behavior Management in the Digital Age: Teacher and Student Gaps

It would be reasonable to suggest that understanding your student’s generational characteristics and influences should be considered throughout the creation of any behavior management plan. Prensky (2001) argued that today’s students have not just changed slightly from those of the past, nor have they simply changed their verbiage and clothing styles, as has
mostly happened across previous generations. Many of today’s students, Kindergarten through university represent some of the first generations to grow up with new technologies and vast content knowledge at their fingertips. This generation’s familiarity and instinctive nature in utilizing technology in their everyday lives allows tools such as Smartphones, tablets, YouTube and Google to provide essential and limitless learning utility in today’s classrooms with little instruction. Prensky argues that because of this technology immersive environment, and the sheer volume of their interaction with it, today’s students think and process information fundamentally differently from their predecessors. He defined this change as a discontinuity resulting from a “singularity”. He defines this singularity as “an event which changes things so fundamentally that there is absolutely no going back” (Prensky, 2001, p.1). He identifies the cause of “singularity” to be rooted in the arrival and swift distribution of digital technology in the last decades of the 20th century, which gave birth to a new type of student, termed “digital native”. This term is also commonly referred to as the Net Generation (Oblinger, Oblinger, 2005, p. 1.2), and Millennials (Taylor 2007). Although the dates vary from author to author, the characteristics attributed to this new generation blend easily from author to author due to the fact that most of the characteristics are founded on the access and utilization of technology and the internet. Prensky (2001) identifies the single biggest problem facing education today as our Digital Immigrant instructors. He identifies them as a mix of teachers and older students. He reports that these instructors often speak an outdated pre-digital age language, and many times struggle to teach a population that speaks an entirely new and distinct language. This student – teacher disconnect is a critical area to investigate as traditional research has continued to find that teacher quality is the most effective predictor of student achievement in the classroom (McCray & Chen, 2012; National Commission on Teaching and America’s Future, 1996; Rice,
This disconnect seems to perpetuate the ever-widening learning gap in today’s education system between how educators are prepared, how teachers approach instructing all student abilities, how students learn, and how students prefer to learn.

One important thought to note is that although Prensky’s 2001 publication is now sixteen years old, there are still “digital immigrants” working in education although their numbers are in decline due to the sheer fact of time. The New Media Consortium (2008) reported that parents, students, faculty, and school administrators continue to view and experience technology very differently and this also continues to widen the learning gap. This gap has resulted in Digital Natives of all classifications often feeling as though “we’ve brought in a population of heavily accented, unintelligible foreigners to lecture them” (Prensky, 2001, p.2). Many times, there is a disconnect between what the immigrant instructor is saying and what the native is understanding. This can have an impact on student behavior in the classroom, as well as how teachers plan to implement behavior management strategies in the classroom. As the United States’ educational student landscape continues to change and adapt to the rise of new technological resources and educational approach research, it is imperative for educators to understand the utility that new STEM Education-based approaches and new resources emit, as well as their utility within the classroom relative to the differing learning groups, student populations and behaviors.

This teaching-learning gap is further widened and compounded by the drastic increase in diverse and Special Education students within the Digital Native community. Reports have indicated that by the year 2020, minority students will account for 56% percent of the nation’s public high-school graduates, and African Americans, Asian Americans, and Hispanics recently comprised more than 79% of the student population in United States elementary schools (Davis, 2012). In addition to increased diversity, students with disabilities make up a sizable portion of
our education system. In 2013, students with disabilities, specifically those receiving special education services under IDEA, made up approximately 13 percent (Civic Enterprise, 2014) of all public-school students in the United States. Students with disabilities constitute significant portions of K-12 public school enrollment so finding ways to engage, teach and identify with them academically is imperative to behavior management, graduation rates and societal success.

In 2002, The No Child Left Behind Act mandated that all students must receive instruction from the most highly qualified teacher, which many school districts interpreted to emphasize content credentials over strategy (Kilanowski-Press, Foote, & Rinaldo, 2010). This political influence has motivated many schools to implement building-wide inclusion models, emphasizing the location that instruction for special education should occur, rather than approached that succeed in teaching students with special needs (Volonino & Zigmond, 2007). This has led to the increase of inclusive classrooms in the United States (Ernst, 2014). The No Child Left Behind Act claimed that social benefits for students with disabilities will ultimately have a positive impact on other skill areas, and that benefits for general education students would include tolerance, which in turn would lead to an more equal society (Clampit, Holfield, & Nichols, 2004; Kilanowski-Press, Foote, & Rinaldo, 2010; Mesibov & Shea, 1996; Scruggs, Mastropieri, & McDuffie, 2007; Volonino & Zigmond, 2007).

The significant learning diversity represented within the national K-12 student population is now requiring teachers to meet the diverse learning and behaviors needs of their students (Kobelin, 2009) more than ever before. To do so, many teachers have turned to instructional and behavioral strategies to make educational experiences relevant, level the playing field for diverse learning, and keep students engaged in learning. Distinctions amongst instructional skill sets, behavior strategies, content knowledge, and credentials between general education and special
education teachers continues to be a barrier in effectively teaching students in an inclusive classroom context. This is due to the fact that special education students require specialized programming, instructional techniques, and behavioral strategies. It is reasonable to suggest based on the research that teachers should be prepared with these skills to help students have an equal chance of succeeding in (STEM) education classrooms and future careers.

**Using student Data to inform instruction:**

Using data to inform instruction is not a new idea in special education. Since the passage of the No Child Left Behind Act (NCLB) in 2001 all states are required to provide state assessments based on rigorous standards. This act has also held educators at every level accountable for the use of scientifically-based research, data driven instruction, and use of standardized tests as a means to improve student learning. Data-driven instruction gained momentum for exceptional learners when the reauthorization of IDEA (2004) introduced the Response to Intervention (RTI) as a strategy to implement data driven instruction by leveraging a student's' abilities through acting strategically responsive to specific student needs. Data-driven instruction is used as a tool in the process of providing and facilitating a RTI approach. IDEA held schools further accountable for utilizing data to inform their instruction by requiring schools utilizing RTI to provide data-based documentation of achievement to parents at reasonable intervals (Zirkel, 2011). Research has shown that using data in instructional decisions can lead to improved student performance for all types of learners (Wayman, 2005; Wayman, Cho, & Johnston, 2007; Wohlstetter, Datnow, & Park, 2008).

Since the NCLB and IDEA, both states and their local school districts are held accountable for implementing measurable goals for all students. The main focus of these legislations is to bridge the gap in academic performance for low income and minority students.
The discussion regarding how to understand and leverage data from student assessments to better inform instruction has mainly been steered by these educational reforms and educational research. In 2007, Diamond reported that all students can find academic achievement if educators engage all learners with a rigorous curriculum, assess their progress, and change instruction as needed (Diamond, 2007). This operates under the assumption that the achievement gap can be resolved if all teachers meet the needs of all students. In meeting the needs of all students, the educator needs to be well informed on the current academic level of each student. It has been reported that analyzing and utilizing data can provide focused and targeted instruction that is customized based on the individual needs of each child (Jacobs, et al., 2009).

Many school districts across urban, suburban, and rural areas are leveraging the use of interim district benchmark assessments to compile data that can evaluate and individualize instruction toward specific standards that students lack mastery. In 2010, a study was conducted in a school district in Philadelphia regarding the use of benchmarks to measure student growth (Bulkley et al., 2010). The study collected data every 6 weeks for an entire year. This research was provided as a basis for further research regarding the importance of the cohesiveness of a school district and teachers, as well as how collaboration and synchronization on all levels within a district can increase both student learning and performance. Another excellent tool that uses data to drive instruction is the utilization of a curriculum-based measurement (CBM). This tool is specifically designed to measure reading fluency and has been reported to pass both reliability and validity tests. According to a 2004 study conducted by McGlinchey and Hixson, CBM delivers an accurate way to collect data and provide continuous monitoring of student progress.

Progress monitoring has been reported to allow teachers to collect continuous feedback on the standards that students have already mastered, and the data necessary to identify gaps in
student knowledge. Ysseldyke and Bolt (2010) conducted a controlled mathematics curriculum experiment in which they implemented progress monitoring through the administration of a pre-test and a post-test with the implementation of an instructional management system. Throughout this research study the experimental group was frequently assessed and analyzed. After analysis of data was performed, both instruction and interventions were customized based on student achievement. The control group in this study used the regularly implemented math curriculum. The group who underwent the data collection method showed significant gains in both standards mastery and post-test results. This result indicated that progress monitoring affords educators with a systematic way to measure individual learning gaps and individualized instruction can ensure academic standards are achieved by all learners and abilities.

Halverson, Grigg, Prichett, and Thomas (2007) conducted a one-year study of four different schools regarding the promise of student data analysis to increase student achievement. This study utilized a data-driven instructional system (DDIS) that aimed to reflect how schools align both standards and instruction to utilize specified assessments which deliver formative feedback and instructional guidance (Halverson, et al., 2007). They reported that this framework provides opportunities for collaboration of communities to collect, share, analyze, respond, and reflect on the ability to use data to drive their instructional decision-making. They reported that DDIS’s ability to translate to differentiated instruction leads to student performance and increased achievement.

Many local school systems across the country are constructing and sharing benchmark assessments that are used to measure student growth, inform teaching practice, and predict future success on state standardized tests. Bulkley, Christman, Goertz, and Lawrence (2010) determined that academic success is heightened when school districts share data and
communicate strategies that they have found to be effective and implementable. This approach creates learning communities with a system of support and communication. Reports indicate that “data collection in and of itself is not enough to steer practice and have a positive impact on learning achievement, it recommended that these communities should be based on three distinct types of sense making; “strategic, affective, and reflective” (Blanc et al., 2010, p. 212).

Professional development is also a critical component of learning communities and should be steered by data driven-based instruction of students. An illustration of this is the 2008 study conducted as the result of a federal grant through the Reading Excellence Act by Hayes and Robnolt. This study reported on student learning impacts regarding the use of data driven decision making to inform professional development. In this study, teachers utilized informal assessments that were currently being used to determine placement and learning gaps of students. Once analyzed they used this data to build a learning community and identify grade level specific professional development topics that would meet student needs. When teachers and administrators build communities, it brings about discussions that allows educators to seek and share necessary instructional strategies and interventions, as well as professional development that will increase both their practice and student achievement (Blanc, et al., 2010).

The act of utilizing data to steer instruction has been reported by researchers to increase student achievement. Dappen, Isemhagen, and Anderson (2005) performed a research study known as the Nebraska STARS Program. This program was based on two pillars, local district control and accountability. In this study the testing data produced continuous and uninterrupted growth for both students and educators involved. They reported that this growth was mainly due to the educator’s ability to make critical verdicts in the assessment of their students which led to teachers becoming more equipped and able to provide individualized and targeted instruction.
This program provided teachers the necessary control to respond instantly to the instructional needs of their students, which resulted in students exhibiting higher performance. Shanahan, Hyde, Mann, and Manrique (2005) conducted a quantitative study of an urban school district located in Southern California. The population of students in the study was comprised of 98% minorities and 95% free or reduced lunches who raised their test scores by a minimum of 12%. The increases were determined to be a result of benchmark assessments to inform instruction, curriculum guides aligned with state standards, and professional learning. Professional learning comprised of training for the interpretation of data as well as new hands-on pedagogies to teach mathematics. As standards drive most content in the classroom, it was critical to use benchmarks assessments for data that were in sync with standards, therefore enabling the data collected and analyzed to steer teaching practice.

As differentiated instruction, behavior management and data informed instruction have been well researched and proven as best practices to teach students with disabilities, it is imperative that we analyze the teacher preparation programs which are responsible for the transfer of these strategies to future educators. Are traditional route teacher preparation programs including these instructional strategies and techniques in their coursework which leads to the Teacher of Students with Disabilities (TOSD) credentialing of students?

**Teacher of Students with Disabilities Academic Background and Certification**

According to Western Washington University, undergraduate students whom would like to receive a credential in Special Education must take coursework, pass a practicum, and pass the Special Education Washington Educators Skills Test (WEST-E). The website for Western Washington University in Washington can be found at https://wce.wwu.edu/sped/special-education-p-12-plus-content-endorsement-bae-dual-endorsement.Western Washington
University and many other universities across the United States are accredited by CAEP, “the accreditation of educator preparation providers having programs leading to certification / licensure, bachelor’s, master’s, post-baccalaureate, and doctoral degrees in the United States and internationally” (www.caepnet.org). CAEP utilizes the 2012 Council for Exceptional Children (CEC) Initial Preparation Standards to evaluate and accredit universities with a Special Education program leading to a TOSD credential. To further illustrate the background that first year teachers have in Special Education, Table 1 identifies skills obtained in the undergraduate experience pertaining to CEC standards, undergraduate special education coursework and the WEST-E assessment

Table 1: Council for Exceptional Children (CEC) Initial Preparation Standards:

<table>
<thead>
<tr>
<th>Initial Preparation Standard 1: Learner Development and Individual Learning Differences</th>
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**Key Elements**

| 1.1  | Beginning special education professionals understand how language, culture, and family background influence the learning of individuals with exceptionality. |
| 1.2  | Beginning special education professionals use understanding of development and individual differences to respond to the needs of individuals with exceptionality. |

<table>
<thead>
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<th>Initial Preparation Standard 2: Learning Environments</th>
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**Key Elements**

<p>| 2.1  | Beginning special education professionals, through collaboration with general educators and other colleagues, create safe, inclusive, culturally responsive learning environments to engage individuals with exceptionality in meaningful learning activities and social interactions. |
| 2.2  | Beginning special education professionals use motivational and instructional interventions to teach individuals with exceptionality how to adapt to different environments. |
| 2.3  | Beginning special education professionals know how to intervene safely and appropriately with individuals with exceptionality in crisis. |</p>
<table>
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<tr>
<th>Initial Preparation Standard 3: Curricular Content Knowledge</th>
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<tr>
<td>3.0 Beginning special education professionals use knowledge of general and specialized curricula to individualize learning for individuals with exceptionalities.</td>
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</table>

**Key Elements**

| 3.1 Beginning special education professionals understand the central concepts, structures of the discipline, and tools of inquiry of the content areas they teach, and can organize this knowledge, integrate cross-disciplinary skills, and develop meaningful learning progressions for individuals with exceptionalities. |
| 3.2 Beginning special education professionals understand and use general and specialized content knowledge for teaching across curricular content areas to individualize learning for individuals with exceptionalities. |
| 3.3 Beginning special education professionals modify general and specialized curricula to make them accessible to individuals with exceptionalities. |

<table>
<thead>
<tr>
<th>Initial Preparation Standard 4: Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0 Beginning special education professionals use multiple methods of assessment and data sources in making educational decisions.</td>
</tr>
</tbody>
</table>

**Key Elements**

| 4.1 Beginning special education professionals select and use technically sound formal and informal assessments that minimize bias. |
| 4.2 Beginning special education professionals use knowledge of measurement principles and practices to interpret assessment results and guide educational decisions for individuals with exceptionalities. |
| 4.3 Beginning special education professionals, in collaboration with colleagues and families, use multiple types of assessment information in making decisions about individuals with exceptionalities. |
| 4.4 Beginning special education professionals engage individuals with exceptionalities to work toward quality learning and performance and provide feedback to guide them. |

<table>
<thead>
<tr>
<th>Initial Preparation Standard 5: Instructional Planning and Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0 Beginning special education professionals select, adapt, and use a repertoire of evidence-based instructional strategies to advance learning of individuals with exceptionalities.</td>
</tr>
</tbody>
</table>

**Key Elements**

| 5.1 Beginning special education professionals consider individual abilities, interests, learning environments, and cultural and linguistic factors in the selection, development, and adaptation of learning experiences for individuals with exceptionalities. |
| 5.2 Beginning special education professionals use technologies to support instructional assessment, planning, and delivery for individuals with exceptionalities. |
| 5.3 Beginning special education professionals are familiar with augmentative and alternative communication systems and a variety of assistive technologies to support the communication and learning of individuals with exceptionalities. |
5.4 Beginning special education professionals use strategies to enhance language development and communication skills of individuals with exceptionalities.

5.5 Beginning special education professionals develop and implement a variety of education and transition plans for individuals with exceptionalities across a wide range of settings and different learning experiences in collaboration with individuals, families, and teams.

5.6 Beginning special education professionals teach to mastery and promote generalization of learning.

5.7 Beginning special education professionals teach cross-disciplinary knowledge and skills such as critical thinking and problem solving to individuals with exceptionalities.

<table>
<thead>
<tr>
<th>Initial Preparation Standard 6: Professional Learning and Ethical Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0 Beginning special education professionals use foundational knowledge of the field and their professional ethical principles and practice standards to inform special education practice, to engage in lifelong learning, and to advance the profession.</td>
</tr>
</tbody>
</table>

**Key Elements**

6.1 Beginning special education professionals use professional ethical principles and professional practice standards to guide their practice.

6.2 Beginning special education professionals understand how foundational knowledge and current issues influence professional practice.

6.3 Beginning special education professionals understand that diversity is a part of families, cultures, and schools, and that complex human issues can interact with the delivery of special education services.

6.4 Beginning special education professionals understand the significance of lifelong learning and participate in professional activities and learning communities.

6.5 Beginning special education professionals advance the profession by engaging in activities such as advocacy and mentoring.

6.6 Beginning special education professionals provide guidance and direction to paraeducators, tutors, and volunteers.

<table>
<thead>
<tr>
<th>Initial Preparation Standard 7: Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0 Beginning special education professionals collaborate with families, other educators, related service providers, individuals with exceptionalities, and personnel from community agencies in culturally responsive ways to address the needs of individuals with exceptionalities across a range of learning experiences.</td>
</tr>
</tbody>
</table>

**Key Elements**

7.1 Beginning special education professionals use the theory and elements of effective collaboration.

7.2 Beginning special education professionals serve as a collaborative resource to colleagues.

7.3 Beginning special education professionals use collaboration to promote the well-being of individuals with exceptionalities across a wide range of settings and collaborators.
Practicum and Internship Requirement (TOSD)

In order for an individual to receive a special education credential they must pass a practicum and internship requirement. These requirements place the student into an authentic school/community environment working with a special education teacher and students of varying abilities and disabilities.

**Practicum:** These experiences include: 1.) Practicum experience in school setting designed to provide opportunities to demonstrate effective teaching and behavior management practices, 2.) Practicum experience in school/community settings. Designed to provide opportunities for students to develop, implement, and monitor literacy intervention programs for individuals or small groups of students, 3.) Practicum experience in school/community settings. Designed to provide opportunities for students to develop, implement, and monitor instructional intervention programs in literacy for small and large groups, 4.) Practicum experience in school/community settings. Designed to provide opportunities for students to develop, implement, and monitor instructional intervention programs in Math for small and large groups.

**Internship:** These experiences include: 1.) Supervised teaching experience to develop and demonstrate teaching competence for children and youth with disabilities, 2.) Passing WEST-E

**Washington Educator Skills Test (WEST-E) for Special Education Endorsement**

This exam covers a variety of pedagogies and best practices that must be mastered to achieve a TOSD credential. They include the ability to: 1.) Demonstrate knowledge of human growth and development, 2.) Understand the characteristics and needs of students with disabilities, 3.) Demonstrate knowledge of the factors affecting learning and development of students with disabilities, 4.) Demonstrate knowledge of types and characteristics of assessments for students with disabilities, 5.) Demonstrate knowledge of procedures for conducting assessments to
address the individual needs of students with disabilities, 6) Apply knowledge of procedures for
developing and implementing individualized programs for students with disabilities, 7.)
Demonstrate knowledge of strategies for designing and managing learning environments to
promote the learning, behavioral, and social interaction skills of students with disabilities in
alignment with state standards, 8.) Demonstrate knowledge of research-based strategies that
promote positive academic outcomes for students with disabilities, 9.) Demonstrate knowledge
of research-based methods for promoting students' adaptive, communication, and independent
living skills, 10.) Understand the philosophical, historical, and legal foundations in the education
of individuals with disabilities, 11.) Apply knowledge of strategies for communicating and
collaborating with others to help students with disabilities achieve desired learning outcomes,
12.) Demonstrate knowledge of the professional responsibilities of the special education teacher.

Based on the Council for Exceptional Children (CEC) Initial Preparation Standards that
universities and colleges utilize to guide their TOSD credentialing process for undergraduate
education students it is clear that they teach strategies and techniques related to differentiated
instruction, behavior management, and data to inform instruction.

Differentiated instruction is covered by CEC standards:

3.0 Beginning special education professionals use knowledge of general and specialized
curricula to individualize learning for individuals with exceptionalities.

3.3 Beginning special education professionals modify general and specialized curricula
to make them accessible to individuals with exceptionalities.

5.0 Beginning special education professionals select, adapt, and use a repertoire of evidence-
based instructional strategies to advance learning of individuals with exceptionalities.

5.1 Beginning special education professionals consider individual abilities, interests, learning
environments, and cultural and linguistic factors in the selection, development, and
adaptation of learning experiences for individuals with exceptionalities.
5.5 Beginning special education professionals develop and implement a variety of education and transition plans for individuals with exceptionalities across a wide range of settings and different learning experiences in collaboration with individuals, families, and teams.

Behavior management is covered by CEC standards:

2.0 Beginning special education professionals create safe, inclusive, culturally responsive learning environments so that individuals with exceptionalities become active and effective learners and develop emotional well-being, positive social interactions, and self-determination.

2.1 Beginning special education professionals, through collaboration with general educators and other colleagues, create safe, inclusive, culturally responsive learning environments to engage individuals with exceptionalities in meaningful learning activities and social interactions.

2.2 Beginning special education professionals use motivational and instructional interventions to teach individuals with exceptionalities how to adapt to different environments.

2.3 Beginning special education professionals know how to intervene safely and appropriately with individuals with exceptionalities in crisis.

Data to inform instruction is covered by CEC standards:

4.0 Beginning special education professionals use multiple methods of assessment and data sources in making educational decisions.

4.1 Beginning special education professionals select and use technically sound formal and informal assessments that minimize bias.

4.2 Beginning special education professionals use knowledge of measurement principles and practices to interpret assessment results and guide educational decisions for individuals with exceptionalities.

4.3 Beginning special education professionals, in collaboration with colleagues and families, use multiple types of assessment information in making decisions about individuals with exceptionalities.

4.4 Beginning special education professionals engage individuals with exceptionalities to work toward quality learning and performance and provide feedback to guide them.
Overview of the Dissertation

As global job industries continue to demand and be led by the Science, Technology, Engineering and Mathematics disciplines, the United States government has responded to these needs through educational reform. At the same time these disciplines have taken a front seat to global industries, the special education population has risen to new heights and has led to an increase in inclusive STEM classroom placements (Ernst et al, 2014). Prior to this national STEM focus and reform there was a trend of placing students with learning disabilities in non-core curriculum course work. This appeared to place them at serious disadvantages with regards to Science and Mathematics. However, the new focus on STEM education and special education reform has led to many of these students being placed in general education core content classrooms. This shift has led to the increase in the creation of inclusive STEM classrooms whom are responsible for carrying out this educational reform and instructional shift. The integrative nature and STEM focused approaches are making effective educational reform and instructional shifts even more complex. Given this historically unique educational circumstance, this dissertation seeks to shed light on STEM education and special education teacher’s instructional and content knowledge preparedness. These studies aim to identify problematic conditions which may impact appropriate instruction within an Inclusive STEM education classroom context. This research will conduct two exploratory studies that examine the instructional preparedness for first year Special Education and first year STEM Education teachers’ as well as the content credentials attained to educate Students with Disabilities within an inclusive STEM Education classroom.

This study will utilize a secondary analysis of the 2011-2012 School and Staffing Survey Teacher Questionnaire (SASS TQ) datasets to conduct national analysis for the instructional preparedness (Section III, Questions 33afg) of both Special Education and STEM Education
teachers, as well as their state-level certification areas to reflect potential indicators of preparedness to educate in an Inclusive STEM education classroom.

The first study will report on the level of instructional preparedness for first year secondary STEM educators and first year Special educators to differentiate instruction (Section III, Question 33f), manage classroom environments and classroom discipline (Section III, Question 33a), as well as utilization of data to inform instruction (Section III, Question 33g). Identifiable differences in instructional preparedness among first year STEM educators and first year Special Education teachers will be presented.

The second study utilizes the 2011-2012 SASS TQ datasets to analyze elementary and secondary Special Educators and STEM educators teaching credentials and certifications as indicators to determine if they are prepared to teach in an Inclusive STEM education classroom.
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Chapter 3. Manuscript One

Instructional Readiness in the Inclusive STEM Classroom

Louis Rossi

Abstract

With the advent of full inclusion, teachers must adapt to an increasing number of students with disabilities in the general education classroom. In STEM education, this focus is on the pedagogical shifts associated with the creation of inclusive STEM education classrooms. Often it requires that STEM education teachers and special education teachers work together in the same classroom. Although their initial instructional preparedness is very distinct from one another, the increase in students with disabilities and the implementation inclusive STEM education classrooms has created new opportunities for both STEM education teachers and special education teachers to collaborate. This study utilizes the Schools and Staffing Survey Teacher Questionnaire to identify similarities and differences in preparedness of first year STEM education and special education teachers in instructional best practices necessary to facilitate students with disabilities in the inclusive STEM education classroom.

Keywords: Special Education, STEM education, School and Staffing Survey Teacher Questionnaire, Differentiated Instruction, Behavior Management, Data-driven Instruction
Background

The rise in population of students with disabilities and the inclusion of students with disabilities in general education classrooms has reshaped the educational landscape in the United States (Gregory & Chapman, 2002). As many of these inclusive classrooms operate within the STEM education disciplines (Ernst & Williams, 2015; Green & Casale-Ciannola, 2011), it is necessary for STEM education teachers to be prepared from an instructional perspective to properly facilitate instruction in an inclusive STEM education classroom. However, this task is often exacerbated by the large number of students with disabilities STEM teacher often have on their caseloads (Ernst & Williams, 2014; Ernst and Williams, 2015; Williams, Kau & Ernst, 2015).

The increase in inclusive STEM education classrooms has had a significant impact on the roles and responsibilities of STEM education teachers and special education teachers. These inclusive classrooms often have STEM education teachers and special education teachers working side-by-side. While STEM education teachers are well-prepared in their content areas, they often lack the pedagogical skills needed for specialized instruction. Special education teachers are well-prepared with individualized and specialized instructional strategies (CEC, 2004) though they often lack knowledge of STEM content areas.

The increase in inclusive STEM education classrooms requires that STEM education teachers adopt many of the research-based special education instructional strategies to ensure that learning for all students is occurring within their classrooms. This is especially critical since reports generally indicate that teachers characteristically identify themselves as unprepared to present educational concepts to students with disabilities (Bender, 2002; Bender, 2008; Bender & Shores, 2007) and tended to use few targeted strategies (Agran & Alper, 2000). Obtaining these
special education skill-sets is critical for STEM education teachers’ mission to reach all students. Among special education research-based instructional practices, differentiated instruction, behavior management and data-informed instruction are among the most commonly used.

Preparedness

It has been long established that teacher quality is an important predictor of student achievement and that teacher preparedness and content expertise play a critical role in facilitating learning (McCray & Chen, 2012; National Commission on Teaching and America’s Future, 1996; Rice 2003; Wright, Horn, & Sanders, 1997). Students with disabilities have learning needs that vary from student to student and can require different instructional approaches than their regular education peers in an inclusive classroom environment. The reported increase in students with disabilities (National Center for Education Statistics, 2016), and heightened placement in inclusive settings (Ernst & Williams, 2014; National Center for Education Statistics, 2016) has raised the importance for teachers to be prepared to utilize best practices to meet all student learning needs and has created new challenges for secondary STEM teachers.

Best practices for students with categorical disabilities who are receiving instruction in an inclusive STEM education classroom include the assignment of pair/group projects, employment of multiple means of representations, providing clear and complete instruction and assigned materials, allowing of self-selected topics of student’s interest, and encouragement of alternative expression/reporting means (Ernst, 2014). All of these best practices for an inclusive STEM education environment can be facilitated by three common inclusive instructional strategies; differentiated instruction, behavior management and the use of data to inform instruction. These three are connected and are among key inclusive instructional strategies. Reports indicate that students with disabilities in inclusive classroom settings can find success when teachers
implement behavior management and utilize differentiated instruction (Clampit, Holifield, & Nichols, 2004; Kilanowski-Press, Foote, & Rinaldo, 2010; Scruggs, Mastropieri, & McDuffie, 2007; Volonino & Zigmond, 2007; Mitchum, Young, West, & Benyo, 2001). In order for differentiated instruction to be implemented effectively, teachers need to assess student learning carefully and routinely, and use this data to inform decisions regarding the selection of a differentiation strategy (Conner et al., 2011). For inclusive STEM education teachers to reach all students and meet their learning needs, it is important for them to be prepared to deploy differentiated instruction, behavior management and utilize data to inform decisions in their classrooms.

**Differentiated Instruction.**

In order to optimize academic success of the general education curriculum standards for students with disabilities it is critical to increase efforts to differentiate instruction in an inclusive classroom setting (Lawrence-Brown, 2004). Given the nature of inclusive education, students with disabilities whom are unable to keep pace with their general education peers without substantial support are included in the general instruction, creating mixed-ability classrooms. This mixed ability setting “makes differentiated instructional strategies a must, especially given the simultaneous push for all students to achieve high standards” (Lawrence-Brown, 2004). Utilizing differentiated instruction enables students with disabilities to access both the general education content and demonstrate what they’ve learned (King-Sears, 2001). With differentiated instruction and appropriate supports, intended benefits of inclusion for students with disabilities can be realized (Lawrence-Brown, 2004).

Differentiated instruction (DI) is an educational framework that encompasses a variety of lesson plans and tailored curriculum selection that meets an individual students’ readiness,
language skills, comprehension abilities, academic skills, and cultural differences (Dombek & Conner, 2012; Tomlinson, 1999). The goal of DI is to capitalize on each student's development and individual accomplishments by meeting his or her learning needs and fostering academic growth (Dombek & Conner, 2012; Tomlinson, 1999; Tomlinson, 2001).

In order to effectively utilize DI as an approach inside the classroom, students need to be able to demonstrate autonomy and self-direct their learning. This can be problematic as “we don’t yet know how to teach self-direction, collaboration, creativity, and innovation the way we know how to teach long division” (Rotherham & Willingham, 2010, p. 19). Rotherham and Willingham concluded that knowledge and skills are interconnected, and that an educators’ understanding of curriculum, content, and assessment must improve before they can implement DI.

Many schools in the United States structure their classrooms utilizing the 'mixed ability' approach to grouping students, combining all types of abilities and diversities in a classroom. This approach can be overwhelming and puzzling for teachers in their mission to meet the academic needs of every student in their classroom. This mission can be even more cumbersome when aiming to reach students with disabilities in a mixed-ability STEM-based inclusion setting. Many teachers struggle to provide every student with learning opportunities that are individually designed and work best for each individual student. This is incredibly difficult given the fact that what works for some students will not work for others (Berliner & Biddle, 1995).

As teachers attempt to attain new instructional approaches to adapt to a shifting educational landscape and rising diverse population, it is becoming increasingly difficult for them to excel in their teaching responsibilities, utilization of best practice, and meeting the diverse needs of their students. As teacher preparation programs are foundational to a first-year
teacher’s content, skillset, and approach, it would be reasonable to suggest its great importance in transferring instructional best practices to their student who will be entering the classrooms as teachers.

**Behavior Management**

The ability for a teacher to keep students on-task and appropriately manage their classroom environment and student behavior is foundational to both teaching and learning. As such, behavior management is a critical component of teaching in every classroom, including inclusive environment (Scruggs, Mastropieri, & McDuffie, 2007; Volonino & Zigmond, 2007). The increase in students with disabilities and associated behavior issues over the past two decades provides evidence that it is imperative for educators to be prepared to create an inclusive learning community where all students can succeed both socially and academically (George Washington University Milken Institute School of Public Health, 2015).

Research has indicated that students with disabilities who lack on-task skills frequently struggle in inclusive classrooms that lack strategies to accommodate individualized behavioral and learning needs. However, reports indicate that these students can achieve success when teachers implement behavior management techniques, such as self-monitoring (Clampit, Holifield, & Nichols, 2004; Kilanowski-Press, Foote, & Rinaldo, 2010; Scruggs, Mastropieri, & McDuffie, 2007; Volonino & Zigmond, 2007; Mitchum, Young, West, & Benyo, 2001). Self-monitoring is a common behavior management strategy used by special education teachers. It has been reported as an effective tool for students with disabilities, including those classified with ADHD to increase their academic performance and attention behaviors (Mitchum, Young, West, & Benyo, 2001).
According to the Center for Disease Control and Prevention, in 2011-2012 approximately 237,000 children from two to five years of age had an Attention Deficit Hyperactivity Disorder diagnosis based on parent reports. This was roughly 57% higher than the estimate for 2007-2008. Among these children, approximately 50% received behavioral treatment for their attention and behavioral issues (Danielson M. et. al, 2017). Given increased scale of the population with attention and behavioral issues, the trend suggests that inclusive classrooms will likely see an increase in students with attention and behavioral issues.

Attention and behavior disorders have been reported to have a negative impact on a student’s ability to attain new content and skills (Barkley, 2006; Dunlap, 2009; Heward, 2013; Mesibov & Shea, 1996) and are a root cause for educators to separate students (Salend & Duhaney, 1999; Santoli, Sachs, Romey, & McClurg, 2008). Research suggests that students who lack on-task skills often struggle in inclusive settings, but can find success when teachers modify classroom procedures, implement behavior management and teaching strategies to incorporate effective pedagogies, such as self-monitoring and differentiated instruction (Clampit, Holifield, & Nichols, 2004; Kilanowski-Press, Foote, & Rinaldo, 2010; Scruggs, Mastropieri, & McDuffie, 2007; Volonino & Zigmond, 2007; Mitchum, Young, West, & Benyo, 2001).

Data-informed Instruction

Using student data to inform instruction provides teachers with an opportunity to make informed decisions about the content and skills that learners need to be successful. Since the passage of the No Child Left Behind Act (NCLB) of 2001, all states must now provide standardized assessments based on rigorous standards. This has held teachers at all levels responsible to use scientifically-based research, data driven instruction, and standardized tests to guide them in their mission to improve student learning. Data-driven instruction received
increased acceptance for exceptional learners in 2004 with the reauthorization of the Individuals with Disabilities Education Act (IDEA). This act introduced Response to Intervention (RTI) as a means to integrate data-driven tools which are strategically responsive to specific student learning needs. IDEA also targeted the strategy of data to inform instruction by requiring schools to provide data-based documentation of achievement to special education student’s parents at reasonable intervals (Zirkel, 2011). Research has also supported the use of data-driven instruction through reports that indicate that data-driven instructional decisions can lead to improved student performance for all types of learners (Wayman, 2005; Wayman, Cho, & Johnston, 2007; Wohllestetter, Datnow, & Park, 2008). Furthermore, with the passage of the Every Student Succeeds Act (2015), all states are mandated to not only provide state assessments based on rigorous standards but are now held accountable for implementing measurable goals for all students. How to manage and leverage student assessment data to better inform teaching and increase achievement has been extensively reported over the past two decades. One well-established data driven methodology is progress monitoring. Progress monitoring is rooted in special education research that gauges a particular student’s progress toward the mastery of a concept or skill that is reflective of curricular goal (Deno, Fuchs, Marston, & Shinn, 2001; Stecker & Fuchs, 2000). Progress monitoring provides student assessment data which is used by an educator to make decisions regarding a special education student’s achievement towards a goal and objective in their IEP and overall program effectiveness (Deno, Espin, & Fuchs, 2002; Fuchs & Fuchs, 1999).

Using data to inform instruction provides teachers with the ability to respond immediately to the instructional needs of their learners, which can result in higher student performance. An urban school district located in Southern California comprised of students
which were 98% minorities and 95% free or reduced lunches raised their standardized test scores by over 12% (Shanahan, Hyde, Mann, & Manrique, 2005). The changes were attributed to benchmark assessments to inform instruction, curriculum guides aligned with state standards, and professional learning. One of the major components of the professional learning was specified training in the interpretation of data. Since learning standards direct most content presented in the classroom, it was reported to be critical for teachers to use benchmarks assessments for data that were in sync with standards which enabled the data collected and analyzed to steer teaching practice.

Diamond (2007) reported that all learners can find academic achievement if educators engage all students with a demanding curriculum, monitor their progress, and change instruction as required. To accomplish this Diamond reported that the educator needs to be well informed on the current academic level of each student. Analyzing and utilizing data provides focused and targeted instruction that is customized based on the individual needs of each child (Jacobs, et al., 2009). When schools align both standards and instruction while utilizing specified assessments that deliver formative feedback and instructional guidance, the use of this data can drive instructional decision-making, translate to differentiated instruction, and lead to heightened student performance and achievement (Halverson, et al., 2007). Many local school systems across the United States are constructing benchmark assessments that are being leveraged to measure student gaps, competencies, inform teaching practice, and predict future student performance on state standardized tests. These findings can be furthered heightened when school districts share data and communicate strategies that they have found to be effective and implementable (Bulkley, et al., 2010). As research indicates the importance of employing behavior management, differentiated instruction, and data-informed instructional strategies for
facilitating learning for students with disabilities in an inclusion setting, it is important to investigate the level of instructional preparedness that both STEM and Special educators have as they enter the field of teaching.

**Research Questions**

As evidenced through research, the inclusive educational classroom relies on instructional and management abilities of educators specific to differentiated instruction, behavior management, and utilizing data to inform instruction. These abilities can be investigated through the use of nationally representative data for STEM and special educators. The Schools and Staffing Survey Teacher Questionnaire (SASS TQ) permits direct examination of first year secondary educator STEM and special education instructional preparedness as it pertains to differentiated instruction, behavior management, and utilizing data to inform instruction. This investigation was guided by three research questions associated with beginning secondary STEM education and Special Education teachers perceived instructional readiness with best practices within their core instructional academic areas. The questions are as follows:

1. What is the level of perceived instructional readiness for first year secondary STEM educators?
2. What is the level of perceived instructional readiness for first year secondary Special Educators?
3. Are there identifiable differences in perceived instructional readiness among first year secondary STEM educators and first year secondary Special Education teachers?

**Instrumentation**

This study utilized the 2011-12 Schools and Staffing Survey (SASS) data set to analyze variables within the context of this study. The SASS is a system of related questionnaires. It is
composed of five types of questionnaires: a school district questionnaire, principal questionnaire, school questionnaire, teacher questionnaire (SASS TQ), and a school library media center questionnaire. This study employed the SASS TQ. Tourkin et al. (2010, p. 8–9) concisely identified the SASS instrumentation purpose and procedure as:

The SASS is conducted by the National Center for Education Statistics (NCES) on behalf of the US Department of Education in order to collect extensive data on American public and private elementary and secondary schools. The SASS provides data on the characteristics and qualifications of teachers and principals, teacher hiring practices, professional development, class size, and other conditions in schools across the nation. SASS is a large-scale sample survey of K–12 school districts, schools, teachers, library media centers, and administrators in the USA. The SASS was designed to produce national, regional, and state estimates for public elementary and secondary schools and related components (e.g., schools, teachers, principals, school districts, and school library media centers); national estimates for BIE-funded and public charter schools and related components (e.g., schools, teachers, principals, and school library media centers); and national, regional, and affiliation strata estimates for the private school sector (e.g., schools, teachers, and principals). Therefore, the SASS is an excellent resource for analysis and reporting on elementary and secondary educational issues.

Participants

Given reports that STEM educators most often do not elect to attend special education-based professional development (Li, 2015), the primary source of special education instructional
strategies for educators takes place in teacher preparation programs, prior to their career as an educator. Given these reports and purpose of teacher preparation program teacher preparation is best measured at the onset of their careers.

The target population for this investigation was first year, secondary, full and part-time public-school Science, Technology, Mathematics, and Special Education teachers. Teachers’ placement into these categories was determined by their main teaching assignment. The main teaching assignment was determined by SASS TQ question, “This school year, what is your MAIN teaching assignment field at THIS school?”

Teachers with response codes indicating Science General, Biology or Life Sciences, Chemistry, Earth Science, Integrated Science, Physical Sciences, or Physics were categorized as Science teachers. Teachers were categorized as Technology teachers if their response codes indicated Construction Trades, Engineering, or Science Technologies (including CADD and drafting), Manufacturing and Precision Production (electronics, metalwork, textiles, etc.), Communications and Related Technologies (including design graphics, or printing), or General Technology Education (Technological systems, industrial systems, and pre-engineering). Teachers were categorized as Mathematics teachers if they responded with a category code indicating Algebra I, Algebra II, Algebra III, Basic and General Mathematics, Business and Applied Math, Calculus and Pre-calculus, Geometry, Pre-algebra, Statistics and Probability, or Trigonometry. Science, Technology and Mathematics teachers were collectively categorized as STEM teachers.

Special education teachers were those who chose the code for Special Education, Any. Special Education, Any is comprised of Special Education, General, Autism, Deaf and Hard-of-hearing, Developmentally Delayed, Early Childhood Special Education, Emotionally Disturbed
or Behavior Disorders, Learning Disabilities, Intellectual Disabilities, Mildly or Moderately
Disabled, Orthopedically Impaired, Severely or Profoundly Disabled, Speech or Language
Impaired, Traumatically Brain-injured, Visually Impaired, and Other Special Education.

Teaching experience was determined by SASS TQ variable TOTYREXP which was the
sum of the years of teaching experience. We chose those teachers with one year of teaching
experience because the dependent variable in this study is only addressed by the SASS TQ for
first year teachers. The SASS TQ variable TLEV2_03 was employed to make the determination
of instructional level. The target population for this study was secondary teachers. The variable
TLEV2_03 grouped teachers’ responses into elementary or secondary as the instructional level.
The SASS TQ defines secondary teachers were those teachers who, in general, instructed any of
grades seven through 12.

Data were weighted with the SASS TQ supplied replicate weights to approximate the
population of Science, Technology, Mathematics, and Special Education teachers. The
placement scheme and data weighting resulted in 8,790 Science teachers, 890 Technology
teachers, 13,760 Mathematics teachers, and 6,640 Special Education teachers. A descriptive
profile of teachers for the four teaching areas are presented in Table 1.

<table>
<thead>
<tr>
<th>Table 2. Descriptive information for first-year teachers in each content area.</th>
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</thead>
<tbody>
<tr>
<td>Variable</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Weighted Sample Size</td>
</tr>
<tr>
<td>Mean Age (years)</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Full-time Teacher</td>
</tr>
<tr>
<td>Part-time Teacher</td>
</tr>
</tbody>
</table>

Note. Weighted sample values are rounded to the nearest 10 per IES protocol. Standard
deviation is in parentheses.
Methods

This study analyzed data from the SASS TQ restricted-use dataset. A restricted-use license was applied for and access was authorized by the NCES. Specific IES reporting protocols were followed where the results were sent to IES for approval and authorization for release. The results were authorized for release. The methodology closely follows that of Ernst and Williams (2014, 2015) and Williams, Kaui, and Ernst (2015).

The primary variable of interest in this study was perceived instructional readiness. It was a composite variable that was the sum of three questions asking teachers’ how prepared they felt they were in their first year to: 1) Handle a range of classroom management or discipline situations? 2) Use data to inform instruction? and 3) Differentiate instruction in the classroom? Responses for each question were answered on a four-point Likert scale: 1) not prepared at all, 2) somewhat prepared, 3) well prepared, and 4) very well prepared. We deemed this variable to be perceived instructional readiness as it is based on the teachers’ perceptions of their ability. Summed scores could range from three to 12. Higher scores indicated a higher perceived level of instructional readiness.

The teaching area mean score differences on perceived instructional readiness were analyzed using AM Statistical Software. Independent sample t-tests were used to identify statistically significant mean score differences of perceived instructional readiness between the teaching areas. The first analysis examined STEM teachers collectively to Special Education teachers on perceived instructional readiness. The second analysis examined the three STEM teaching areas (Science, Mathematics, and Technology Education) compared to Special Education teachers on perceived instructional readiness. Probability levels of .05 or less were
deemed to be statistically significant and Cohen’s \(d\) was calculated to determine that effect size for any statistically significant results found. Data were weighted using the Teacher Final Sampling Weight (TFNLWGT) variable and the SASS TQ supplied 88 replicate weight variables. A balanced repeated replication procedure was utilized as required by the IES to adjust standard errors (Tourkin et al., 2010). All analyses were completed with weighted data and all data and degrees of freedom were rounded to the nearest 10 per IES protocol.

**Results**

A descriptive account of subject area values is presented in Table 2 for the collective STEM teacher and Special education teacher comparisons for perceived instructional readiness. An independent sample \(t\)-test found a statistically significant difference between Special education teachers who had statistically significantly higher perceived instructional readiness score (\(M = 8.996, SD = 1.866\)) than STEM teachers collectively (\(M = 7.882, SD = 2.010\)); \(t(90) = -2.116, p = .037\). Cohen's \(d\), \((8.996 - 7.883) / 1.939\) = 0.574, indicated a moderate effect size for this difference.

<table>
<thead>
<tr>
<th>Teacher Area</th>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SE</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM All</td>
<td>Instructional readiness</td>
<td>23,440</td>
<td>7.882</td>
<td>0.174</td>
<td>2.01</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Special Education</td>
<td>Instructional readiness</td>
<td>6,640</td>
<td>8.996</td>
<td>0.497</td>
<td>1.866</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>

Note. \(SE\) is standard error. \(SD\) is standard deviation. Min is minimum score. Max is maximum score.

Table 3 shows the values within STEM education and Special education for teacher area comparisons. Six independent samples \(t\)-tests were conducted based on the information listed in Table 3. The results for the independent samples \(t\)-tests area comparisons are listed in Table 4.

<table>
<thead>
<tr>
<th>Teacher Area</th>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SE</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>Instructional readiness</td>
<td>13,760</td>
<td>8.025</td>
<td>0.246</td>
<td>1.996</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Science</td>
<td>Instructional readiness</td>
<td>8,790</td>
<td>7.689</td>
<td>0.252</td>
<td>2.003</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Technology Education</td>
<td>Instructional readiness</td>
<td>890</td>
<td>7.571</td>
<td>0.765</td>
<td>2.098</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>
The results for the independent samples $t$-tests area comparisons showed that for the majority of the area comparisons there were no statistically significant differences between the areas for perceived instructional readiness. The teaching areas appeared to be equal in their assessment of their perceived instructional readiness. The one statistically significant difference found was between Special education teachers who had a statistically significantly higher perceived instructional readiness score ($M = 8.996, SD = 1.866$) than Science teachers ($M = 7.689, SD = 2.003$); $t(90) = 2.573, p = .012$. Cohen’s $d$, $(7.689 - 8.996) / 1.936 = 0.675$, indicated a moderate effect size for this difference. Although there was a statistically significant difference between STEM collectively and Special education, the difference appeared to be primarily due to the Science teachers.

Table 5. Independent samples $t$-test results for instructional readiness.

<table>
<thead>
<tr>
<th>Area 1</th>
<th>Area 2</th>
<th>Mean 1</th>
<th>Mean 2</th>
<th>df</th>
<th>$t$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>Math</td>
<td>7.689</td>
<td>8.025</td>
<td>90</td>
<td>-0.925</td>
<td>0.357</td>
</tr>
<tr>
<td>Technology Education</td>
<td>Math</td>
<td>7.571</td>
<td>8.025</td>
<td>90</td>
<td>-0.601</td>
<td>0.549</td>
</tr>
<tr>
<td>Technology Education</td>
<td>Science</td>
<td>7.571</td>
<td>7.689</td>
<td>90</td>
<td>-0.145</td>
<td>0.885</td>
</tr>
<tr>
<td>Special Education</td>
<td>Math</td>
<td>8.996</td>
<td>8.025</td>
<td>90</td>
<td>1.651</td>
<td>0.102</td>
</tr>
<tr>
<td>Special Education</td>
<td>Science</td>
<td>8.996</td>
<td>7.689</td>
<td>90</td>
<td>2.573</td>
<td>0.012</td>
</tr>
<tr>
<td>Special Education</td>
<td>Technology Education</td>
<td>8.996</td>
<td>7.571</td>
<td>90</td>
<td>1.511</td>
<td>0.134</td>
</tr>
</tbody>
</table>

Note. $df$ is degrees of freedom. $t$ is $t$ value. $p$ is probability level.

Discussion and Conclusion

The importance of instructional readiness cannot be understated if the inclusion of students with disabilities is to be successful. In inclusive STEM education classrooms, it is important that STEM teachers are able to manage instruction, manage behavior, and implement data-driven educational solutions. Baker (2005) reported that reactive and adverse teaching methods result in teacher frustration and can cause the teachers to withdraw from their position.
as an educator whereas, teachers who are properly equipped to use a variety of research-based teaching methods, both instructional and behavioral, are better prepared to educate in diverse learning environments.

The necessary considerations when determining the appropriate placement of a student with disabilities in an inclusive environment include matching the student’s ability and required modifications with the least restrictive environment (LRE). The inclusive classroom will not always be the appropriate LRE for students with disabilities. To ensure success, pedagogical and behavioral services that will be available within the LRE are critical to consider prior to an official placement. An example of a pedagogical service is differentiation of instruction. This is a critically important pedagogy to help children with disabilities succeed in an inclusive classroom. Since the inclusive classroom often contains students with varied abilities, differentiation includes various levels of activities, while at the same time employing a variety of strategies to meet the needs of all students with different abilities.

Bakken (2016) reported that teacher training is an aspect that is very important to the success of students with disabilities in an inclusive environment. Prior to a placement of a student with disabilities into an inclusive classroom, Bakken reported that the Individualized Education Plan team needs to answer the following questions: 1) What training does a general education teacher have working with students with disabilities? and 2) How might the special education teacher support the general education teacher and the student with disabilities? If inclusion is to be successful, STEM education teachers and special education teachers need to work closely together and compromise. It requires that the teachers have training and support to overcome the challenges together” (Bakken, 2016).
References


Chapter 4. Manuscript Two

The Inclusive STEM Education Classroom: Elementary and Secondary Special Education and Elementary and Secondary STEM Education Teacher Credentials

Louis Rossi

Abstract

As STEM education becomes integrated across disciplines, the population of inclusive classrooms containing students with disabilities will continue to rise. This presents challenges to both STEM education teachers and Special education teachers. Do STEM education and special education teachers have the appropriate content credentials to effectively support the diverse needs of students and curriculum in inclusive STEM education classes? To examine this question, this study utilized a secondary analysis of the 2011-2012 Schools and Staffing Survey Teacher Questionnaire restricted-use dataset to produce a nationally representative sample to determine how the degrees and state-level certification areas of Special education teachers and STEM education teachers reflect potential indicators of preparedness to educate students with disabilities in an inclusive STEM education classroom.

Keywords: Special Education, STEM education, School and Staffing Survey Teacher Questionnaire, Credentials, Inclusion
Background

The increase in the number of students with disabilities and an emphasis on STEM education within our current educational system has given rise to an unprecedented number of inclusive classrooms within the STEM disciplines (Ernst & Williams, 2014, 2015a, 2015b; Williams, Kaui, & Ernst, 2016). In the past, many students with disabilities were ‘pulled-out’ of the general education environment to receive instruction. This mindset that students with disabilities could not be successful in a general education classroom due to their requirements for individualized instruction was prevalent for many years in both general and special education. Starting in the late 1980’s approximately 30% of students with disabilities spent more than 80% of their time in general education classrooms getting instruction in the general education curriculum (Bakken, 2016). By 2013, the number of students with disabilities that received instruction in general education classrooms had more than doubled. It was reported that 61% of students with disabilities were receiving instruction in the general education setting (U.S. Department of Education, National Center for Education Statistics, 2016).

Green and Casale-Ciannola (2011) reported that more students with disabilities are now receiving instruction in an inclusive STEM education setting than in the past and stated this increase has had a significant impact on the roles and responsibilities of general education teachers. Effective inclusive classrooms consist of appropriate student placement with academically and pedagogically-abled teachers who are capable of delivering best practices for facilitating learning for students with disabilities. However, most general education teachers characteristically identify themselves as unprepared to deliver educational concepts to students with disabilities (Bender, 2002; Bender, 2008; Bender & Shores, 2007).
While inclusion education research has reported that inclusive models produced positive benefits academically and socially for students with and without disabilities, it identified that high-quality teacher preparedness (through education and training) is vital for the process to be successful (Bakken, 2016). Similarly, teacher preparedness and content expertise play an essential role in facilitating learning within the classroom and teacher quality is an excellent predictor of student achievement (McCray & Chen, 2012; National Commission on Teaching and America’s Future, 1996; Rice 2003; Wright, Horn, & Sanders, 1997). One indicator of high quality teacher preparedness is licensure and certification (Allen, 2010). Darling-Hammond (2000) and Ferguson (1991, 1996) found that teachers’ expertise, specifically their qualifications, were more important to student achievement than socioeconomic status. Podgursky (2002) corroborated by stating that teachers with appropriate credentials, professional development, and classroom practices could counterbalance the impact that socioeconomic disadvantage has on student learning.

Teacher certification status and student achievement are positively correlated (Darling-Hammond, 1999, 2000; Felter, 1999; Laczko-Kerr & Berliner, 2002). Darling-Hammond (1999) reported that states with the highest number of certified teachers also had the highest student results on the National Assessment of Educational Progress. Laczko-Kerr and Berliner (2002) found that students who received instruction from highly qualified certified teachers performed significantly better on state assessment in the areas of language arts (including reading) than those taught by teachers whom lacked certification.

Browell, Ross, Colón and McCallum (2005) examined the importance of teacher certification and teacher quality directly related to teacher preparation and found that this issue has been under investigation since the 1980’s. Valli and Rennert-Ariev (2000) reviewed nine
educational reports and found the strongest consensus for determining teacher quality was the importance of disciplinary preparation (content) and multicultural emphasis. The U.S. Secretary of Education, (U.S. Department of Education, 2002) claimed that teacher subject matter knowledge was a key factor in improving student achievement.

**Research Questions**

Entry in a STEM field or taking STEM classes are increasingly seen as important in order for students with disabilities to be successful and to secure high paying jobs. Many students with disabilities first venture into STEM classes in the primary/elementary setting. At this level many students with disabilities are co-taught and supported in the general education classroom by special education teachers along with the general education teacher. These teachers are tasked with providing the foundational skills and knowledge in STEM subject matter. At this level most of the students with disabilities are involved in STEM through basic classes such as math and science. Most of the information should not pose a problem to competent special education teachers and student academic and behavioral issues should not pose a serious problem to STEM teachers.

Later, at the secondary level, the special education teacher’s role remains similar with co-teaching and support functions. At this level the subject matter becomes more specialized, challenging, and advanced. This juncture is important because it could possibly set the tone for a student’s interest in STEM material for the future. At this level, the special education teacher may have to co-teach a class. They would be required to actually plan and teach a lesson in any STEM area. Do special education teachers have the content knowledge necessary to complete the task of co-teaching STEM classes? Likewise, do STEM teachers possess the instructional skills
to adequately support these students in their same classrooms (i.e., behavior management, differentiate instruction, data-driven research-based interventions)?

Full-inclusion models of instruction for students with disabilities are in place in most school systems. These models often necessitate the need for Special education teachers to co-teach with STEM teachers. Likewise, many STEM teachers are faced with high caseloads of individuals with disabilities who are mainstreamed in their classrooms both with and without classroom assistance. The purpose of this study was to examine cross-credentialing between STEM education and Special education teachers. Are the two field mutually exclusive or are there some commonalties between the fields? The following research questions guided this research:

1.) To what extent are elementary and secondary STEM education teachers credentialed in Special education?

2.) To what extent are elementary and secondary Special education teachers credentialed in STEM education?

**Instrumentation**

The Schools and Staffing Survey (SASS) is conducted by the National Center for Education Statistics (NCES) on behalf of the U.S. Department of Education in order to collect extensive data on American schools. The SASS is an excellent source on the characteristics and qualifications of teachers and principals, teacher hiring practices, professional development, class size, and other conditions in schools across the United States. Because the SASS is a comprehensive large-scale survey of K–12 education in the United States it is composed of five types of questionnaires. This study employed the SASS Teacher Questionnaire (SASS TQ). The purpose of the SASS TQ was to obtain information about teachers, such as education and
training, teaching assignment, certification, workload, and perceptions and attitudes about teaching. According to Tourkin et al (2010, p. 3):

The overall objective of SASS is to collect the information necessary for a comprehensive picture of elementary and secondary education in the United States. The abundance of data collected permits detailed analyses of the characteristics of schools, principals, teachers, school libraries, and public-school district policies. The linkage of the SASS questionnaires enables researchers to examine the relationships among these elements of education. Therefore, SASS provides a multitude of opportunities for analysis and reporting on elementary and secondary educational issues.

Participant Description

The population for this study was full and part-time Science, Technology Education, Mathematics, and Special education teachers in public school systems within the United States. The placement into a teaching area was defined by the response to SASS TQ question 16, “This school year what is your MAIN teaching assignment at THIS school?” Table 1 show the coding scheme used to place each teacher in their respective teaching area.

<table>
<thead>
<tr>
<th>Teaching Area</th>
<th>Code</th>
<th>Summary Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science</td>
<td>210</td>
<td>Science, General</td>
</tr>
<tr>
<td></td>
<td>211</td>
<td>Biology or life sciences</td>
</tr>
<tr>
<td></td>
<td>212</td>
<td>Chemistry</td>
</tr>
<tr>
<td></td>
<td>213</td>
<td>Earth sciences</td>
</tr>
<tr>
<td></td>
<td>215</td>
<td>Integrated science</td>
</tr>
<tr>
<td></td>
<td>216</td>
<td>Physical sciences</td>
</tr>
<tr>
<td></td>
<td>217</td>
<td>Physics</td>
</tr>
<tr>
<td>Mathematics</td>
<td>191</td>
<td>Algebra I</td>
</tr>
<tr>
<td></td>
<td>192</td>
<td>Algebra II</td>
</tr>
<tr>
<td></td>
<td>193</td>
<td>Algebra III</td>
</tr>
<tr>
<td></td>
<td>194</td>
<td>Basic and general mathematics</td>
</tr>
</tbody>
</table>
The target population for this study was elementary and secondary teachers. As such, we chose those teachers who indicated that they taught at either the elementary or secondary level. The SASS TQ variable TLEV2_03 was employed to make the determination of instructional level. The variable TLEV2_03 grouped teachers’ responses into either elementary or secondary as the instructional level. For the purpose of this study elementary teacher are those who teach kindergarten through sixth grade. Secondary teachers are those teachers who, in general, instructed any of the grades from seven through 12. Table 7 provides a description of these teachers for elementary teachers and Table 8 provides a description of secondary teachers.

### Table 7. Descriptive information for elementary teachers in each content area.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Science Education</th>
<th>Mathematics Education</th>
<th>Technology Education</th>
<th>Special Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighted Sample Size</td>
<td>18,180</td>
<td>31,760</td>
<td>4,720</td>
<td>239,290</td>
</tr>
<tr>
<td>Age (Years)</td>
<td>40.97</td>
<td>42.33</td>
<td>45.10</td>
<td>42.09</td>
</tr>
<tr>
<td>Teaching Experience (Years)</td>
<td>12.18</td>
<td>14.65</td>
<td>16.86</td>
<td>13.08</td>
</tr>
<tr>
<td>Male</td>
<td>17.1%</td>
<td>81.0%</td>
<td>38.2%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Female</td>
<td>82.9%</td>
<td>19.0%</td>
<td>61.8%</td>
<td>94.3%</td>
</tr>
<tr>
<td>Full-time Teacher</td>
<td>92.9%</td>
<td>89.7%</td>
<td>57.8%</td>
<td>89.8%</td>
</tr>
<tr>
<td>Part-time Teacher</td>
<td>7.1%</td>
<td>10.3%</td>
<td>42.2%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Bachelor’s Degree or Less</td>
<td>44.9%</td>
<td>36.0%</td>
<td>51.5%</td>
<td>36.2%</td>
</tr>
</tbody>
</table>
Table 8. Descriptive information for secondary teachers in each content area.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Science Education</th>
<th>Mathematics Education</th>
<th>Technology Education</th>
<th>Special Education</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weighted Sample Size</td>
<td>208,520</td>
<td>250,230</td>
<td>45,890</td>
<td>191,310</td>
</tr>
<tr>
<td>Age (Years)</td>
<td>41.67</td>
<td>40.83</td>
<td>46.89</td>
<td>41.73</td>
</tr>
<tr>
<td>Teaching Experience (Years)</td>
<td>12.80</td>
<td>12.81</td>
<td>15.34</td>
<td>13.03</td>
</tr>
<tr>
<td>Male</td>
<td>40.0%</td>
<td>36.8%</td>
<td>79.2%</td>
<td>24.2%</td>
</tr>
<tr>
<td>Female</td>
<td>60.0%</td>
<td>63.2%</td>
<td>20.8%</td>
<td>75.8%</td>
</tr>
<tr>
<td>Full-time Teacher</td>
<td>97.9%</td>
<td>97.8%</td>
<td>95.9%</td>
<td>94.7%</td>
</tr>
<tr>
<td>Part-time Teacher</td>
<td>2.1%</td>
<td>2.2%</td>
<td>4.1%</td>
<td>5.3%</td>
</tr>
<tr>
<td>Bachelor’s Degree or Less</td>
<td>41.0%</td>
<td>44.1%</td>
<td>54.4%</td>
<td>34.4%</td>
</tr>
<tr>
<td>Master’s Degree or Higher</td>
<td>59.0%</td>
<td>55.9%</td>
<td>45.6%</td>
<td>65.6%</td>
</tr>
<tr>
<td>Fully Certified</td>
<td>91.1%</td>
<td>89.8%</td>
<td>86.1%</td>
<td>89.1%</td>
</tr>
<tr>
<td>Traditional Certification Route</td>
<td>74.2%</td>
<td>81.3%</td>
<td>76.9%</td>
<td>81.1%</td>
</tr>
<tr>
<td>Alternative Certification Route</td>
<td>25.8%</td>
<td>18.7%</td>
<td>23.1%</td>
<td>18.9%</td>
</tr>
</tbody>
</table>

Note. Weighted sample values are rounded to the nearest 10 per IES protocol.

Methods

The methodological approach of this study closely followed that of Besterman, Williams, and Ernst (2018) and was a secondary analysis of the SASS TQ restricted-use dataset. Initial access to the restricted-use dataset was authorized by the NCES to Virginia Tech. In accordance to the restricted-use access agreement, specific reporting protocols and the results were submitted to IES for review. After review, the NCES authorized the release of the findings to a general audience.

The two research questions explored in this study examined teacher credentials concerning STEM education and Special education teachers. In this SASS TQ analyses there
were 559,290 instances for STEM educators and 430,600 instances for Special educators within the weighted results. When broken into primary and secondary levels, this resulted in 54,660 instances for STEM educators and 239,290 instances for Special educators for primary and 504,630 instances for STEM educators and 191,310 instances for Special educators for secondary. The NCES and IES require that all weighted n’s be rounded to the nearest 10 to assure participant anonymity. Therefore, data presented in the tables and narratives may not add to the total N reported due to rounding adjustments. All analyses were conducted with weighted data.

This study analyzed the credentials of STEM educators collectively compared the credentials of Special education teachers. Additional analyses each area of STEM education compared to Special education. The percentage of STEM educators both collectively, and in individual areas, were examined on credentials related to both STEM education and Special education. Conversely, Special education teachers were examined concerning their special education and STEM education credentials.

**Certification Credentials**

The SASS TQ has 13 questions related to certification. The first 10 are questions are related to state certifications held by the teacher. The remaining three are related to any National Board Certifications held by the teacher. The teacher lists the codes for certifications that they hold.

In this study, Science, Technology education and Mathematics were collectively categorized as STEM certification credentials. Response SASS TQ codes indicating a STEM certification credential are listed in table 6 under Science, Technology Education and Mathematics sections.
Reponses codes indicating a Special education certification credential were Special Education, General, Autism, Deaf and Hard-of-hearing, Developmentally Delayed, Early Childhood Special Education, Emotionally Disturbed or Behavior Disorders, Learning Disabilities, Intellectual Disabilities, Mildly or Moderately Disabled, Orthopedically Impaired, Severely or Profoundly Disabled, Speech or Language Impaired, Traumatically Brain-injured, Visually Impaired, and Other Special Education.

**Degree Credentials**

The SASS TQ has 11 questions relating to degree credentials. They included a bachelor’s degree code, bachelor’s degree second major code, bachelor’s degree minor code, master’s degree code, Vocational code, Associates degree code, second bachelor’s degree code, second master’s degree code, Education Specialist degree code, Advanced graduate studies code, and PhD code. The SASS TQ names corresponding to the degree codes for the STEM fields were Mathematics, Biology or life sciences, Chemistry, Earth sciences, Physics, Other natural sciences, Construction Trades, Engineering, or Science Technologies (including CADD and drafting), Manufacturing and Precision Production (electronics, metalwork, textiles, etc.), Communications and Related Technologies (including design graphics, or printing), or General Technology Education (Technological systems, industrial systems, and pre-engineering). The Special education credentialing code was Special education, any. This corresponded to any type of degree relating to special education.

**Results**

Table 4 shows the services loads, certification and degree credentials for primary STEM education teachers and Special education teachers. Table 5 shows the service loads, certification and degree credentials for secondary STEM education teachers and Special education teachers.
Over 90 percent of all elementary and secondary STEM education and Special education teachers reported having students with disabilities (SWD) on their caseloads. The mean number of SWDs on the caseloads varied widely among the STEM disciplines.

At the elementary level, a lower percentage of Special education teachers had STEM certification than STEM education teachers had Special education (SPED) certification. Special education teachers had a higher percentage of STEM degrees compared to STEM education teachers with SPED degrees. Technology education teachers were noteworthy as they had the highest service load of SWDs (even higher than SPED teachers) and they had a SPED certification rate roughly three times higher than Mathematics teachers and five times higher than Science teachers.

At the secondary level, a higher percentage of Special education teachers had STEM certification than STEM education teachers had SPED certification. A higher percentage of Special education teachers also had STEM degrees than STEM education teachers had SPED degrees. Technology education teachers had a higher caseload of SWDs than Mathematics and Science, but it was not higher than Special education teachers at the secondary level.

<table>
<thead>
<tr>
<th>Teaching Area</th>
<th>Teachers with SWDs</th>
<th>Service Load SWDs</th>
<th>SPED Certification</th>
<th>STEM Certification</th>
<th>SPED Degree</th>
<th>STEM Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEM All</td>
<td>83.7%</td>
<td>12.74</td>
<td>5.3%</td>
<td>27.6%</td>
<td>2.7%</td>
<td>23.6%</td>
</tr>
<tr>
<td>Science</td>
<td>89.9%</td>
<td>14.04</td>
<td>2.8%</td>
<td>26.4%</td>
<td>3.0%</td>
<td>19.3%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>79.8%</td>
<td>7.09</td>
<td>5.3%</td>
<td>27.8%</td>
<td>2.9%</td>
<td>27.9%</td>
</tr>
<tr>
<td>Technology Education</td>
<td>85.9%</td>
<td>45.70</td>
<td>15.2%</td>
<td>31.5%</td>
<td>0.0%</td>
<td>35.9%</td>
</tr>
<tr>
<td>Special Education</td>
<td>98.9%</td>
<td>14.44</td>
<td>94.0%</td>
<td>2.7%</td>
<td>76.2%</td>
<td>4.8%</td>
</tr>
</tbody>
</table>

Note. SWD is students with disabilities. SPED is special education. STEM is science, technology, engineering and mathematics education.
Table 10. Students with disabilities service load and SPED and STEM credentials at the secondary level.

<table>
<thead>
<tr>
<th>Secondary</th>
<th>Teachers with SWDs</th>
<th>Service Load SWDs</th>
<th>SPED Certification</th>
<th>STEM Certification</th>
<th>SPED Degree</th>
<th>STEM Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEM All</td>
<td>91.8%</td>
<td>12.04</td>
<td>5.5%</td>
<td>81.8%</td>
<td>3.9%</td>
<td>68.6%</td>
</tr>
<tr>
<td>Science</td>
<td>93.3%</td>
<td>13.35</td>
<td>4.7%</td>
<td>84.5%</td>
<td>2.8%</td>
<td>74.7%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>90.0%</td>
<td>10.19</td>
<td>6.5%</td>
<td>80.4%</td>
<td>4.9%</td>
<td>63.4%</td>
</tr>
<tr>
<td>Technology Education</td>
<td>94.3%</td>
<td>16.11</td>
<td>4.1%</td>
<td>77.5%</td>
<td>3.4%</td>
<td>69.0%</td>
</tr>
<tr>
<td>Special Education</td>
<td>99.9%</td>
<td>27.47</td>
<td>94.4%</td>
<td>10.8%</td>
<td>74.8%</td>
<td>6.5%</td>
</tr>
</tbody>
</table>

Note. SWD is students with disabilities. SPED is special education. STEM is science, technology, engineering and mathematics education.

Discussion and Conclusions

The results from this study support the notion that it is imperative that STEM education teachers and Special education teachers work together to educate students with disabilities in the inclusive STEM classroom (Ernst & Williams, 2015b, Williams, Kaui, & Ernst, 2016) as neither group has sufficient overlap in degree or certification credentials to accomplish the task alone. Over the last twenty years there has been a movement away from traditional education classrooms. This movement aimed at creating a more interdisciplinary, hands-on approach, focusing on STEM instruction for all students, including those students with disabilities. Given this focus, it would be reasonable to expect that student achievement would be increasing in these academic discipline areas for all students. In the case of general education students, there has not been a noticeable increase in performance in STEM subject areas. With regards to students with categorical disabilities, research indicates they are still encountering much difficulty mastering STEM content (Basham, & Marino, 2013).

Not only are students with disabilities performing lower than their general education peers in STEM academic areas, but it was reported that this low performance is leading student
with disabilities to become discouraged with STEM content as early as middle school (Marino, 2010). This is alarming because students with disabilities make up roughly one out of every eight public-school students in the United States and have a graduation rate that is almost 20 percentage points lower than the average graduation rate for general education students.

This not only makes students with disabilities the second lowest graduation rate of all groups but indicates that roughly 12% of our students are discouraged with STEM prior to even entering high school (Civic Enterprise, 2014). From a societal perspective, this is problematic due to the reported influx of STEM related jobs, as well as an increase in the number of science, technology, engineering, and mathematics jobs in the United States designed intentionally for students with disabilities (Basham, & Marino, 2013).

Even though many of students with disabilities are very capable to perform these jobs and their essential tasks, many of them do not take the initiative to pursue STEM careers after high school and college (Basham, & Marino, 2013). As the number of students with disabilities continues to rise, it is more important than ever to ensure that they are successfully engaged in the STEM education learning process so that they are effectively prepared to engage in the increasing STEM-based work force. One way to ensure this is to investigate and verify the preparation and credentialing of those educators whom are responsible for their instruction within the STEM education learning environment. Alignment of teacher capability regarding preparation and credentials to students needs is critical to understanding the quality of instruction in all STEM classrooms, including inclusive STEM.

As the importance of teacher preparedness and content credentials has been long established within the research community, we must look to those that are postured to receive instruction to ensure that educators understand both their content and their instructional
audience. Within inclusive STEM environments, both special educators and STEM educators play critical roles in effective student support, teaching, and development. Credentials represent knowledge and experiences obtained that indicate instructional preparedness for interdisciplinary inclusive environments.

References


Besterman, K, Williams, T, & Ernst, J.V. (under review). *STEM Teachers’ Preparedness for English Language Learners.*


Podgursky, M. (2002). *NAEP background questions: What we can learn from NAEP about the effect of schools and teachers on student achievement?* Columbia, MO.


Chapter 5. Conclusion to the Dissertation

In order for STEM education and Special Education teachers to meet the needs of all learners in their increasingly inclusive STEM classrooms it is imperative that they are prepared from both an instructional and content perspective to manage and deliver effective instruction (Ernst, 2014). The importance of instructional readiness and appropriate content credentialing of teachers are critical components to the success of students with disabilities in an inclusive STEM education classroom setting.

Instructional preparedness is one of the foundational component for best practice and accomplishing student achievement goals and objectives. This includes the learned ability of special education and STEM teachers to be able to manage instructional presentation, manage behavior, and implement data-driven educational solutions. Teachers who are properly prepared to use a variety of research-based teaching methods, both instructional and behavioral, are better equipped to educate in diverse learning environments as it reduces reactive and adverse teaching methods which result in teacher frustration causing teachers to withdraw from their position as an educator (Baker, 2005). The ability to map a student’s ability and required modifications to the least restrictive environment (LRE) have always been at the heart of a CST teams duty in providing appropriate placements for students with disabilities as inclusive classroom settings are not always appropriate. For a student with disabilities to truly find success in a placement, the CST must investigate and assess the pedagogical and behavioral services that will be present within the decided LRE. One such critical pedagogical service employed by teachers to assist students with disabilities is the capability of a teacher to differentiate instruction to meet the child’s ability level in an inclusive setting. This is specifically important in an inclusive classroom as this setting contains students with varied abilities, and differentiation includes
varied levels of activities, and employs a variety of strategies to meet the needs of all students with different abilities.

Teacher training plays a large role in instructional readiness for teachers and is an important aspect to the success of students with disabilities in an inclusive environment (Bakken, 2016). In fact, Bakken reported that the Individualized Education Plan team needs to answer questions regarding general educator’s training in working with students with disabilities as well as the special education teacher’s role in supporting both the general education teacher and the student with disabilities in the classroom. If inclusion is to be successful, STEM education teachers and special education teachers need to work closely together and compromise. It requires that the teachers have training and support to overcome the challenges together.” (Bakken, 2016) The results of study-one support the notion that in order for inclusion to be implemented and facilitated successfully, both STEM education teachers and special education teachers will need to collaborate, compromise and be provided with appropriate training and support to overcome teaching and learning challenges together (Bakken, 2016) (Ernst & Williams, 2015b, Williams, Kau, & Ernst, 2016). This notion requires further investigation and planning specifically regarding pedagogical-based Science teacher preparation curriculum. Although there was a statistically significant difference between STEM collectively and Special education regarding perceived instructional readiness, the difference appeared to be primarily due to the Science teachers.

This notion is further supported by the SASS TQ data which indicated that neither STEM educators or Special educators have a sufficient overlap in degree or certification credentials to accomplish the task of educating in an inclusive setting alone. This is a concern as not only are teachers operating in an Inclusive STEM classroom responsible for independent content
knowledge of STEM subjects, but over the last twenty years there has been a movement away from traditional silo discipline-based education classrooms. This recent movement is aimed at creating a more interdisciplinary, hands-on approach, focusing on STEM instruction for all students, including those students with disabilities. Given this new focus and dedicated resources both research and funding-based, it would be reasonable to expect that student achievement would be increasing in these academic discipline areas for all students. In fact, general education students have not noticeable increase in achievement in STEM subject areas and students with categorical disabilities are still encountering much difficulty mastering STEM content (Basham, & Marino, 2013). In regards specifically to students with disabilities, they are performing lower than their general education peers in STEM academic areas and are becoming discouraged with STEM content as early as middle school (Marino, 2010).

Not only was there a reported insufficient overlap of credentials between STEM education and special education teachers, the sheer amount of STEM teachers with special education credentials was extremely low. At the elementary level only 5.3% of all STEM teachers had a special education certification, and at the secondary level only 5.5% of all STEM teachers had a special education certification. This leaves approximately 95% of all K-12 STEM teachers lacking the appropriate credentials to properly service roughly 12% of all student populations.

The drop-off of special education students in STEM subjects is distressing as they make up approximately 12% of public-school students and have graduation rate that is almost 20 percent lower than the average graduation rate for general education students (Civic Enterprise, 2014). From a societal perspective, this is concerning due to the reported fact that many special education students do not take the initiative to pursue STEM careers after high school and
college (Basham, & Marino, 2013) at the same time there has been an increase of STEM related jobs designed intentionally for students with disabilities (Basham, & Marino, 2013). Given these industry opportunities and the rise in number of students with disabilities it is becoming increasingly important for our educational systems to ensure their successful engagement and learning in the STEM education learning process. One reasonable starting point would be to investigate and verify the teacher preparation and credentialing process of those educators whom are responsible for their instruction within the STEM education learning environment. The alignment of teacher preparation programs regarding instructional readiness and content credentials to students needs is critical to understanding the quality of instruction in all STEM classrooms, including inclusive STEM.

As the significance of teacher preparedness from both an instructional and content credential perspective have been long established in educational research, and the increase of special education students continue to rise, we must look to our student populations to ensure that teachers understand both audience from both a content and their instructional audience. Special educators and STEM educators play critical roles in facilitating effective student support, teaching, and development within inclusive STEM environments whereas their credentials represent knowledge and experiences obtained through teacher preparation programs that can be viewed as indicators of instructional preparedness for interdisciplinary inclusive STEM environments.

**Implications**

Given the findings of this study it is imperative that we identify and investigate implications. The reported lack of instructional preparedness for first year secondary STEM education and Special education teacher to employ inclusive STEM education best practices, specifically differentiated
instruction, behavior management and data to inform instruction, education associated with students with disabilities be a focal factor of teacher preparation. Given the findings of this study regarding the reported lack of sufficient overlap of credentialing between STEM educators and Special educators, states and credentialing associations should formally create dual certification and credentialing processes for STEM and Special educators localized at the state level. The results of this study would also advocate for widespread inclusive STEM education credentialing and programming. The reported lack of interest and participation in Special education professional development of general education teachers would advocate for revision of topics and formats of offered Special education professional development.

Future Research Recommendations

Given the findings of this study I would suggest further investigation into the credentialing and instructional programs available to higher-education students pursuing a teaching career in the STEM disciplines. This coupled with the reported findings indicating the lack of attendance in professional development and workshops by general education teachers in the area of special education throughout their career also is suggestive of an investigation regarding PD offerings and workshops related to special education.

Teacher Preparation Programs

Special education coursework is predominately focused on instructional strategies and lacks content expertise and mastery. It would be reasonable to assume that in order to effectively employ instructional strategies, one would have to understand the breadth of the content in which is situated within the instructional strategy. Employing an instructional strategy regarding a specific content without the appropriate understanding of the content could lead to a disconnected understanding of concepts for students within a discipline. The approach of
delivering content without content connection mastery could be considered more of a hot-fix approach to delivering content, then it would be to truly teach to understanding. I would propose the further investigation into a hybrid approach to TOSD credentialing process. This may be accomplished through a requirement of a discipline-based minor or focus of study (minimum credit) within the endorsement which would dictate the inclusive environments they are permitted to instruct.

**Professional Development**

With the reported lack of instructional preparedness by first year secondary STEM teachers to employ instructional strategies to special education students, and lack of attendance in special education PD and workshops, further investigation into PD offerings and school guidelines is recommended. Are these offerings presented as critical to general education teachers? Do these offerings occur during opportune times for general education teachers, given the focus on standardized testing? Do school administrators require or provide guidelines specific to general education teachers attendance in special education workshops? Do state mandated Professional Improvement Plans require educators to include special education trainings for teacher whom are creating Professional Development Plans?

**Discipline Specific Best Practices:**

Differentiated instruction, behavior management, and data to inform instruction are cross disciplinary and ability level best practices. The reported lack of instructional preparedness in these areas for STEM education teachers may signify their overall unpreparedness in their specific discipline as well. Further research should be conducted regarding High-Leverage and Decomposition of practices for teachers in specific content and grade levels and measured for initial preparedness. Based on these findings, teacher preparation programs may want to integrate
both High-Leverage and decomposition of practice for core STEM areas into both their
curriculum and credentialing assessments.