Instructional Readiness in the Inclusive STEM Classroom

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Abstract

Since the implementation of school inclusion, STEM educators have been tasked with serving an increasing number of students with disabilities in their classrooms. Often this requires that STEM educators and Special educators work together in the same classroom. Although their initial instructional preparedness is very discipline specific, the increase in inclusive STEM education classrooms has created new opportunities for both STEM educators and Special educators to collaborate. This study utilizes the *National Teacher and Principal Survey* to identify similarities and differences in perceived readiness for beginning secondary STEM educators and Special educators in instructional best practices necessary to facilitate students with disabilities in the inclusive STEM education classroom. While no statistically significant differences in perceived readiness scores were found within STEM educators, Special educators had statistically significantly higher perceived readiness scores than STEM educators both collectively and individually.

Keywords: Special Education, STEM Education, *National Teacher and Principal Survey*, Differentiated Instruction, Behavior Management, Data-driven Instruction

An increase in the 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 (Green & Casale-Ciannola, 2011; Williams, Ernst, & Rossi, 2018), 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 increase in the number of students with disabilities STEM teachers often have on their caseloads (Ernst & Williams, 2014, 2015; Williams, Ernst, & Clark, 2018).

This increase has had significant impact on the roles and responsibilities of both STEM education teachers and Special education teachers. 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 for individualized and specialized instructional strategies (Jones & Peterson-Ahmad, 2017; CEC, 2015) but often lack knowledge of STEM content areas.

Inclusive STEM education classrooms require that STEM education teachers adopt many of the research-based Special education instructional strategies to ensure that opportunities for learning for all students is occurring within their classrooms. This is especially critical since reports generally indicated that teachers characteristically identified 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 (Cramer, 2015; Agran & Alper, 2000). Among special education research-based instructional practices most commonly used are differentiated instruction, behavior management, and data-informed instruction. Obtaining these special education skill-sets is critical for STEM education teachers' mission to reach all students.

Preparedness to Teach Students with Disabilities

The increase in students with disabilities and their placement in inclusive STEM settings has created new challenges for secondary STEM teachers with regard to their preparation to teach students with disabilities (National Center for Education Statistics, 2016). Williams, Ernst, and Rossi (2018) investigated the preparedness of secondary STEM educators and Special educators to serve students with disabilities in the inclusive STEM classroom through the examination of teaching credentials. They found that there was very little overlap on credentialing between STEM education teachers and Special education teachers. Only a very small percentage of secondary STEM education teachers had cross-credentialing in Special education, even though over 90 percent reported having students with disabilities on their caseloads. They found that a higher percentage of Special education teachers had STEM certification than STEM education teachers had Special Education certification and a higher percentage of Special education teachers had STEM related degrees than STEM education teachers had Special Education related degrees.

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 (Tatar, Tuysuz, Tosun, Ilhan, 2016; McCray & Chen, 2012; Rice 2003; Wright, Horn, & Sanders, 1997). Even in an inclusive classroom environment, students with disabilities have learning needs that vary from student to student and may require instructional approaches that are different than their general education peers. Best practices for students with disabilities who are receiving instruction in an inclusive STEM education classroom can be facilitated by differentiated instruction, behavior management and the use of data to inform instruction. For inclusive STEM education teachers to reach all students and meet their learning needs, it is important for them to be prepared to deploy these best practices in their classrooms. How prepared are STEM educators to implement the research-based best practices of differentiated instruction, behavior management, and data-informed instruction in their classrooms?

Differentiated Instruction. Differentiated instruction (DI) is an educational framework that encompasses a variety of lesson plans and tailored curriculum selection that meets an individual student's 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). 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 those who will be entering the classrooms as teachers.

Behavior Management. A teacher's ability to appropriately manage his or her classroom environment and student behavior is foundational to both teaching and learning. 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 behaviorally and academically (George Washington University Milken Institute School of Public Health, 2015). Behavior disorders have a negative impact on a student's ability to attain new content and skills (Barkley, 2006; Heward, 2013; Mesibov & Shea, 1996) and are a root cause for educators to separate students from the classroom (Salend & Duhaney, 1999; Santoli, Sachs, Romey, & McClurg, 2008). Behavior management is a critical component of teaching in every classroom.

Data-informed Instruction. Student data should be utilized to make informed decisions about the content and skills that learners need to be successful. 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. 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). 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).

Research Questions

As evidenced through research, the inclusive educational classroom relies on the instructional and management abilities of educators specific to differentiated instruction, behavior management, and the utilization of data to inform instruction. These three abilities can be investigated through the use of nationally representative data for STEM educators and Special educators. The *National Teacher and Principal Survey Teacher Questionnaire* (NTPS TQ) permits direct examination of beginning secondary STEM and Special education instructional readiness as it pertains to these three abilities. This investigation was guided by three research questions associated with beginning secondary STEM educators' and Special educators 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 beginning secondary STEM educators?
(2) What is the level of perceived instructional readiness for beginning secondary Special educators?
(3) Are there identifiable differences in perceived instructional readiness among beginning secondary STEM educators and beginning secondary Special educators?

Method

Instrumentation

This study utilized the 2015-2016 *National Teacher and Principal Survey* (NTPS) to analyze variables within the context of this study. The NTPS is a system of related questionnaires and is composed of three types of questionnaires: principal questionnaire, school questionnaire, and teacher questionnaire (NTPS TQ).This study employed the NTPS TQ. Goldring, Taie, Rizzo, and Riddles (2017, p. 1-3) stated that:

> The purpose of NTPS is to collect information that can provide a detailed picture of U.S. elementary and secondary schools and their staff. This information is collected through the following surveys: school, principal, and teacher. Information from all the surveys can be linked The Teacher Questionnaire contained nine sections: General Information; Class Organization; Education and Training; Certification; Early Career Experiences; Teacher Working Conditions; School Climate and Teacher Attitudes; General Employment and Background Information; and Contact Information. Estimates can be produced at the national level for each target population (i.e., schools, principals, and teachers).

Participants

The target population for this investigation was beginning secondary, full and part-time public school Science Education, Technology and Engineering Education, Mathematics Education, and Special Education teachers. Teachers' placement into these categories was determined by their main teaching assignment. The main teaching assignment was determined by NTPS TQ question, "Using Table 1 on page 10, this school year, in what subject is your MAIN teaching assignment at THIS school, that is, the subject matter in which you teach the most classes?" Table 1 in the NTPS TQ contained the response codes used to determine main teaching assignment.

Teachers with NTPS TQ 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 and Engineering 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 Engineering, 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 NTPS TQ variable NEWTCH who are teachers with three or fewer years of experience. The NTPS TQ variable TLEV_2CAT was employed to make the determination of instructional level. The target population for this study was secondary teachers. The variable TLEV_2CAT grouped teachers' responses into elementary or secondary as the instructional level. The NTPS TQ defines secondary teachers as those teachers who, in general, instructed any grades seven through twelve.

Data were weighted with the NTPS TQ supplied replicate weights to approximate the population of Science, Technology and Engineering Education, Mathematics, and Special Education teachers. The placement scheme and data weighting resulted in 31,220 Science teachers, 5,540 Technology teachers, 36,530 Mathematics teachers, and 27,350 Special Education teachers. A descriptive profile of teachers for the four teaching areas is presented in Table 1.

Procedure

This study analyzed data from the NTPS TQ restricted-use dataset. A restricted-use license was obtained 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 Besterman, Williams, and Ernst (2018).

The primary variable of interest in this study was perceived instructional readiness. This composite variable was the sum of three questions asking teachers how prepared they felt in their first year to: 1) handle a range of classroom management or discipline situations, 2) use data from student assessments 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

Variable	Science Education	Mathematics Education	Technology & Engineering Education	Special Education
Weighted Sample Size	31,220	36,530	5,540	27,350
Mean Age Years	30.22 (8.06)	29.25 (8.35)	39.11 (11.09)	32.40 (8.94)
Male	40.6%	31.7%	76.4%	28.5%
Female	59.4%	62.9%	23.6%	71.5%
Full-time Teacher	97.9%	98.7%	99.2%	93.1%
Note. Weighted sample values are rounded to the nearest 10 per IES protocol. Standard deviation is in parentheses.				

Table 1. Descriptive information for teachers in each content area.

Teacher Area	Variable	N	Mean	*SE*	*SD*	Min	Max
STEM All	Instructional readiness	73,300	7.479	0.088	2.102	3	12
Special Education	Instructional readiness	27,350	8.476	0.12	1.965	3	12
Note. *SE* is standard error. *SD* is standard deviation. Min is minimum score. Max is maximum score.							

Table 2. Area scores for perceived instructional readiness.

Teacher Area	Variable	N	Mean	*SE*	*SD*	Min	Max
Math	Instructional readiness	36,530	7.479	0.109	2.065	3	12
Science	Instructional readiness	31,220	7.466	0.135	2.111	3	12
Technology and Engineering Education	Instructional readiness	5,540	7.558	0.313	2.291	3	12
Special Education	Instructional readiness	27,350	8.476	0.12	1.965	3	12
Note. *SE* is standard error. *SD* is standard deviation. Min is minimum score. Max is maximum score.							

Table 3. Area scores for perceived instructional readiness.

Area 1	Area 2	Mean 1	Mean 2	*df*	*t*	*p*
Science	Math	7.466	7.479	200	0.085	0.933
Technology & Engineering Education	Math	7.558	7.479	200	0.238	0.812
Technology & Engineering Education	Science	7.558	7.466	200	0.265	0.791
Special Education	Math	8.476	7.479	200	6.549	< .001
Special Education	Science	8.476	7.466	200	6.04	< .001
Special Education	Technology & Engineering Education	8.476	7.558	200	2.661	0.008
Note. *df* is degrees of freedom. *t* is *t* value. *p* is probability level.						

Table 4. Independent samples t-test results for perceived instructional readiness between Science, Math, Technology and Engineering Education, and Special Education.

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 collectively examined STEM teachers to Special Education teachers on perceived instructional readiness. The second analysis examined the three STEM teaching areas (Science, Mathematics, and Technology & Engineering Education) compared to each other and 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 NTPS TQ supplied 200 replicate weight variables. A Jackknife 2 replication procedure was utilized as required by IES (Goldring, Taie, Rizzo, & Riddles, 2017). 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 ($M = 8.476$, $SD = 1.965$) than STEM teachers collectively ($M = 7.479$, $SD = 2.102$); $t(200) = 7.204$, $p < .001$. Cohen's *d* (0.490) indicated a moderate effect size for this difference.

Table 3 shows the values within STEM education and Special education for area comparisons. This table contains descriptive information for each of the teacher areas examined in this investigation. 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. The results showed that within the STEM area comparisons there were no statistically significant differences found for perceived instructional readiness. The STEM teaching areas appeared to be equal in their assessment of their perceived instructional readiness. There were statistically significant differences found between Special education teachers who had statistically significantly higher perceived instructional readiness scores than Science teachers, Technology and Engineering Education teachers, and

Math teachers. Cohen's *d* indicated a moderate effect size for this difference for Science teachers (0.495), Technology and Engineering Education teachers (0.430), and Math teachers (0.494).

Discussion

We believe that the majority of students with disabilities can be successfully included and educated in STEM education classrooms. However, the importance of instructional readiness cannot be understated if the inclusion of students with disabilities is to be successful. Williams, Ernst, and Rossi (2018) stated that neither STEM education teachers nor Special education teachers had sufficient training, as demonstrated through the overlap in degree or certification credentials, to accomplish the task alone. Within inclusive STEM classrooms, both Special educators and STEM educators play critical roles in providing effective student support, teaching, and development. In inclusive STEM education classrooms, it is essential that STEM teachers are able to manage instruction, manage behavior, and implement data-driven educational solutions. Based on the results of this study, progression is needed in instructional readiness among STEM educators in these areas.

While the inclusive STEM education classroom may not be the most appropriate, least restrictive environment (LRE) for students with severe disabilities, it is the most appropriate LRE for the majority of the students with mild to moderate disabilities. The necessary considerations when determining the appropriate placement in an inclusive environment includes matching the student's ability and required modifications with the LRE. It also requires an honest assessment of the level of support needed for the student to be successful in the inclusive STEM classroom and the abilities of the teachers to provide this support. To ensure success, it is critical to consider pedagogical and behavioral services that will be available within the LRE prior to an official placement. Teacher training is an aspect that is very important to the success of students with disabilities in an inclusive environment (Bakken, 2016). 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).

Prior to a placement of a student with disabilities into an inclusive classroom, Bakken (2016) suggested that the Individualized Education Plan team 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? The results from this study support the notion that it is vital that STEM education teachers and Special education teachers work together to educate students with disabilities in the inclusive STEM classroom. It requires that the teachers have training and support to overcome the challenges together. If inclusion is to be successful, STEM education teachers and Special education teachers need to work closely together and capitalize on each other's strengths.

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