Teaching Credentials in the Inclusive STEM Classroom

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Abstract

As integrated STEM education becomes more commonplace, the number of inclusive STEM classrooms containing students with disabilities will continue to rise. This presents many challenges to both STEM education teachers and Special education teachers. Do STEM education and Special education teachers have the appropriate 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

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; Ernst & Williams 2015; Williams, Kaui, & Ernst, 2015). 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 & 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).

An indicator of high quality teacher preparedness is licensure and certification (Allen, 2010). Browell, Ross, Colón & McCallum (2005) examined the importance of teacher certification and teacher quality directly related to teacher preparation. They 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.

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 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 content 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 may be required to plan and teach a lesson in any STEM content 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)?

Research Questions

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. 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 fields mutually exclusive or are there some commonalties between the fields? The following research questions guided this research:

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

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

Methodology

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 shows the coding scheme used to place each teacher in their respective teaching area.

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. The SASS TQ defines an elementary teacher as those who teach kindergarten through sixth grade. Secondary teachers were those teachers who, in general, instructed any of the grades from seven through 12. Table 2 provides a description of elementary teachers and Table 3 provides a description of secondary teachers.

Teaching Area	Code	Summary Description
Science	210	Science, General
	211	Biology or life sciences
	212	Chemistry
	213	Earth sciences
	215	Integrated science
	216	Physical sciences
	217	Physics
Mathematics	191	Algebra I
	192	Algebra II
	193	Algebra III
	194	Basic and general mathematics
	195	Business and applied math
	196	Calculus and pre-calculus
	198	Geometry
	199	Pre-algebra
	200	Statistics and probability
	201	201 Trigonometry
Technology and Engineering Education	246	Construction Technology - (Construction design and engineering, CADD and drafting)
	249	Manufacturing Technology (electronics, metalwork, precision production, etc.)
	250	Communication Technology (Communication systems, electronic media, and related technologies)
	255	General Technology Education (Technological systems, industrial systems, and pre-engineering)
Special Education	110	Special Education, Any

Table 1. SASS TQ codes and summary descriptors representing the main teaching assignment used to place teachers.

Variable	Science Education	Mathematics Education	Technology and Engineering Education	Special Education
Weighted Sample Size	18,180	31,760	4,720	239,290
Age (Years)	40.97	42.33	45.10	42.09
Teaching Experience (Years)	12.18	14.65	16.86	13.08
Male	17.1%	81.0%	38.2%	5.7%
Female	82.9%	19.0%	61.8%	94.3%
Full-time Teacher	92.9%	89.7%	57.8%	89.8%
Part-time Teacher	7.1%	10.3%	42.2%	10.2%
Bachelor's Degree or Less	44.9%	36.0%	51.5%	36.2%
Master's Degree or Higher	55.1%	64.0%	48.5%	63.8%
Fully Certified	93.7%	90.2%	82.8%	88.3%
Traditional Certification Route	80.5%	89.8%	93.0%	85.0%
Alternative Certification Route	19.5%	10.2%	7.0%	15.0%

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

Table 2. Descriptive information for elementary teachers in each content area.

Procedure

The methodological approach of this study closely followed that of Besterman, Williams, and Ernst (2018) and was a secondary analysis of the 2011-2012 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 the Institute for Education Sciences (IES) for review. After review, the IES 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 the 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 elementary and secondary levels, this resulted in 54,660 instances for STEM educators and 239,290 instances for Special educators for elementary 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 were performed for 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.

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

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

Table 3. Descriptive information for secondary teachers in each content area.

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 and Engineering education, and Mathematics were collectively categorized as a STEM certification credential. Response SASS TQ codes indicating a STEM certification credential were those that indicated Science General, Biology or Life Sciences, Chemistry, Earth Science, Integrated Science, Physical Sciences, Physics, 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), 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. 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). For Special education the credentialing code was Special education, any. This corresponded to any type of degree relating to special education.

Teaching Area	Teachers with SWDs	Case-load SWDs	SPED Certification	STEM Certification	SPED Degree	STEM Degree
Elementary						
STEM All	83.7%	12.74	5.3%	27.6%	2.7%	23.6%
Science	89.9%	14.04	2.8%	26.4%	3.0%	19.3%
Mathematics	79.8%	7.09	5.3%	27.8%	2.9%	27.9%
Technology & Engineering Education	85.9%	45.70	15.2%	31.5%	0.0%	35.9%
Special Education	98.9%	14.44	94.0%	2.7%	76.2%	4.8%
Secondary						
STEM All	91.8%	12.04	5.5%	81.8%	3.9%	68.6%
Science	93.3%	13.35	4.7%	84.5%	2.8%	74.7%
Mathematics	90.0%	10.19	6.5%	80.4%	4.9%	63.4%
Technology & Engineering Education	94.3%	16.11	4.1%	77.5%	3.4%	69.0%
Special Education	99.9%	27.47	94.4%	10.8%	74.8%	6.5%

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

Table 4. Students with disabilities service load and SPED and STEM credentials at the elementary and secondary level

Results

The data indicated that there is very little overlap between STEM education teachers and Special education teachers on credentialing. Only a very small percentage of teachers had cross-credentialing even though over 80 percent of all elementary and over 90 percent of all 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. Table 4 shows the services loads, certification and degree credentials for primary and secondary STEM education teachers and Special education teachers

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.

Discussion

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, 2015; Williams, Kaui, & Ernst, 2015) as neither group has sufficient overlap in degree or certification credentials to accomplish the task alone. Over 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 students 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 related jobs in the United States designed intentionally for students with disabilities (Basham, & Marino, 2013).

Even though many 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.

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