Special Populations At-Risk for Dropping Out of School: A Discipline-Based Analysis of STEM Educators

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Introduction

Why are certain sub-groups of students dropping out of school? Kemp (2006) cited two general categories as reasons why students deemed at-risk discontinue high school enrollment. The first category, considered the primary reason for school dropout, was academic failure. These students had significantly lower achievement in science and math courses (Shifrer & Callahan, 2010) and struggled with low grades and grade-level retention. The second category was disengagement in school. Students who were at-risk experienced "limited quality in relationships and socialization" (Scanlon & Mellard, 2002, p. 239) leading to disengagement from co-curricular and extracurricular school activities and functions were at a higher risk to drop out of school. This suggests the need for increased academic support both in and out of the classroom.

With the increased national focus on science, technology, engineering, and mathematics (STEM) instruction for students with disabilities, it would seem logical that their performance would be substantially improving. However, they continue to struggle with STEM content (Basham, & Marino, 2013), perform lower than their peers without disabilities, and often become disenfranchised with STEM content as early as middle school (Marino, 2010). The outcome looks equally grim for students with limited English proficiency. The U.S. Department of Education released The Nation's Report Card: Science 2011, which showed that students with LEP scored 48 points lower than non-limited English proficient students on the National Assessment of Educational Progress science scale. This is extremely important because approximately 21 percent of all public school students are LEP and the numbers are expected to increase rapidly in the coming years.

Understanding the various needs and requirements, as well as the issues and challenges, of students with disabilities and LEP in STEM disciplines can be better understood and met by knowing where they are being served and who is providing the service. This can be clarified by examining the service capacity of technology, science, and mathematics education teachers and the specific service capacity differences between technology and science teachers, technology and mathematics teachers, and science and mathematics teachers.

Special Populations and Students At-Risk Defined

The term at-risk is often used to describe students or groups of students who are considered to have a high likelihood of failing academically or dropping out of school. The definition of at-risk often encompasses numerous factors associated with school failure or increased dropout rate. The term at-risk without proper context and definition can evoke many possibilities, characteristics, and conditions that can make comparisons and interpretation difficult. Therefore, in this investigational description, the term at-risk is defined as individuals who have a high likelihood of failing or dropping out of school and who are from special populations.

The term special populations was taken from the Carl D. Perkins Career and Technical Education Improvement Act of 2006 (20 U.S.C. 2301 et seq.) and refers to: (A) individuals with disabilities; (B) individuals from economically disadvantaged families, including foster children; (C) individuals preparing for non-traditional fields; (D) single parents, including single pregnant women; (E) displaced homemakers; and (F) individuals with limited English proficiency. This paper addressed students at-risk by examining two specific special populations within this group. The special populations were individuals with disabilities and individuals with limited English proficiency.

Students with disabilities represent a wide range of conditions. Within this group there are 13 categories of disabilities, as identified by the Individuals with Disabilities Education Act (IDEA, 2004) part B, for children and youth ages three through 21 in public school. The disability categories included in IDEA 2004 are autism, deaf-blindness, deafness, emotional disturbance, hearing impairment, intellectual disability, multiple disabilities, orthopedic impairment, other health impairment, specific learning disability, speech or language impairment, traumatic brain injury, and visual impairment,

including blindness. Students with disabilities require comprehensive assessments that allow schools to identify the disability or disabilities and to determine specific accommodations in the students' individualized education plans (IEP). Accommodations included in the IEP are alternative assignments and assessments, increased time on assignments and assessments, supplementary supports, such as a translator, note taker, or reader, the use and inclusion of universal design principles, or the use of assistive technologies.

The second group was students with limited English proficiency (LEP). Limited English proficient students are those who have limited ability in speaking, reading, writing, or understanding the English language, and whose native language is a language other than English, or who lives in a family or community environment in which a language other than English is the dominant language. They are a varied group and represent a wide constituency. There are over 5.5 million LEP students in U.S. public schools representing more than 400 different languages. Eighty percent of LEP students speak Spanish as their first language. Similar to students with disabilities, students with LEP have special testing and academic accommodations.

Since it has been shown that preparing a student for future success requires a high school diploma (Zhang & Law, 2005), it would seem plausible that these supports would increase graduation rates for both students with disabilities and students with LEP. However, students with disabilities and students with LEP have a much higher probability of not graduating from high school when compared to their peers. Two-thirds of students with disabilities will leave high school without a diploma (U.S. Department of Education, 2012). This is nearly double the rate of their non-disabled peers (President's Commission on Excellence in Special Education, 2002). Similarly, the U.S. Department of Education 2011 found that nearly half of the states graduated less than 60 percent of students with LEP in 2010-2011; with cohort graduation rates ranging from 25 percent to 84 percent. Considering this epidemic, educational needs of these subgroups in STEM education can be better understood by first examining by whom and where they are actually served.

Research Question

The purpose of this study was to determine the mean service capacity of students with disabilities and LEP of STEM teachers in the United States and to investigate the potential service capacity differences between technology, science, and mathematics education teachers using the results from the 2011-2012 Schools and Staffing Survey. This study was guided by the following research questions:

1. What is the mean service capacity of students with disabilities and LEP of STEM teachers?
2. With regards to the mean service capacity of students with disabilities and LEP, are there statistically significant differences between technology, science, and mathematics education teachers?

The mean service capacity was explored through the frequency and proportional accounts of weighted technology, science, and mathematics educator reports of students with disabilities and LEP taught within the period of a single academic year. The differences in mean service capacity were investigated through testing associated trial hypotheses:

A) There is no difference in mean service capacity (students with disabilities and LEP) of technology education and science education teachers;

B) There is no difference in mean service capacity (students with disabilities and LEP) of technology education and mathematics education teachers; and

C) There is no difference in mean service capacity (students with disabilities and LEP) of science education and mathematics education teachers.

Secondary dataset analysis was employed to examine the collective and stratified technology, science, and mathematics education teachers' service capacity of students with disabilities and LEP. The Schools and Staffing Survey of the National Center for Education Statistics datasets provides size and complexity that allows for weighted identification and analysis between contributions concerning accommodation services of technology, science, and mathematics education teachers from a national perspective.

Instrumentation

The United States Department of Education collects comprehensive data on American public and private primary and secondary school districts, schools, teachers, library media centers, and administrators via the administration of the Schools and Staffing Survey (SASS) by the National Center for Education Statistics (NCES).

The SASS offers information of a wide range of topics, including general school conditions, perceptions of school climate, hiring, compensation, and 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, SASS is an excellent resource for analysis and reporting on elementary and secondary educational issues retention practices, and student, teacher, and administrator characteristics (Tourkin, et al., 2010).

The SASS is a set of related questionnaires that was conducted by the NCES on behalf of the United States Department of Education in order to collect extensive descriptive data on public and private elementary and secondary schools in the United States. The SASS is national in scale and provides rich information to represent the target population through five types of questionnaires: a School District Questionnaire, Principal Questionnaire, School Questionnaire, Teacher Questionnaire and a School Library Media Center Questionnaire. The Teacher Questionnaire (SASS TQ) was specifically designed to collect teacher information regarding their education, training, and certification, assignment(s) and workload, professional development, and perceptions and attitudes toward the profession.

For this study, the researchers chose to specifically use the data from the 2011-2012 SASS TQ. The SASS TQ provides the most up-to-date data for public school teachers in the SASS series. This study created participant groups based on teacher responses to SASS TQ question 16, "This school year, what is your MAIN teaching assignment at THIS school? (Your main assignment is the field in which you teach the most classes)". The three participant groups (Science Education, Mathematic Education, and Technology Education) were created as follows:

1. Science Education was teachers indicating any of the Natural Sciences subject-matter specific codes;
2. Mathematic Education was teachers indicating any of the Mathematics subject-matter specific codes; and
3. Technology Education was teachers indicating four Career or Technical Education subject-matter specific codes: Construction Technology, Manufacturing Technology, Communications Technology, or General Technology Education.

Within these groups, researchers examined the number of students with IDEA disabilities and LEP for each participant group, based on teacher responses to SASS TQ question 14, "Of all students you teach at this school, how many have an Individualized Education Program (IEP) because they have disabilities or are special education students?" and teacher responses to SASS question 15, "Of all the students you teach at this school, how many are of limited-English proficiency or are English-language Learners (ELLs)? (Students of limited-English proficiency [LEP] are those whose native or dominant language is other than English and who have sufficient difficulty speaking, reading, writing, or understanding the English language as to deny them the opportunity to learn successfully in an English-speaking-only classroom)".

Methodology

This methodology of this study is based on Ernst,

Variable	Science Education	Mathematics Education	Technology Education
Weighted Sample	226700	281990	50610
Mean Years Experience	12.75	13.01	15.48
Male	86520	98050	38150
Female	140170	183940	12460
Mean Categorical	13.41	9.84	18.87
Mean LEP	7.10	5.98	7.60
Mean Service Load	20.51	15.82	26.48

Note: Mean Service Load was comprised of the sum of the Mean Categorical and the Mean LEP variables. Weighed sample values are rounded to the nearest 10 per NCES protocol.

Table 1. Descriptive Information for Teacher Areas

STEM Group	Weighted N	Mean At Risk	SE (Mean)	Standard Deviation	Minimum	Maximum
Science Ed	226700	20.505	0.743	23.938	0	240
Math Ed	281990	15.819	0.423	17.826	0	210
Tech Ed	50610	26.475	1.851	35.303	0	260
Note: Weighed sample values are rounded to the nearest 10 per NCES protocol.						

Table 2. Subject Area Comparisons for Students at-risk

Li, and Williams (2014) research examining the characteristics of Engineering Design Graphics teachers. This study consisted of a secondary analysis of the SASS TQ dataset administered by the NCES. Initial access was applied for and authorized by the NCES to *Institution*. The access provided members of the research team with designated single-site user admittance. Specific protocol and reporting information was submitted and subsequently accepted, where the NCES authorized approval and release. As per the rules of using restricted use data, all sample sizes and degrees of freedom were rounded to the nearest 10.

Within the SASS TQ, 559,300 instances populate the weighted results for technology, science, and mathematics education teachers. Per the rules of using restricted-use data, the NCES and IES require that all n's and degrees of freedom be rounded to the nearest 10 for SASS data to assure participant anonymity. Therefore, data in tables and narrative may not add to the total N reported because of rounding requirements.

The two study research questions were explored through the 559,300 instances within the SASS TQ dataset. For the purposes of analyses, technology education, science education, and mathematics education educator results were categorically summarized and represented in terms of service capacity of students with disabilities and students with LEP. The primary variables of interest in this study were the number of eligible students with disabilities and students with LEP served by the participant teacher groups. The number of eligible students with disabilities served was determined by responses from teachers who reported teaching students with recognized disabilities requiring an individualized education plan. The number of students identified as LEP was determined by responses from teachers

who reported teaching students who were individuals who did not speak English as their primary language and who had a limited ability to read, speak, write, or understand English. Data from the SASS TQ items for this group was extracted and analyzed using descriptive statistics and comparative analysis. Demographic information regarding participants' gender and years of experience can also be found in Table 1.

Data Analysis and Findings

Analysis of the descriptive statistics (see Table 1) illustrates evident gender differences in teachers of science, mathematics, and technology education, with 1.6 times more females than males in science, 1.8 times more in math, but 3.0 times more males than females in technology education. With regards to students with categorical disabilities, technology education accommodates 1.4 times more students with disabilities than science education and 1.9 times more than mathematics education. There appears to be a more homogenous number of students with LEP in the technology education and science education courses, but the LEP service load is approximately 1.2 times larger in both technology education and science education than in mathematics education. However, mean service load for technology education is notably higher than both the mean service load for science education (1.3 times larger) and mathematics education (1.7 times larger).

Standard error of the mean (Table 2) was calculated because the data used weighted samples and estimates that, for each subject area, how far the sample mean would be from the population mean. For example, if a sample of technology education teachers were taken

from the population, the mean of students at-risk would fall between ±1.851 of the weighted mean of 26.475 students at-risk. Technology education students at risk range from zero students to 260 students within a single school year, while science education students at risk and mathematics education students at risk had a range from zero to 240 and zero to 210, respectively. These statistics indicate a variance in the degree of inclusivity of subject area classrooms.

Independent-sample t-tests (see Table 3) were used to establish statistically significant difference in the mean number of students at-risk' service capacity for teachers who classified their primary teaching assignment as Technology Education (General Technology Education, Manufacturing Technology, Communication Technology, and Construction Technology), Science Education, and Mathematics Education in public schools. Independent-sample t-tests were conducted because each participant group's observations were independent and not influenced by other groups' observations. This resulted in three t-test comparisons between the three participant groups. The reported results were determined using a balanced repeated replication procedure employing the appropriate replicate weights as required by the NCES for SASS statistical analyses since SASS was developed to produce national, regional, and state estimates for public primary and secondary schools and their related constituents. The degrees of freedom were rounded to the nearest 10 per the NCES protocol when reporting statistical analyses.

Technology Education teachers had a higher number of students (μ=26.475) than Science Education teachers (μ=20.505) and Mathematics

	Mean (μ)			Mean (μ)	Difference	Std. Error Difference	df	t value	p value
Science Ed	20.505		Math	15.819	4.686	1.057	90	4.606	<.001
Tech Ed	26.475		Math	15.819	10.656	2.023	90	5.169	<.001
Tech Ed	26.475		Science	20.505	5.970	2.370	90	2.357	.021
Note: Weighted sample values and degrees or freedom are rounded to the nearest 10 per the NCES protocol.									

Table 3. Results from t-test for At-Risk Comparisons

Education teachers (μ=15.819). These differences were statistically significant, $t(90)$=2.357, p<0.021 when comparing Technology Education and Science Education, $t(90)$=5.169, p<0.000 when comparing Technology Education and Mathematics Education, and $t(90)$=4.606, p<0.000 when comparing Science Education and Mathematics Education. These results demonstrate that Technology Education teachers have a higher mean number of students at-risk compared to Science Education teachers and Mathematics Education teachers than would have been expected due to chance. However, it is of note that SASS results are self-reported which denotes the data dependency on individual answers of the study specified questions and may include unexpected interpretations of the question(s) by the respondent or respondent answers not being accurate or truthful. SASS provides specific data which requires the existing study and its corresponding questions to be framed within the context of the SASS TQ study survey questions.

Conclusions and Implications

Shifrer and Callahan (2010) identified "disproportionate credit accumulation in non-core course taking" (p. 65) by students with disabilities. Their research studied the differences in credit accumulation of nonacademic course and science and math courses. Due to low achievement in core courses, students with learning disabilities completed high school required science and math courses and for the remainder of their high school careers were placed in non-core courses like technology and communication (Shifrer & Callahan, 2010). Prior to the national STEM focus, the trend of placing students with learning disabilities in non-core course work appeared to place them at serious disadvantages with regards to science and math. However, with the pronounced emphasis on technology, non-core coursework better prepares students with learning disabilities by providing them with STEM knowledge and skills.

STEM teachers are uniquely positioned to lead the way in intervening on behalf of students at-risk with curricula focused on both vocational training and academic knowledge/skills (Shifrer & Callahan, 2010). Constructivist pedagogy and practices are shaping the science and mathematics reforms and are changing the way special education is integrating the two theories through the use of technology and technological advancements (Woodward & Montague, 2002). Additionally, Ernst and Moye (2013) discovered benefits beyond academic achievement that included successful engagement in coursework and improvement in self-perception for students at-risk.

Technology education aims to teach students to be technologically literate through the exploration and design of medical technologies, agricultural and related biotechnologies, energy and power technologies, information and communication technologies, transportation technologies, manufacturing technologies, and construction technologies (International Technology Education Association, 2007). The comprehensive nature of technology education inherently demonstrates its interdisciplinary characteristics which integrates specific content knowledge within a realistic context that allows application of knowledge within students' lives (Herschbach, 1998). Students collaboratively and interactively design, construct, and resolve real-world problems which presents students at-risk with a better learning environment because it allows them to use existing knowledge to create new knowledge (Cardon, 2000). Constructivist environments can become more structured by merging with behavioral models (Woodward & Montague, 2002). Such an integration of instructional models allows teachers the flexibility to provide a hands-on, interactive learning environment combined with direct skills instruction and practice also necessary for students at-risk. Students at-risk would "have dropped out of school" (Cardon, 2000, p. 54) had they not been given the opportunity to enroll in technology education courses. Technology education courses have the potential to model instructional strategies that provide effective learning for students at-risk. Science and mathematics education courses could benefit from further investigation of pedagogical practices and strategies that encourage students to construct personal meaning and knowledge through interactive investigations and explorations.

Technological advances "accentuate the gap between what is typically taught to students with learning disabilities and what individuals need to know in a world filled with computing devices" (Woodward & Montague, 2002, p. 92). Technology has the unique ability to promote effective classroom practices while allowing students at-risk to experience and interact with it. When faced with parts of an investigation that prove difficult for students at-risk and prevent them from successfully connecting with the "learning environment and achieving meaningful learning outcomes ... technology-based scaffolds can then be identified and incorporated into the investigation as a means to circumvent barriers and enhance students' processing abilities" (Marino, 2010, p. 6). With technology as a necessary and existing part of its curriculum, technology education already illustrates how to successfully incorporate technology in engaging and effective ways. Science and math education courses can capitalize by using technology to improve instruction and learning and to allow students at-risk to develop necessary technological literacies through contextual applications (Woodward & Montague, 2002).

Students at-risk rise above expected outcomes when provided with positive academic and environmental experiences at school (Cardon, 2000). Positive academic experiences go beyond academic performance. They include affirming relationships with teachers, counselors, administrators, and other students. They also could include extracurricular activities that have the potential to increase and improve social skills and self-perceptions, as well as classroom activities that allow for self-expression that can develop and advance self-determination (Cardon, 2000; Ernst & Moye, 2013; Zhang & Law, 2005). The collaborative and social nature of technology education can support at-risk students' development of teamwork, communication, and cooperative learning skills (Gokhale, 1995; Resta & Laferriere, 2007). Through broader scale incorporation of similar practices, science and mathematics educators could offer students similar opportunities within the breadth of the STEM education disciplines.

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