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Secondary Engineering Design Graphics Educators: Credentials, Characteristics, and Caseload

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Abstract

Although the caseload of students with categorical disabilities and limited English proficiency has increased in recent years for secondary engineering design graphics teachers, the level of preparation to teach students with these characteristics has not. Given that teachers must develop inclusive classroom environments for all students, the current state for teacher preparation in regards to working with students with categorical disabilities and limited English proficiency needs to be explored. This study analyzes data from the School and Staffing Survey Teacher Questionnaire to determine the current characteristics, credentialing, and caseload for secondary engineering design graphics teachers. The results show that almost two-thirds of engineering design graphics teachers have a bachelor's degree or less, while half of those have less than a bachelor's degree. In addition, approximately one-third of all engineering design graphics teachers are certified through alternative licensing programs, which include little to no preparation in working with students with categorical disabilities and limited English proficiency. The implications of these results are that as caseloads increase for teachers working with students with categorical disabilities and limited English proficiency, more preparation is required to provide teachers with evidence-based pedagogy in order for these students to achieve their learning potential.

Introduction

Secondary level engineering design graphics courses are an important part of preparing students with the necessary engineering graphics skills and knowledge to be successful in corresponding higher education programs. Many of these concepts are prerequisite for a range of STEM-related career choices that students may choose to pursue in a higher education setting. Even if not a specific course requirement, it can be extremely useful for students to have an understanding of how engineering design graphics knowledge and practices operate both in and outside of STEM-related fields. Addressing the needs of diverse populations within secondary school engineering design graphics courses is critical for STEM fields. Teacher preparation in the area of engineering design graphics needs to address this issue in order to engage all students in these courses. However, current teacher preparation programs do not lend themselves to address the

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needs of the growing diverse classroom that exists in most secondary level engineering design graphics courses (Zirkle, Martin, & McCaslin, 2007).

It is common to find an inclusive group of students within the average general education classroom. In recent years, the numbers of students with categorical disabilities and limited English proficiency (LEP) have increased in all academic disciplines (Casale-Giannola, 2012; U.S. Snyder, de Brey, & Dillow, 2016), with no exception given to skill-based courses such as engineering design graphics (Ernst, Li, & Williams, 2014). As gauged by the School and Staffing Survey Teacher Questionnaire (SASS TQ) datasets, the mean numbers of students in engineering design graphics courses that have a categorical disability or LEP increased between both the 2007-2008 dataset and the 2011-2012 dataset. Students with a categorical disability or LEP make up a significant proportion of the total number of students in the average classroom (Ernst et al., 2014). Under the protection of the Individuals with Disabilities Act (IDEA), millions of students across the education system receive extra supports that allow them to participate in their courses alongside their non-disabled peers. IDEA protects students between the ages of 3 years and 21 years of age in 13 different disability categories which include, 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) (National Dissemination Center for Children with Disabilities, 2012). Students with LEP are defined as “students whose primary language is not English” (Friend & Bursuck, 2014, p. 29) and are not covered under IDEA. These students may be similar to students with categorical disabilities in that they may require extra educational supports. These supports may include bilingual or other instruction outside of the main classroom that provides students the opportunity to learn English while continuing with the standard curriculum in the general classroom setting.

To accommodate the diverse range of students, teachers may consider applying adaptive or universal design features when planning lessons. Universal design features provide an effective approach to student learning that allows educators to deliver instruction through methods that make learning accessible for all students (Michigan State University, 2017; Shaw, 2011). These design features not only apply to classroom instructional time, but also include support materials that influences all areas of the students’ learning experience such as videos, labs, fieldwork, and computer technology (Burgstahler, 2011). Under guidelines set by IDEA, schools assess and decide what supports are needed for each student through the collaborative work of teachers, student disability specialists, and parental involvement. This method of assessment can lead to students with similar diagnoses receiving a wide variety and levels of support in a classroom environment. Most of this responsibility falls on the teacher to create the necessary environment needed for students with categorical disabilities and LEPs based on the student’s Individualized Education Plan (IEP). It is difficult in any educational setting to

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know exactly what services to provide in order to create an equal opportunity learning environment, even when catering to the student's IEP. However, the teacher can provide several accommodations in the classroom without completely restructuring the physical setting (Green & Casale-Giannola, 2011; Tomlinson, 1999). Inclusive environments may utilize differentiated instruction, collaborative activities, or common adaptive technologies (Leiding, 2009).

There is little research showing how the differences in teacher preparation relate to the ability to teach students with categorical disabilities. Every teacher preparation program is different, but prior research concludes the average teacher preparation program provides minimal courses in preparing teachers to work with students with categorical disabilities (Zirkle et al., 2007). Preparation programs for Career and Technical Education (CTE), the category under which Engineering Design Graphics falls, teachers may receive even less training for teaching students with categorical disabilities due to the number of courses needed to prepare them for the diverse range of content knowledge they need to teach (Casale-Giannola, 2012). In most teacher preparation programs, it is common for there to be only one course that focuses on managing students with accommodations, IEPs, or 504 plans. The primary focus of student accommodations covered during preparation courses include differentiating assessments, such as large print, the use of read-aloud assignments, or individualized testing facilities. However, student accommodations can include a much larger variety of possibilities. These could include but are not limited to modified instructional methods (e.g., repeat and summarize key points, use audiovisual aids, conduct oral testing or alternative assessments), equipment (e.g., hand or foot controls, adjustable tables); or adapted curriculum objectives to meet specific student needs (Missouri State Department of Elementary and Secondary Education, 1999). Very few teachers will have the opportunity to practice the necessary classroom management that comes along with having multiple students with categorical disabilities in their classrooms (Shaw, 2011), much less in a unique environment that can be found in CTE courses that do not subscribe to the many of the same traditional situations that are found in core subject classrooms. Some studies suggest that regardless of what a teacher learns within a teacher preparation program, it is the personal opinion of the teacher that dictates how a classroom should operate when there are students with categorical disabilities (Jordan, Schwartz, & McGhie-Richmond, 2009). For engineering design graphics teachers, much of the content has been taught using similar practices for many years, which makes it difficult for some teachers to adapt to the changing needs of their classrooms, creating unique challenges for actively including all students (White, 2015).

Most secondary level teachers earn a traditional teaching license. The most traditional path is to attain a teaching license through attending a four-year university. By obtaining a Bachelor's degree in a specific teaching content area such as science, math, or elementary education, teachers gain content knowledge as well as educational peda-

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gogical knowledge. However, there is a shorter, less costly option for those that wish to pursue teaching after spending time in industry, or another career. This is an alternative certification program. These programs prepare an individual to take the knowledge used in their previous jobs, and relay it in a way that relates to the curriculum at a given age level. The content of these programs can vary greatly based on the type, content area, and the state in which it occurs. However, the hope is that an individual should be adequately prepared to teach after participating in an alternative certification program (Bowen, 2013). Depending on the program, a Bachelor's degree may not be required to participate in an alternative certification program. The number of years in practical experience in the field can be equated to schooling experience, meaning in some cases the education level of these teachers may not exceed an associate's degree. Engineering design graphics courses teach skills in areas such as drafting or CADD (computer aided drafting and design) and are typically taught by teachers from a variety of backgrounds. Many of these teachers gained their knowledge on the subject from their years spent in careers where they used these skills on a daily basis.

There is limited research describing whether the ability to teach students with categorical disabilities is different based on a teacher's certification pathway. However, regardless of the certification process, a large number of teachers do not have a full teaching certification when they begin teaching (Ruhland & Bremer, 2003). However, in most traditional programs, content about teaching students with categorical disabilities is typically covered in at least one course. Generally, in an alternative program, which varies based on state and district, there is not an explicit course covering how to teach students with categorical disabilities. Despite the presence of these courses, most teachers, regardless of certification pathway, do not feel adequately prepared to teach students with categorical disabilities (Boyer & Mainzer, 2003). Many reported they needed ongoing support when teaching students with categorical disabilities and would have preferred receiving this during the teacher preparation program, as well as through targeted professional development opportunities (Casale-Giannola, 2012; Ruhland & Bremer, 2003). Teachers that participate in these professional development opportunities often feel more prepared to teach students with categorical disabilities than the teachers that do not (Jobling & Moni, 2004). Inclusive classrooms and the elevated expectations for all students call for a change in preservice teacher preparation, both traditional and alternative, as there is a need to include students with categorical disabilities in all areas of education, and for them to learn alongside their non-disabled peers (Harvey, Yssel, Bauserman, & Merbler, 2010).

More information is needed to describe the preparation of engineering design graphics teachers and their qualifications for working with diverse populations of students. Ernst et al. (2014) reported the number of students with LEP and categorical disabilities is increasing in classrooms of engineering design graphics teachers. The goal of the current study is to reinforce the data about the categorical disability caseload and to provide

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additional data on the descriptive nature of teacher demographics, teaching locations, teaching levels, and teacher preparations characteristics for engineering design graphics teachers in the United States. Therefore, this paper reports evidence-based information for the following research questions:

1. What are the demographic characteristics of Engineering Design Graphics teachers?
2. What are the credentials of Engineering Design Graphics teachers?
3. What is the caseload of student population features and characteristics within Engineering Design Graphics teachers' classrooms?

Methodology

Instrumentation

This study employed data from the most recent SASS TQ survey. The SASS TQ consists of five questionnaires: a School District Questionnaire, Principal Questionnaire, School Questionnaire, Teacher Questionnaire, and a School Library Media Center Questionnaire. This study analyzed data from the SASS TQ restricted-use data files that contains variables not available in the public-use data set. There are 85 questions comprising nine sections. According to Tourkin et al. (2010, p. 1):

> "The School and Staffing Survey Teacher Questionnaire 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 public and private elementary and secondary schools. The SASS TQ 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. The overall objective of the SASS TQ is to collect the information necessary for a comprehensive picture of elementary and secondary education in the United States. The SASS TQ was designed to produce national, regional, and state estimates for public elementary and secondary schools and related components and is an excellent resource for analysis and reporting on elementary and secondary educational issues."

Sampling Weights

The SASS TQ survey design utilizes sampling weights that allow researchers to generalize the data to the sampled population (Thomas, Heck, & Bauer, 2005). Sampling weights for elementary schools, secondary schools, and teachers used in the SASS TQ "take into account the school's selection probability, to reduce biases that may result from unit non-response, and to make use of available information from external sources to improve the precision of sample estimates" (Kena et al., 2015) and to help estimate national public school teacher populations while maintaining the original sample sizes.

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Due to the complexity of the SASS TQ survey design, stratification of data (sampling each subpopulation independently), clustering (teacher selection within schools), and oversampling (over selection of educators containing certain characteristics) techniques are used to maintain the validity of the data. Direct estimates of sampling errors, in this type survey, will characteristically underestimate the sampling variability in the summary statistics and distort test of statistical significance (Finster, 2013; Hahs-Vaughn, 2005; Thomas & Heck, 2001). NCES developed weights to balance this bias and replicate weights for the SASS TQ design to be incorporated in a study to construct unbiased population assessments. Fundamentally, these weights help to summarize and correct for the probability of selection and are inversely proportional to the probability of selection (Finster, 2013; Tourkin et al., 2010).

Participant Selection

In this study, the participants who gave a subject-matter code 246 (CADD and Drafting) to Question 16 in the 2011-2012 SASS TQ, "This school year, what is your MAIN teaching assignment field at THIS school?", were identified as engineering design graphics teachers. The resulting weighted number of teachers was 12,240.

Variables Analyzed

Several demographic variables were analyzed collectively to answer Research Questions 1 and 2. To answer Research Questions 1, the following variables were analyzed; gender, age, teaching experience, employment status, race, ethnicity, and teaching location, including urbanicity, region, and school level. To answer Research Question 2, the following variables were analyzed; level of education, certification status, route to certification, and qualification status. Research Question 3 analyzed the caseload for categorical disabilities, including the number of students with recognized disabilities, the number of students with LEP, and the service load of at-risk students with categorized disabilities and LEP combined.

Procedure

This study consisted of a secondary analysis of the most recent SASS TQ restricted-use license dataset to present a national profile of engineering design graphics teachers. Specified reporting protocols were followed and data findings were submitted to the Institute for Educational Sciences (IES) for approval and authorization for release. Data were analyzed using SPSS 23.0. Data for the descriptive analyses were weighted using the variable Teacher Final Sampling Weight (TFNLWGT). All n's were rounded to the nearest 10 to assure anonymity per National Center for Educational Statistics (NCES) and IES requirements and data in the tables may not add up to the total N initially reported due to rounding adjustments. When any estimates did not meet the NCES or IES reporting protocols, they were not reported in the tables and were noted with an asterisk (Dinkes, Cataldi, Lin-Kelly, & Snyder, 2007; Robers, Kemp, Rathbun, Morgan, & Snyder, 2014).

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Results

To answer Research Question 1, the variables analyzed include gender, age, teaching experience, employment status, race, ethnicity, and teaching location.

Gender, Age, Teaching Experience, and Employment Status

Demographic information concerning teacher gender, age, teaching experience and teaching status is presented in Table 1. Engineering design graphics teachers are predominately male and full-time teachers. Their age and teaching experience suggests that these teachers are in the middle of their expected teaching careers.

Table 1
Percentage of engineering design graphics teachers according to gender, age, teaching experience, and status.

	Male	Female	Mean Age	Mean Experience	Full-time Status
Engineering Design Graphics Teachers	93.7	6.3	48.12	14.74	97.1

Race and Ethnicity

Teachers' self-reported race is presented in Table 2. This information was collected for the purposes of establishing a demographical make-up of engineering design graphics teachers. Racial category descriptors are presented verbatim as they appeared on the SASS TQ survey. Participants were allowed to make more than one selection. However, the majority of the participant's data reflected one category. The most prevalent self-selected racial category represented was White, followed by Hispanic and Black or African-American. Asian, Native Indian or Alaskan Native, and Native Hawaiian or Other Pacific Islanders were the least prevalent self-selected racial categories with numbers low enough not to meet IES reporting requirements. As noted, data for certain descriptors did not meet IES and NCES reporting standards and were not presented in the tables. The table total does not equal 100 percent due to the remainder (2.9%) of the participants choosing two or more categories.

Table 2
Percentage of engineering design graphics teachers on self-reported racial categories.

	Hispanic	White	Black or African-American	Asian	Native Hawaiian or Other Pacific Islander	American Indian or Alaska Native
Engineering Design Graphics Teachers	4.2	89.8	3.1	*	*	*

Note. Descriptors were taken directly from the SASS TQ
* Did not meet IES reporting requirements.

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Location

The location of engineering design graphics teachers was examined through urbanicity, region, and school type. These results are presented in Table 3. The majority of engineering design graphics teachers teach in rural and suburban areas. Towns had the lowest percentage. The south had the highest percentage engineering design graphics teachers and the west had the lowest. Secondary or high school settings were the most predominate settings for engineering design graphics teachers.

Table 3
Location of engineering design graphics teachers in percentages.

	Urbanicity		
City	**Suburban**	**Town**	**Rural**
21.0	30.1	13.3	35.8
	Region		
Northwest	**Midwest**	**South**	**West**
23.6	26.5	37.8	12.0
	Four category school level		
Primary	**Middle**	**High**	**Combined**
*	5.2	88.7	6.0
	Two category school level		
	Primary	**Secondary**	
	*	99.5	

* Does not meet IES reporting requirements.

Level of Education

Table 4 shows the highest level of education that was reported. It should be noted that only the highest degree obtained is reported. It does not include the reporting of multiple or similar degrees. The Bachelor’s degree tended to be the most prevalent degree among engineering design graphics teachers. However, there is a large percentage of engineering design graphics teachers who have an associate degree when compared ot

Table 4
Percentage of engineering design graphics teachers highest degree obtained.

	Associate	**Bachelors**	**Masters**	**Educational Specialist**	**Doctorate**
Engineering Design Graphics Teachers	30.2	37.5	24.0	5.3	5.1

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Certification Status, Route, and Qualification Status

Table 5 shows the certification status, certification route, and qualification status of engineering design graphics teachers. Approximately 81 percent of the teachers are fully-certified and about one-third enter into the profession through alternative programs. The SASS TQ defines alternative programs as a program that was designed to expedite the transition of non-teachers to a teaching career, for example, a state, district, or university alternative certification program.

Table 5
Percentage of Engineering Design Graphics Teachers certification, and career path entry.

	Regular or standard state certificate	Alternative certification program	Traditional certification program
Engineering Design Graphics Teachers	81.0	34.6	65.4

Categorical Disability Caseload

Regarding students with categorized disabilities, the results are shown in Table 6. Engineering design graphics teachers reported a mean of 12.45 students with categorized disabilities, a mean of 3.58 of students with LEP, and approximately 16 students with at-risk indicators on their caseload.

Table 6
Engineering Design Graphics Teachers caseloads.

	Mean Categorical	Mean LEP	Service Load
Engineering Design Graphics Teachers	12.45 SD =10.75	3.58 SD = 10.06	16.03 SD = 19

Conclusions and Implications

Over the past decade, research shows an increase in the caseload for engineering design graphics teachers for students with categorical disabilities and LEP resulting in an even higher level need for familiarity and preparation, through either teacher education programs, alternative certification, or professional development opportunities (Ernst et al., 2014). The results of the current study highlight that 30.2% of engineering design graphics teachers have less than a bachelor’s degree as their highest level of education. This is notable when factoring the adequacy of preparation teachers received regarding preparedness to teach students with categorical disabilities and LEP. Another 37.5% of engineering design graphics teachers have been credential through bachelor’s degrees. Therefore, approximately 68% of all engineering design graphics teachers have a bach-

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elor's degree or less. With many undergraduate teacher preparation programs struggling to find the flexibility and credits hours to include pedagogical courses for teaching students with categorical disabilities, the majority of engineering design graphics teachers probably do not have adequate training to confidently and effectively teach the rising population of students with categorical disabilities and LEP. In addition, 34.6% of engineering design graphics teachers reported being certified through an alternative certification program. Very rarely would an alternative certification program contain content about teaching strategies for students with categorical disabilities or LEP.

As the number of students with categorical disabilities and LEP increases within the classroom, improving the knowledge of teaching strategies specifically for these students is becoming critical. Using evidence-based pedagogy is required for these students to achieve their learning potential. This paper specifically addresses these needs for engineering design graphics teachers. By providing this information, additional research can be designed to help understand how engineering design graphics teachers can be better prepared to work with students with categorical disabilities and LEP. The results of this analysis demonstrates that, due to the types of certifications and highest level of degree earned, engineering design graphics teachers may be lacking the necessary pedagogical knowledge to teach students with categorical disabilities and LEP. Further research will help determine the specific knowledge level of engineering design graphics teachers as well as how teacher preparation programs are providing the necessary pedagogical content in regards to working with these groups of students.

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