The "Who, What, and How Conversation": Characteristics and Responsibilities of Current In-service Technology and Engineering Educators

By Jeremy V. Ernst and Thomas O. Williams

ABSTRACT

This study, using the Schools and Staffing Survey (SASS), investigates K-12 technology and engineering educator and service load similarities and differences as they compare to the broader educational population. Specifically, teacher demographics, educational levels, certification status/pathways, and student caseload characteristics are explored. Results indicate that technology and engineering educators have a notable background and preparation distinctions to that of peer educators. Additionally, there are notable distinctions in the student population in which this group of educators serve.

Keywords: Schools and Staffing Survey, teacher characteristics, teacher caseload

INTRODUCTION AND BACKGROUND

The technology and engineering education in K-12 settings has drawn increasing attention from teacher educators, researchers, and historians regarding its classroom context, curricula, pedagogies, and paradigm shift. A considerable amount of research grounded in this area has been conducted discussing the historical foundations, current trends, needs, and issues. This research addressed K-12 technology and engineering education in various aspects of programs and practice (Dugger, 2007; Dugger, French, Peckham, & Starkweather, 1992; Meade & Dugger, 2004; Sanders, 2001), preparation, licensure, and endorsement (Moye, 2009; Volk, 1993; Volk, 1997; Zuga, 1991), and educator dynamics (Haynie, 2003; McCarthy & Berger, 2008; Zuga 1996). However, these pioneer efforts have left some inconsistencies and discrepancies. A more around representative description should be presented to reflect the overall state of K-12 technology and engineering education in the United States.

Several studies (Dugger, 2007; Newberry, 2001; Meade & Dugger, 2004; Moye, 2009; Ndahi & Ritz, 2003) have revealed vastly different conclusions regarding the landscape of technology and engineering education. For example, K-12 in-service educator count ranges from 25,258 teachers in 50 states (Dugger, 2007) to 38,537 teachers in 48 states (Newberry, 2001). Moye, Dugger, & Starkweather (2012) attributed such a variation to a number of factors: the lack ofrespondents to surveys, the different infrastructures of school systems, the lack of leadership of technology and engineering educators, and the lack of accurate data collection from the state.

A standardized reporting set could potentially provide a prevailing reporting format. The U.S. Department of Education and the National Center for Education Statistics (NCES) employ standardized reporting mechanisms under federal educational funding clusters and guidelines, resulting in a comprehensive account of educators and their characteristics with each educational discipline. Data collected within this system spans the nation and results in an inclusive collection of metrics from educators within a range of educational disciplines. One instrument within this reporting complex is the Schools and Staffing Survey (SASS).

Research Questions

Considering the variation and inconsistencies in reporting within technology and engineering education, this research was launched to assist in building a national profile of these discipline-based descriptors. Additionally, the research questions assisted in determining similarities and differences between technology and engineering education and the broader educational community. Specifically this research addressed the following:

1. What are the characteristics and credentials of technology and engineering educators and how do they compare to other in-service educators?

2. What student population features and characteristics are identifiable within technology and engineering classrooms, and how do they compare to other in-service educators?

Schools and Staffing Survey

SASS has been described by the Institute of Education Sciences as:

> "… [a] large-scale sample survey of K-12 school districts, schools, teachers, library media centers, and administrators in the United States. It includes data from public, public charter, private, and Bureau of Indian Education (BIE) funded school sectors. Therefore, SASS provides a multitude of opportunities for analysis and reporting on elementary and secondary educational settings. The Schools and Staffing Survey 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 (Tourkin, Thomas, Swaim, Cox, Parmer, Jackson, Cole, & Zhang, 2010, p. 1)."

Data utilized within this study comes from five questionnaires within the 2011-12 SASS: a School District Questionnaire, Principal Questionnaire, School Questionnaire, Teacher Questionnaire, and a School Library Media Center Questionnaire. The SASS Teacher Questionnaire (SASS TQ) targeted questions to gather data from teachers that would identify their levels of education and training, teaching assignments, certification, and workload.

METHODOLOGY

The methodology closely followed that of Ernst and Williams (2014) and Ernst, Li, and Williams (2014). 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 Virginia Tech. The access provided a member of the research team with designated single-site user admittance. Specific protocol and reporting information was submitted and subsequently accepted, where the NCES and Institute for Educational Sciences (IES) authorized approval and release. The NCES and IES require that weighted all n's be rounded to the nearest ten to assure participant anonymity. Therefore data in tables and narrative may not add to the total N reported because of rounding requirements.

PARTICIPANT SELECTION

In this study, the participants who gave subject-matter codes relating to technology and engineering education for Question 16 in the **2011–2012 SASS TQ**, "This school year, what is your MAIN teaching assignment field at THIS school?" were identified and placed in their respective disciplines. Table 1 shows associated codes and descriptors used to group technology and engineering education teachers. All demographic data presented were weighted using the Teacher Final Sampling Weight (TFNLWGT) variable, which is appropriate for descriptive statistics. T-tests employed an additional 88 replicate weights that were supplied in the SASS data file by IES. This resulted in 50,610 instances within the weighted results for all technology

TABLE 1. Technology & engineering educator SASS codes and summary descriptors representing main teaching assignment.

Area	Code	Summary Description
Technology & 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)

Note. SASS is the Schools and Staffing Survey and engineering education teachers. Data from the **2011–2012 SASS TQ** for technology and engineering educators were extracted and analyzed using a variety of descriptive statistics.

VARIABLES ANALYZED

Gender, Age, Teaching Experience, and Employment Status.

The gender of technology and engineering education teachers was determined by SASS TQ question 78, "Are you male or female?" Teachers' age was determined by the SASS TQ variable AGE_T. Teaching experience was determined by the SASS TQ variable TOTYREXP. Teaching experience is calculated as the sum of all years taught full or part-time in public and private schools. Status was determined by the SASS TQ variable FTPT. This is a two-level teaching status variable that indicates whether the respondent is teaching full-time or part-time.

Race and Ethnicity.

The racial make-up of technology and engineering education teachers was determined by two questions on the SASS TQ. Question 80 asked, "Are you of Hispanic or Latino origin?" The respondent answered either yes or no. Question 81 asked, "What is your race?" Respondents were to mark one or more of the listed races to indicate what race(s) they consider themselves. The SASS TQ provided five choices for race: White, Black/African-American, Asian, Native Hawaiian/Other Pacific Islander, or American Indian/Alaska Native. Because respondents are allowed to make more than one selection, the percentages may not always add up to 100 percent.

Level of Education.

The SASS TQ variable HIDEGR was used to determine the highest degree obtained and held by the teacher. This variable can range from Associate through Ph.D. and was used as the indicator for education level. This variable does not take into account multiple degrees (e.g., double Bachelors or double Masters), only the highest degree obtained.

Certification Status, Route, and Qualification Status.

Question 37a, "Which of the following describes the teaching certificate you currently hold that certifies you to teach in THIS state?" was used to identify whether or not the teachers were certified in the subject(s) they teach. The question was used to determine whether the certification route was alternative or through a traditional college program was Question 41, "Did you enter teaching through an alternative certification program?" An alternative program is designed to expedite the transition of non-teachers to a teaching career, for example, a state, district, or university alternative certification program. The respondent was requested to indicate either an alternative or traditional path to certification.

Question 42, "This school year, are you a Highly Qualified Teacher (HQT) according to your state's requirements?" was used to determine whether the teacher was presumed to be HQT. Generally, to be highly qualified, teachers must meet requirements related to (1) a bachelor's degree, (2) full state certification, and (3) demonstrated competency in the subject area(s) taught. The HQT requirement is a provision under the No Child Left Behind (NCLB) Act of 2001.

Caseload.

The SASS TQ variable PUPILS-D was used to determine the mean total number of students taught. Teachers were asked how many students they teach per day in their content area. To specifically address the research questions relating to students with categorical disabilities and limited English proficiency and service load, data derived from Questions 14 and 15 on the SASS TQ were analyzed. Service load was calculated by the researchers to be the sum of responses to Questions 14 and 15.

The number of categorized students who are served was determined by responses from teachers who reported teaching students with recognized disabilities requiring an individualized education plan as determined from the Question 14, "Of all the students you teach at this school, how many have an Individualized Education Program (IEP) because they have disabilities or are special education students?" Teachers either checked none or entered an integer.

Likewise, the number of students identified as LEP was determined by responses from teachers who reported teaching students who did not speak English as their primary language and who had a limited ability to read, speak, write, or understand English. This number was derived from the response to Question 15, "Of all the students you teach at this school, how many are of limited-English proficiency? (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.)"

RESULTS

Gender, Age, Teaching Experience, And Employment Status
Demographic information concerning teacher gender, age, teaching experience, and teaching status is presented in Table 2. One notable finding was gender disparity between the two groups. With regard to gender, there is a large discrepancy between technology and engineering education teachers and all other teachers. Technology and engineering education teachers are predominantly male (75%), while the category "all other teachers" was predominately female (77%).

Test statistics for information reported as a mean (teacher age and teacher experience) were tabulated and evaluated in efforts to determine differences, if any. Even though age and experience were statistically significantly different, there appeared to be little practical difference between the groups. The profile for both groups was quite similar in age and experience and the majority were employed as full-time teachers.

TABLE 2. Technology & engineering educator gender, age, teaching experience, and status as reported on the 2011-2012 SASS.

Area	Male	Female	Mean Age	Mean Experience	Full-time Status
Technology & Engineering Education (n = 50610)	38150 (75.4)	12460 (24.6)	46.72 *p = <0.001	15.48 *p = <0.001	46730 (92.3)
All Other Teachers (n = 3334570)	763480 (22.9)	2571090 (77.1)	42.34	13.76	3104110 (93.1)

** P-value for two-sample location test of difference in mean (p = 0.05)*

Note. SASS is the Schools and Staffing Survey.
All n's rounded to the nearest ten per NCES and IES requirements.

Race and Ethnicity
Teachers' self-reported racial description is reported in Table 3. This information was collected through the survey and was reported for the purposes of establishing a demographical make-up of technology and engineering education teachers. Because participants were allowed to make more than one selection, the percentage may not equal 100 percent in Table 3. Both groups were very similar in racial make-up. The only exception was the category "Black/African-American" being approximately three percentage points lower for technology and engineering education teachers.

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. Reported are outcomes of bachelors, masters, educational specialist, and doctorates earned as a single highest degree obtained. In "highest level of education obtained," technology and engineering education teachers are less likely to have a Master's degree and more likely to have a "bachelor's degree or less" than the of all other teacher groups.

TABLE 3. Technology & Engineering educator self-reported racial category from the 2011-2012 SASS.

Area	Hispanic	White	Black/ African-American	Asian	Native Hawaiian/ Other Pacific Islander	American Indian/ Alaska Native
Technology & Engineering Education	3560 (7.0)	46520 (91.9)	2410 (4.8)	1140 (2.3)	250 (0.5)	1370 (2.7)
All Other Teachers	260550 (7.8)	3000320 (90.0)	254740 (7.6)	73930 (2.2)	11110 (0.3)	47280 (1.4)

Note. SASS is the Schools and Staffing Survey. Racial categories were taken directly from the SASS survey. Percentages are in parentheses.
Percentages may not add to 100 because respondents were allowed to choose multiple categories. All n's rounded to the nearest ten per NCES and IES requirements.

TABLE 4. Technology & Engineering educator highest degree obtained.

Area	Bachelors	Masters	Educational Specialist	Doctorate
Technology & Engineering Education	27380 (54.1)	20430 (40.4)	2330 (4.6)	460 (0.9)
All Other Teachers	1450580 (43.5)	1593200 (47.8)	254490 (7.6)	36320 (1.1)

Note. Percentages are in parentheses. All n's rounded to the nearest ten per NCES and IES requirements.

Certification Status, Route, and Qualification Status

In Table 5 the certification status, certification route, and qualification status of technology and engineering educators are shown specific to standard state certification, alternative certification, traditional certification, determination of "highly qualified" and either not "highly qualified," or unknown to the respondent. The profile for technology and engineering education teachers shows that they are less likely to hold a regular or standard state teaching certificate (85.6% vs. 91.3%), more likely to receive certification through an alternative certification program (21.6% vs. 14.5%) and are less likely to be highly qualified in all subjects taught (59.3% vs. 72.9%) than the category all other teachers.

Caseload

The caseloads of technology and engineering education teachers are illustrated in Table 6 pertaining to total students served, students with an Individualized Education Program (IEP), students who are identified as limited in English proficiency, and total service load of students with IEPs and who are limited in English proficiency. Test statistics were also tabulated and evaluated in efforts to determine differences in student caseload categorizations, if any.

Technology and engineering education teachers were found to have a statistically significantly larger caseload, categorical student load, and service load than all other educators. Their caseload is almost double, with technology and engineering education teachers having a caseload of approximately 92 students and the category "all other teachers" a caseload of approximately 52 students. Technology and engineering education teachers also teach more students with disabilities and have a higher service load than the category "all other teachers." With regard to LEP students, no statistically significant differences were found.

SUMMARY

According to the NCES administered SASS TQ, technology and engineering educator content can be categorized in four areas: (1) construction technology, (2) manufacturing technology, (3) communication technology, and (4) general technology education. Based on these four collective teacher groups, there was no significant difference in the numberof LEP students for technology and engineering teachers

(M = 7.60, SD = 20.24) and all other teachers (M = 7.16, SD = 23.89); t (88) = 0.04, p = 0.98. However, there was a significant difference in the number of IEP students for technology and engineering teachers (M = 18.87, SD = 25.12) and all other teachers (M = 11.26, SD =16.77) for; t (88) = 4.63, p = < 0.001; service load for technology and engineering teachers (M = 26.47, SD = 35.30 and all other teachers

TABLE 5. Technology & Engineering educator certification, career path entry, and qualification status as reported on the 2011–2012 SASS.

Area	Regular or standard state certificate	Alternative certification program	Traditional certification program	Highly qualified in all subjects taught	Unknown or not highly qualified
Technology & Engineering Education	43410 (85.8)	10930 (21.6)	396730 (78.4)	29990 (59.3)	12860 (25.4)
All Other Teachers	3045630 (91.3)	483670 (14.5)	2850900 (85.5)	2430390 (72.9)	587900 (17.6)

Note. *SASS is the Schools and Staffing Survey. Percentages are in parentheses. All n's rounded to the nearest ten per NCES and IES requirements.*

TABLE 6. Technology & Engineering educator caseloads as reported on the 2011–2012 SASS.

Area	Mean number of students served	Mean Categorical	Mean LEP	Service Load
Technology & Engineering Education	91.76 *p = <0.001	18.87 *p = <0.001	7.60 *p = 0.98	26.47 *p = <0.001
All Other Teachers	51.83	11.28	7.16	18.44

** P-value for two-sample location test of difference in mean (p = 0.05)*

Note. SASS is the Schools and Staffing Survey. Categorical are students with disabilities with individualized education programs. LEP is limited English proficiency. Service Load is the sum of Categorical and LEP.

(M = 18.44, SD=32.05) for; t (88) = 3.68, p = < 0.001; teacher's age for technology and engineering teachers (M = 46.72, SD = 11.05) and all other teachers (M = 42.34, SD = 11.44) for; t (88) = 7.09, p = < 0.001; number of students served for technology and engineering teachers (M = 91.76, SD = 71.39) and all other teachers (M = 51.83, SD = 76.43 for; t (88) = 8.73, p = < 0.001; average class size for technology and engineering teachers (M = 18.87, SD = 25.13) and all other teachers (M = 11.28, SD =16.77) for; t (88) = 8.85, p = < 0.001; total years teaching experience for technology and engineering teachers (M =15.46, SD = 10.19) and all other teachers (M = 13.76, SD = 9.38) for; t (88) = 3.32, p = < 0.001.

Evidenced through findings of this study, technology and engineering educators have notable background and preparation distinctions to that of peer educators. Additionally, there are notable distinctions in the student population in which this group of educators serve. Uniqueness in this case presents an opportunity to fill a current void in serving a vital student preparatory role, enriched through educational as well as life experiences of the teacher. According to the Bureau of Labor Statistics, there is an emerging growth in STEM occupations on the horizon (Richards & Terkanian, 2013). As our economy becomes increasingly dependent on STEM fields, rational decisions about scientific and engineering issues drive the need for society as a whole to become more STEM literate (Ravitch, 2013). Technology and engineering education provides equal access to quality STEM academic programs, especially for underrepresented student populations (Spring, 2011). This equal access is necessary for the increase in diversity in the classroom (Ernst, Li, & Williams, 2014).

One proactive solution includes advocacy of inclusive STEM education environments, promoted through formalized teacher learning opportunities. When teachers provide inclusive STEM-focused experiences in an integrated fashion, a positive learning culture is created where students realize importance and value in education (Behrend, et al., 2014; Kearney-Rich, 2014). This strategy not only increases underrepresented student participation in high quality STEM learning but also purposefully links local economies, communities, and universities in conception and delivery (Lynch, Behrend, & Peters, 2013; Lynch & Zipkes, 2012). This is an approach from which students, teachers, communities, as well as technology and engineering education teachers can all benefit. However, in order for these potentials to become a realization, determination of technology and engineering educator preparedness must be considered.

Note: This paper was presented at the 101st Mississippi Valley Technology Teacher Education Conference in St. Louis, MO.

Dr. Jeremy V. Ernst *is an Associate Professor of Integrative STEM Education in the School of Education at Virginia Polytechnic Institute and State University, Blacksburg. He is a member of the Gamma Tau Chapter of Epsilon Pi Tau*

Dr. Thomas O. Williams *is an Associate Professor of Special Education at Virginia Polytechnic Institute and State University, Blacksburg.*

Behrend, T. S., Ford, M. R., Ross, K. M., Han, E. M., Peters Burton, E., & Spillane, N. K. (2014). *Gary and Jerri-Ann Jacobs High Tech High: A case study of an inclusive STEM-focused high school in San Diego, California* (OSPrI Report 2014-03).

Dugger, W. E. (2007). The status of technology education in the United States: A triennial report of the findings from the states. *The Technology Teacher*, 67(1), 14-21.

Dugger, W. E., French, B. J., Peckham, S., & Starkweather, K. (1992). Seventh annual survey of the profession: 1990-91. *The Technology Teacher,* 51(4), 13-16.

Ernst, J. V., Li, S., & Williams, T. O. (2014). Secondary engineering design graphics educator service load of students with identified categorical disabilities and Limited English Proficiency. *Engineering Design Graphics Journal,* 78(1), 1-10.

Ernst, J. V., & Williams, T. O. (2014). Technology and engineering education accommodation service profile: An ex post facto research design. *Journal of Technology Education,* 26(1), 64-74.

Haynie, W. J. (2003). Gender issues in technology education: A quasi-ethnographic interview approach. *Journal of Technology Education*, 15(1), 16-30.

Kearney-Rich, C. (2014). Researchers find that inclusive STEM-focused schools encourage academic learning. *Opportunity Structures for Preparation and Inspiration in STEM*. Retrieved from https://newsdesk.gmu.edu/2014/01/researchers-find-inclusive-stem-focused-schools-encourage-academic-learning/

Lynch, S., Behrend, T., & Burton, E. P. (2013). Inclusive STEM-focused high schools: STEM education policy and opportunity structures. Proceeding of the National Association for Research in Science Teaching, Puerto Rico.

Lynch, S., & Zipkes, S. (2012, January 17). The new wave of STEM-focused schools [Webinar]. *Education Week Webinar*. Retrieved from http://www.edweek.org/go/webinar

McCarthy, R. R., & Berger, J. (2008). Moving beyond cultural barriers: Successful strategies of female technology education teachers. *Journal of Technology Education,* 19(2), 65-79.

Meade, S. D., & Dugger, W. E. (2004). Reporting on the status of technology education in the U.S. *The Technology Teacher,* 64(2), 29-35.

Moye, J. J. (2009). Technology education teacher supply and demand--a critical situation: If the technology education profession is to survive, the time for action to ensure that survival is now. *The Technology Teacher,* 69(2), 30-36.

Moye, J. J., Dugger, W. E., & Starkweather, (2012). The status of technology and engineering education in the United States: A fourth report of the findings from the states (2011-2012).

Ndahi, H., & Ritz, J. (2003). Technology education teacher demand, 2002-2005. *The Technology Teacher,* 62(7), 27-31.

Newberry, P. B. (2001). Technology education in the US: A status report. *The Technology Teacher,* 61(1), 8-12.

Ravitch, D. (2013). *Reign of error: The hoax of the privatization movement and the danger to America's public schools.* New York: Random House Inc.

Richards, E., & Terkanian, D. (2013). Occupational employment projections to 2022. *Monthly Labor Review.* Retrieved from http://www.bls.gov/opub/mlr/2013/article/pdf/occupational-employment-projections-to-2022.pdf

Sanders, M. (2001). New paradigm or old wine? The status of technology education practice in the United States. *Journal of Technology Education,* 12(2), 35-55.

Spring, J. (2011). *American Education.* New York, NY: McGraw-Hill.

Tourkin, S., Thomas, T., Swaim, N., Cox, S., Parmer, R., Jackson, B., Cole, C., & Zhang, B. (2010). Documentation for the 2007–08 Schools and Staffing Survey (NCES 2010-332). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved June 17, 2014 from http://nces.ed.gov/pubsearch

Volk, K. (1993). Enrollment trends in industrial arts/technology teacher education from 1970-1990. *Journal of Technology Education*, 4(2), 46-59.

Volk, K. (1997). Going, going, gone? Recent trends in technology teacher education programs. *Journal of Technology Education*, 8(2), 67-71.

Zuga, K. F. (1991). Technology teacher education curriculum. *Journal of Technology Education*, 2(2), 60-70.

Zuga, K. (1996). Reclaiming the voices of female elementary school educators in technology education. *Journal of Industrial Teacher Education*, 33 (3), 23-43.