STEM Educators: Who Are They?

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STEM Educators – Who Are They?

Technical education or STEM (Science, Technology, Engineering, and Mathematics) education is often touted as the way for students to succeed, for corporations to move forward, and to gain prominence in the world economy. With all this promotion, do we know who is teaching these subjects to our students? This question urged researchers to develop a survey and distribute it to those teaching STEM subjects. The survey collected a variety of information, the results of the demographic section being reported here. The survey responses are from a population of STEM educators teaching at all levels, found to be male and generally teaching in engineering technology programs. The authors offer that an understanding of basic demographics including information concerning formalized training and degrees is necessary to provide the groundwork for areas of future study.

Introduction

STEM is a far-reaching subject. Courses in these areas are offered at all levels and therefore, are taught by many different educators. These educators do not all possess the same training or confidence level. It can be generally agreed on that to be most effective, STEM educators must be passionate about their subject. In order to further STEM education, we must ask "who are STEM educators?" That is, what is their background inside of academia and outside? Knowledge of this background is necessary to form areas of future study that may provide the means to improve STEM education nationally or perhaps globally.

Programs exist to aid STEM educators in engaging students [1] and with integrating STEM in the classroom [2] but little is known about STEM educators themselves. Existing literature is limited to rather niche areas and focuses on performance in the classroom and improving that performance. Information concerning who educators are and where they work is not evident. Without a basic understanding of who STEM educators are, work intending to strengthen teaching abilities cannot be optimized [3]. The intent of this work is to provide a basic look at STEM educators' demographics, education history, and work experience. This early survey provides direction for subsequent survey development and information gathering that will support a better understanding of this population. The results may guide other researchers to other areas of focus, perhaps examining effects on educators beginning in 2-year or 4-year institutions.

Literature Review

Levels of confidence and ability varies among STEM Educators. This is a result of the differing amounts of skill and education across the country. As a result, educators are varied in engagement, inclination, and interest in the material they are offering their charges.

Literature exists with the intent to aid STEM Educators in teaching STEM in ways that better engage students [4] The authors suggest that without an understanding of who these educators are, what their education background is, and their experience outside of academia, aiding them in

their teaching skill, ability to engage students, and interaction in the classroom can prove difficult. The more engaging the educator, the more likely that students will be interested and involved [5]. Limited work exists in support of these ideas, and is quite diverse.

STEM Educators - Who teaches STEM courses? STEM is taught by different educators at different levels. Early students experience STEM from educators teaching through drawing stick figures [6]. Since there are low numbers of educators specialized in physics and other sciences, middle school educators are given certifications other than their college major [7]. Educators are often found in engineers and other professionals who are awarded conditional certificates to teach subjects such as physics, chemistry, and advanced mathematics due to the lack of educators with these skills.

Due to the requirement of advanced degrees in higher education, researchers are recruited to teach despite their relatively little experience teaching. This frequently results in discouraged and disjoined students at a time that is critical to future studies and careers. This leads us to question how much pedagogical training is received by STEM educators, especially in relation to various techniques and in developing a course.

Formal Training in Education. In general, K-12 educators are expected to be trained in both teaching pedagogy and their subject area. However, this does not hold true for higher grades. Most often, this is due to a lack of interested educators.

Work by Ingersoll, Merrill, and May [8] indicates that new educators differ in their education and training. Specifically, they found that math and science educators received more education in their respective subjects but significantly less training in methodology than other educators. They also note that educators are more likely to remain in education if they receive support from mentors and additional teaching education.

The need for STEM educators is on the rise and may become critical in the near future [9]. Shortages already exists at upper levels of STEM educators, therefore necessitating the need to further our understanding of who STEM educators are. This knowledge may provide a clue for targeting recruitment in the future as well as providing better programs.

Experience Teaching. The more experience an educator possesses, the more successful they are in adapting their teaching to the newest research based techniques [10]. Today’s learning environments and classrooms vary heavily, thus, educators must have a significant amount of training both from their education and on the job to be successful. This training includes factors such as time [11], an understanding of their students [12], and observation [13].

Experience in Industrial Positions. Industrial experience can be very valuable when it comes to STEM education. Educators with a background in industry or in government can provide network connections and experiences to their students. This is especially important with regards to applied technology programs where industrial experience is a requirement for all faculty. Theoretical fields such as engineering are not as strict with regards to this type of experience. As a result, there is a lack of understanding of the needs of industrial partners. The lack of experience leads to students that are incompletely trained in industrial skills. Some researchers emphasize industrial experiences to provide faculty with the means to develop successful curriculum [14] that supports industry [15], while others have focused efforts in getting to the root of the problem [16].

Research Questions

Performing early literature review demonstrated an appalling lack of basic information about STEM educators. Therefore, the researchers wondered generally whom STEM Educators are, specifically regarding their demographics and education. It was also suggested through interaction with STEM educators that working experience may also be of interest. The resulting research questions are as follows:

- *What are STEM Educators'*
    - *basic demographics,*
    - *education history,*
    - *and working experience?*

To answer these questions and add to knowledge about STEM educators, a survey was developed.

Methods

Using techniques presented by Blair [17], Fink [18], and Van Selm [19], the researchers created a survey that would provide answers to the above questions. The resulting three section survey was divided into demographics including education history, teaching philosophy, and beliefs about STEM students. The results of the first section are presented in this work.

Survey development. The researches began by creating an outline to develop these sections. This outline served to prevent overlap in questions and ensure that information relevant to research questions would be provided. Multiple choice questions were devised to cover basic demographics and teaching background. Open-ended questions were asked to allow respondents to provide more information about their selections. Open-ended questions are not always the most advantageous, however multiple-choice options could not be devised to retrieve the data sought [19].

Collection Methods. Since this project required human subjects, the researchers sought and obtained IRB (Institutional Review Board) approval. Following this, a link to the survey was distributed to professional educator organizations, school districts, and personal networks to spread the survey over as wide an area as possible. Subjects were made aware of the intent of the project. Records were kept of all contacts and an attempt to equally cover science, technology, engineering, and math educators was made.

Data Analysis Methodology. Responses to 17 questions were gathered using an online Qualtrics survey. The survey received 211 "hits" during the five weeks it was available; however, 10 hits were blank, leaving 201 usable responses. Percentages in this document are based upon the 201 number unless otherwise noted. Microsoft Excel was utilized to compile data into figures that illustrate the composition of the respondents and for calculating percentages.

Survey Questions. The following are the questions asked of the STEM Educators:

Q1. Gender: M/F
Q2. Age in Whole Years: 18-22, 23-30,. 31-37, 38-45, 46-54, 55-64, 65+
Q3. State Where You Teach: Country, State/Province
Q4. State Level That You Teach: K-2, 3-6, 7-8, 9-10, 11-12, F, S, J, Sr, Grad
Q5. State Subject that You Teach: Science, Technology, Engineering, Math, Other
Q6. Your Highest Degree: AS, BS, MS, MBA, Ph.D., Ed.D., Other
    - o If Other, Please State: _____
    - o Year You Graduated with your highest degree: _____
Q7. Where Did You Start College: 2-year, 4-year
Q8. What is Your First Degree In? ET, E, S, T Other, Math, Other
    - o Year You Graduated with Your First Degree
Q9. Do You Have Industrial Experience? Y/N
    - o How many years?
Q10. Do You Have Government Experience? Y/N
    - o How many years?

Findings

When the survey was closed for this investigation there were 201 responses answering more than one question. There were several "hits" of the survey where there were 10 potential respondents that did not complete the survey. 201 participants based all percentages shown in this document upon the completed surveys.

The initial questions of the entire survey are presented below. These questions were answered frequently, as shown in Table 1, while later questions presented in following work were not.

With regard to entire survey completion, seventy-nine percent (79%) completed it while twenty-one percent (21%) did not.

Table 1. Number of Participants Completing The Survey-By Question

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
Percentage Complete	100	100	71	100	100	100	23	97	99.5	98

Gender. The gender division between participants is approximately 10%. The survey was answered by 54.23% males and 44.78% females with 1% not responding. This difference may be significant, however due to the ages shown in the following Figure 1, most of the males responding are 50 years old and older. The females were younger than 50 years old.

Age. The age division between participants is graduated with the answers respondents provided shown in Figure 1.

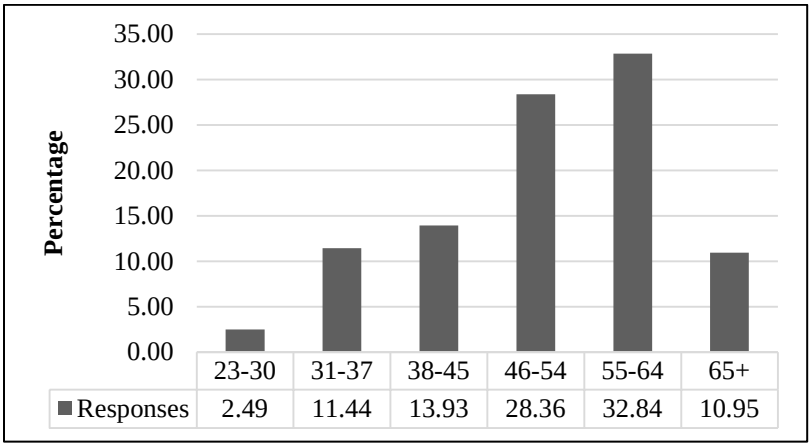


Figure 1. Responses by Age

Location. When asked their location, respondents were more likely to answer Indiana and Connecticut, with others representing 30 of the 50 states. There were a few international respondents: Belgium, Canada, Australia, Cote d'Ivoire, and Kazakhstan.

Levels Taught. Educators were asked what level they teach. The respondents were primarily from the undergraduate level, and most specifically sophomore level. Figure 2 shows the distribution of levels taught at. Note that the percentages shown in Figure 2 are based on returns where some educators selected more than one response for this question.

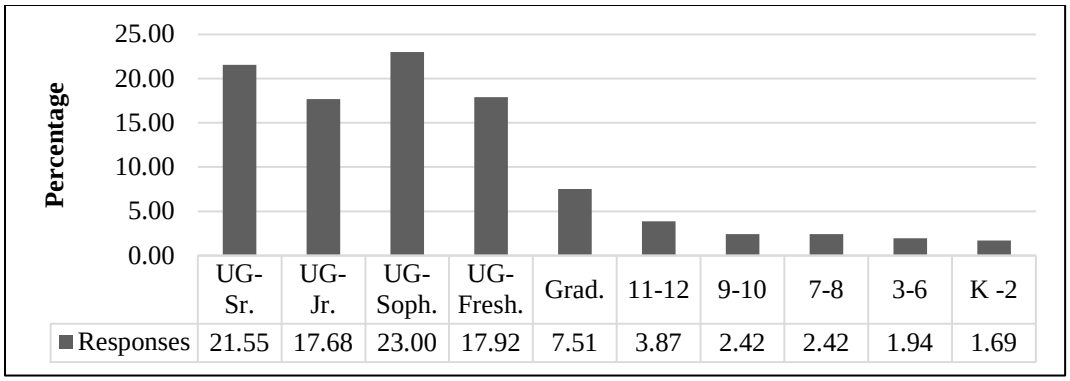


Figure 2. Level Survey Respondents Teach

STEM Subjects Taught. STEM Educators teach in all of the subjects represented by Science, Technology, Engineering, and Mathematics. Based on this survey and the responses from the study population, Figure 3 shows the distribution of educators by primary subject taught.

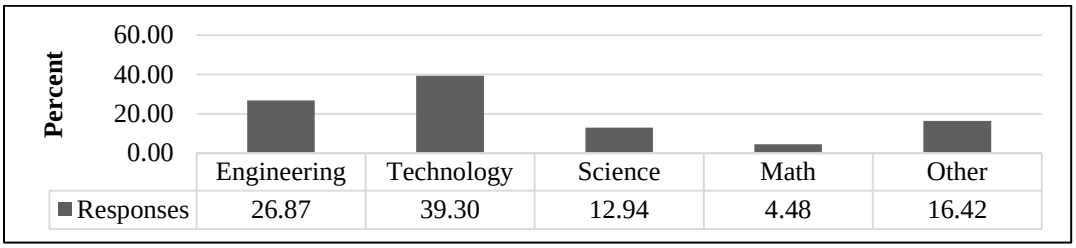


Figure 3. Subjects Taught

STEM Educators Highest Degree. As noted earlier, there is some impact on teaching given the level and type of educator each STEM Educator possesses. It is also important to consider an educators highest degree, when they finished that degree, and how many started in a four-year college as opposed to a two-year college. Figure 4 shows the highest degree by number for the respondents to this survey.

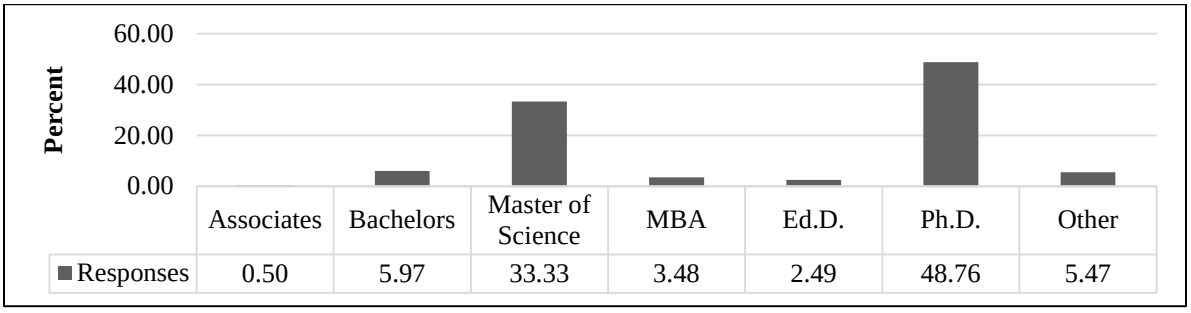


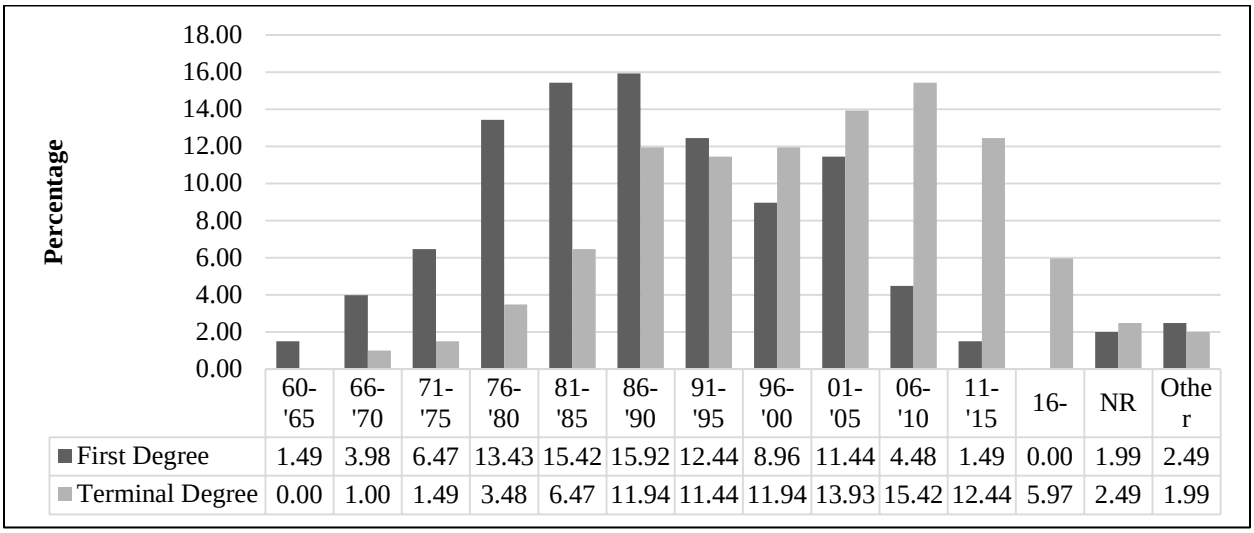
Figure 4. Responses by Highest Degree

Highest Degree. Approximately 6% of the respondents stated other and then responded with the focus of their highest degree. A few of the educators have a JD (Juris Doctor); some have

education related degrees, some in arts and others in education. One of the respondents indicated they completed some of the work for a PhD and another had a doctorate in the social sciences. The remaining degrees noted as other vary with singular subjects for each one.

Year Highest Degree Earned. Terminal or last degree sought is also at times an important focal point of a study such as this. Most commonly, the respondents received their terminal degree between the years of 2006 and 2010, between 2001 and 2005, or between 2011 and 2015. Some educators recently received their terminal degree, with about six percent (6%) graduating in 2016 to the close of the survey.

Year of STEM Educators First Degree. STEM Educators were asked to share a great deal about their education. One of the last questions asked was the year they received their first degree. Figure 5 shows the distribution of those first degrees.

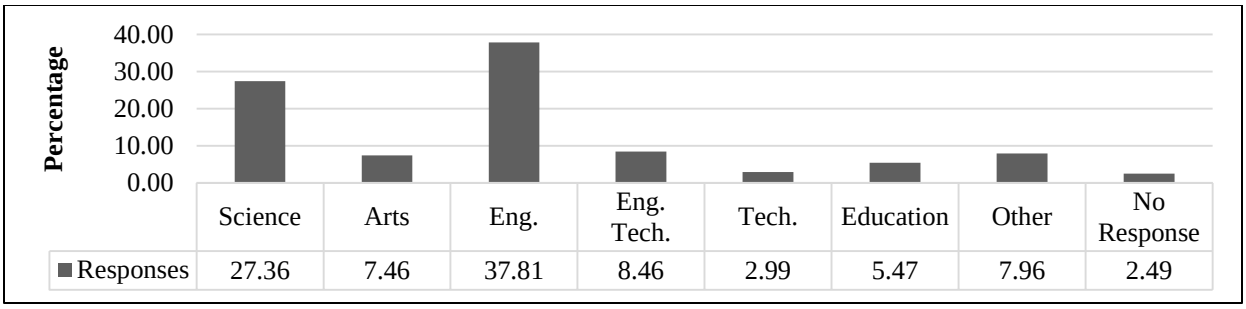


	60-'65	66-'70	71-'75	76-'80	81-'85	86-'90	91-'95	96-'00	01-'05	06-'10	11-'15	16-	NR	Other
First Degree	1.49	3.98	6.47	13.43	15.42	15.92	12.44	8.96	11.44	4.48	1.49	0.00	1.99	2.49
Terminal Degree	0.00	1.00	1.49	3.48	6.47	11.94	11.44	11.94	13.93	15.42	12.44	5.97	2.49	1.99

Figure 5. Year of Terminal and First Degree

Level STEM Educators Started College. A great deal of discussion is often had between those teaching at the 2-year level. Educators at this level wonder how many of their peers began their initial studies in such a college. About 14.93% of survey respondents began in a 2-year college while 84.58% began in a 4-year college. About 0.5% did not respond to this question.

STEM Educators First Degree. There is a variety of perceptions regarding the first degree of STEM Educators. Some ask if those in this field began with the degree and area they are teaching or something else. The respondents varied in their responses, from very specific to generalized. Figure 6 shows generalized grouping of the responses.

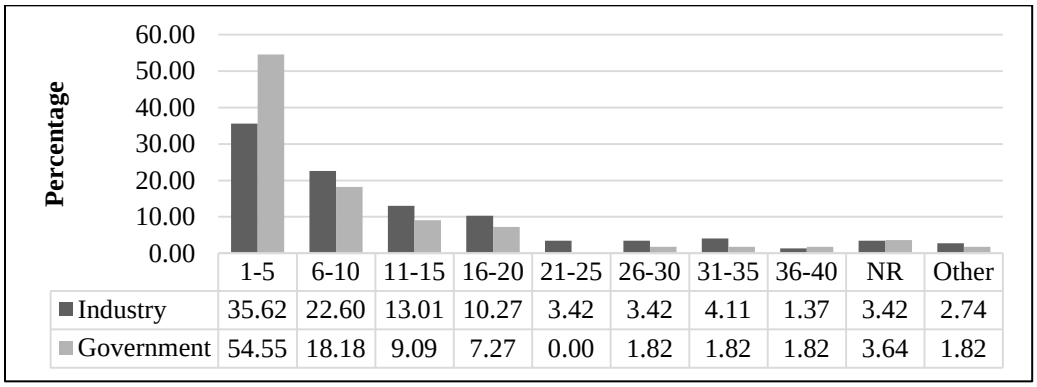


	Science	Arts	Eng.	Eng. Tech.	Tech.	Education	Other	No Response
Responses	27.36	7.46	37.81	8.46	2.99	5.47	7.96	2.49

Figure 6. STEM Educators First Degree

Industrial Experience. STEM Educators were asked if they had industrial experience, 73% of the respondents indicated that they did. They were also asked how many years they spent in industry, most indicated between 1-5 years, where fewer indicated longer periods. Figure 7 shows the distribution of that experience based on the responses of these STEM Educators.

Government Experience. Since the question was asked about industrial experience, the survey also asked about experience in governmental agencies and the years in those positions. Approximately 27% of the STEM Educators indicated they had worked in a government position or facility. Most of the respondents indicated that they worked in these positions for 1-5 years with higher years of experience tapering off beyond that period, as shown in Figure 7.



	1-5	6-10	11-15	16-20	21-25	26-30	31-35	36-40	NR	Other
Industry	35.62	22.60	13.01	10.27	3.42	3.42	4.11	1.37	3.42	2.74
Government	54.55	18.18	9.09	7.27	0.00	1.82	1.82	1.82	3.64	1.82

Figure 7. STEM Educators Years in Industry and Government

Discussion

Because of the survey, the researchers gained insight into basic demographics, education history, and the working experience of STEM educators. STEM educators surveyed appear to be about evenly split between genders, with slightly more male educators surveyed. This was to be expected as STEM fields are generally recognized to be male-dominated, thus the university level respondents were generally male. The educators surveyed are in their late 40s to early 60s and predominantly live in Indiana or Connecticut, though there is representation from 30 U.S. states and five other countries. The researchers intend to focus on the population in the United States as the comparison of other educational systems may confound the results of the data. In

addition, subjects surveyed appear to be predominantly teaching at the Undergraduate level, and of that, mostly sophomores.

The educators surveyed primarily are focused in the technology subset of STEM. Most either had a Ph.D. or their Masters of Science as their terminal degree. Educators surveyed received these degrees in the mid-2000s to early 2010s. The majority of educators surveyed had their first degree in some discipline of engineering and earned it in the 1980s. Eighty-five percent of respondents began their studies in a 4-year college. Most educators surveyed had experience in either government or industry positions and held those positions for around 5 years.

The frequency of government and industrial experience among educators surveyed may indicate the importance of work experience to these particular individuals. Further, the prominence of engineering degrees as first degrees for these educators may show that these individuals did not originally see themselves in careers in education. These serve as areas of potential research.

This survey also asked a number of questions about teaching beliefs and beliefs regarding STEM students, the result of which will be presented in forthcoming work.

This study is limited in the conclusions it can draw. The sample size was relatively small for the area covered by the survey. The survey was distributed during the summer, a time not necessarily ideal for soliciting responses from educators. Additionally, the survey was not conducive to responses from K-12 educators, a problem the researchers have identified and plan to correct. Further iterations of the survey need to include space for educators to clarify answers to “other” options. Clarifying questions and selecting an alternate time to distribute the survey could provide results of a better quantity and quality. Further statistical analysis such as confidence intervals are not relevant in a study that was as limited as this and focused on the demographics of the responding population. Rather deeper statistical analysis will be used for future work to center the responses, while making conclusions regarding other issues addressed in the survey.

Conclusion

Answering the question laid out above, results show that STEM educators are generally male and in their mid-50s. They can be found in any of the U.S. states and primarily are involved in educating college sophomores in technology. They were trained as an engineer in their undergraduate studies and received a Ph.D. as their terminal degree.

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Overall, this survey provided a basic idea of who STEM educators are, what their education history is, and their work experience outside of academia. As a result, the researchers are more aware of generally who STEM educators are. This understanding provides the community at large with direction when researching this unique subset of the population. In addition, the results provide the researchers with a direction to move in when devising further iterations of the survey.

Future Work. An additional, more broadly distributed survey would aid in understanding of the population of STEM educators. Furthermore, an international study would further the understanding of those interacting and coaching STEM students globally. The results of a study of this sort would provide insight into what works in other countries and may be helpful to strengthen STEM Education in the United States and worldwide.

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