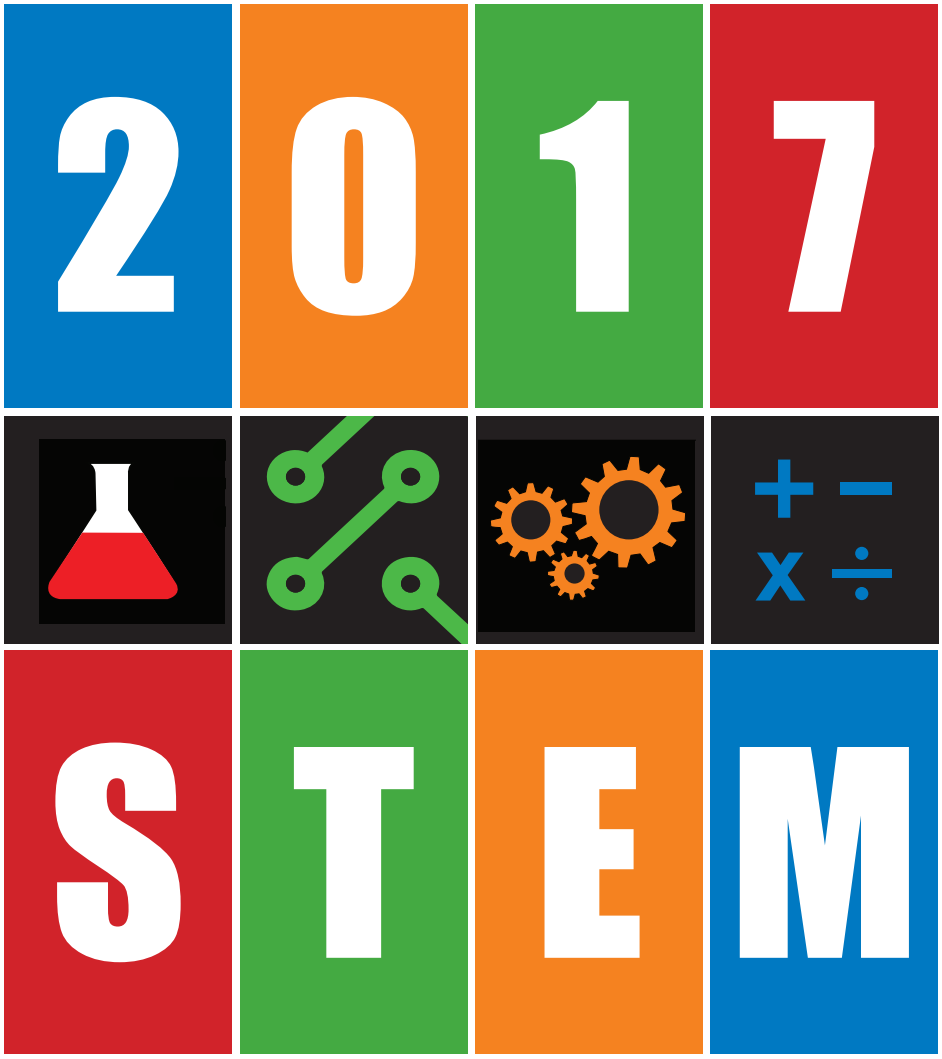

SURVEY IN TENNESSEE

MIDDLE TENNESSEE STATE UNIVERSITY

JONES COLLEGE OF BUSINESS

Business and Economic Research Center

Dr. Murat Arik, Director

AMERICA'S SBDC TENNESSEE

SMALL BUSINESS DEVELOPMENT CENTERS

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MIDDLE TENNESSEE STATE UNIVERSITY

Friends,

I am pleased to share the research findings contained in the following report, *Shaping Tennessee's Future: STEM Workforce Challenges and Opportunities*. This report is the result of the outstanding work of Dr. Murat Arik, director of our Business and Economic Research Center (BERC) and assistant professor of Management at Middle Tennessee State University.

This STEM (science, technology, engineering, mathematics) research continues to assess the challenges our Tennessee businesses face when seeking skilled workers in STEM related fields. This report's survey results provide the critical information necessary for this University to continue to develop programs and curriculum to address the workforce skills in demand by our businesses and industries. For example, to address the growing demand for STEM workforce skills in advanced manufacturing, MTSU launched a new degree program in Mechatronics Engineering that is coupled with a Siemens Industry Inc. Level 3 Professional Certification, making the major the only degree program of its kind in the world! The development of this program is the result of the growth of automation across many business and industry sectors.

As a result of this STEM workforce research and our continuing focus on the needs of our employers, MTSU is uniquely positioned to address the workforce skills gap in Tennessee.

Regards,

Dr. Sidney A. McPhee
President, Middle Tennessee State University

Acknowledgments

I would like to recognize and thank Middle Tennessee State University President Sidney McPhee for promoting, encouraging, and supporting the research initiatives involving STEM workforce dynamics.

Also, I would like to thank Patrick Geho, State Director of the Tennessee Small Business Development Center Network, for his financial contributions to this project and continuing support and feedback throughout the research process. Furthermore, many business leaders, mayors, economic development professionals, and school principals across Tennessee responded to the Business and Economic Research Center (BERC) STEM survey that allowed us to complete this project. I thank them for their efforts and contributions to this project. Special thanks go to the following individuals for making a real difference in this project: BERC's senior editor, Sally Govan; graduate research associate Estrella Ndrianasy; and undergraduate research associate Allison Logan.

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Shaping Tennessee's Future:

STEM Workforce Challenges and Opportunities

Executive Summary

The Business and Economic Research Center (BERC) at Middle Tennessee State University in partnership with the Tennessee Small Business Development Center assessed critical challenges and opportunities in the STEM (science, technology, engineering, mathematics) fields across Tennessee. A survey of businesses, mayors, local economic development officials, and school principals suggests Tennessee faces significant challenges in STEM workforce supply, pipeline, and infrastructure.

Key Findings:

Employment and Skill Gap

- As of 2016, the size of the STEM workforce in Tennessee was around 335,590.
- The STEM workforce in Tennessee is characterized as an oversupply of low-skilled STEM workforce relative to the U.S. average.
- To catch up to the rest of the U.S. in relative share of STEM workforce, 22,000 new STEM jobs are needed in Tennessee.

STEM Workforce Challenges

- Challenges associated with factors affecting the supply of STEM workforce include:
  - Perceived lack of rigor in Tennessee's K-12 education system;
  - Lack of knowledge about programs;
  - Lack of interest and ability;
  - Lack of emphasis on the necessity of difficult subjects.

- Challenges associated with the STEM pipeline include the following:
  - About 70 percent of community stakeholders indicated the Tennessee education system does not produce enough quality/competitive individuals.
  - About 62 percent of community stakeholders did not think students are graduating with the proper skills for STEM-related jobs.
  - About 62 percent of community stakeholders argued the workforce in Tennessee is not going to meet the demands of advanced technology.

    - Community stakeholders rank lack of interest in STEM first and connecting education with employment second among critical challenges for Tennessee.

- Challenges associated with government and infrastructure include:
    - Community stakeholders indicated the role of government in promoting the STEM workforce should be in the areas of funding, promotion, incentives, and awareness.
    - Among nearly 300 comments, making connections between educational institutions and workforce needs ranks first among potential ways to engage business, industry, and other community partners in advancing STEM.
    - About 88 percent of community stakeholders indicated there is potential for aligning and coordinating STEM resources across the state.

- Challenges to businesses include:
    - Businesses indicated technology advancement affects them in many ways: efficiency, continuous improvement, new opportunities, and product development, among others.
    - Inability to fill STEM-related jobs creates significant problems for businesses and will affect their growth.
    - Businesses indicated the local STEM workforce shortage will increase their costs through training programs, non-local recruiting, and relocation.
    - Businesses face the following challenges in recruiting a STEM workforce: skilled labor force, financial challenges, location challenges, and STEM awareness.

Conclusion

Addressing the STEM workforce challenge is critically important for Tennessee for these major reasons:

- Building the capacity for innovation and creativity: A STEM workforce is highly educated relative to all other occupations in an economy.
- For Tennessee, the advanced manufacturing and healthcare industries have become major drivers of economic growth. To build sustainable economic growth, Tennessee should build the capacity of its workforce.
- Economic impact: Addressing the low-skill problem and moving Tennessee's STEM concentration to the national level alone would create an additional 12,000 jobs in the economy.

Chapter 1: Understanding STEM Workforce Dynamics in Tennessee

What is the STEM workforce? What role does it play in an economy? What are its major characteristics? The key to understanding STEM (science, technology, engineering, and math) workforce dynamics lies in the answers to these three basic questions. A review of several studies shows there is no consensus on what the STEM workforce should include.

In terms of the meaning of the STEM workforce, two general definitions emerge:

1. Individuals in a STEM occupation, or
2. Individuals holding a STEM degree.

Although a hybrid approach combining both definitions may provide a better understanding of the STEM workforce, the former is easily quantifiable for research purposes.

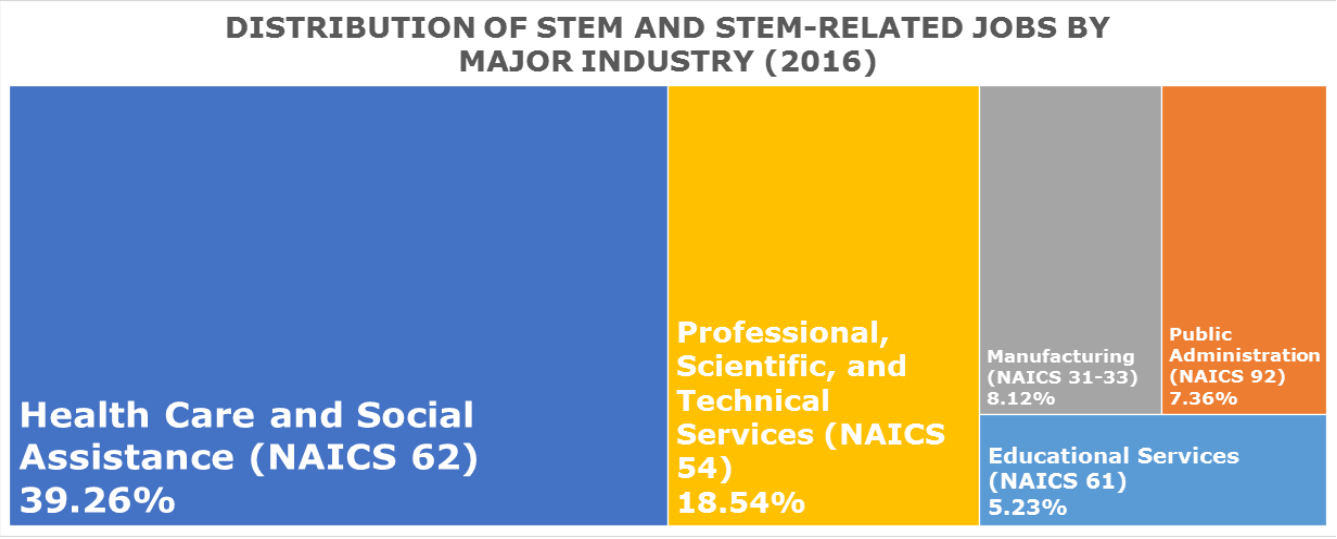
Which occupations should be considered STEM occupations? The following options are widely used by individual researchers and agencies:

1. STEM occupations,
2. STEM-related occupations, and
3. (Sometimes) social science occupations.

This report uses an occupational definition of the STEM workforce. Consistent with the U.S. Census Bureau definition, this approach includes both STEM and STEM-related occupations, including several social science occupations. A total of 98 occupations (63 STEM and 35 STEM-related) are included in the analysis. From this point forward, the term "STEM workforce" is used to refer to STEM and STEM-related occupations in the United States.

Why is the STEM workforce important to an economy?

Since the early 1990s, fast-paced economic transformations within the United States and across the globe have dramatically reduced industry and product life cycles. This in turn has created tremendous challenges and opportunities. For example, Tennessee lost its traditional manufacturing base throughout the 1990s and 2000s. Only during the past decade has the state started rebuilding its manufacturing base, not in traditional sectors such as textiles and furniture but in the advanced manufacturing and automotive sectors. In this transformed manufacturing space, the STEM workforce plays a critical role as a driver of innovation and competitiveness.



Source: BERC and BLS

In Tennessee, the main sectors driving the economy are advanced manufacturing, automotive, professional and business services, health care, transportation, and logistics. These are the major industries employing a substantial percentage of the STEM and STEM-related workforce. Because of the state's heavy reliance on these industries for job growth and economic prosperity, it is important to understand STEM workforce dynamics in Tennessee.

What are some characteristics of STEM occupations? One important aspect of the STEM workforce is that individuals holding these occupations are highly educated. The percentage of STEM bachelor's degree-holders is twice that of bachelor's degree-holders in all other occupations in Tennessee. This has two implications for the state's economy:

(1) Wages and salaries are closely related to educational attainment levels. The higher the educational attainment level of the workforce, the higher the purchasing power of individuals in the economy.

(2) A highly educated workforce is a major source of innovation and entrepreneurial activity.

However, in terms of STEM workforce characteristics, two issues require further elaboration:

(1) Not all workers in STEM occupations have a bachelor's degree or above. Many "technical" occupations that play a critical role in highly competitive industries require only specific training after high school.

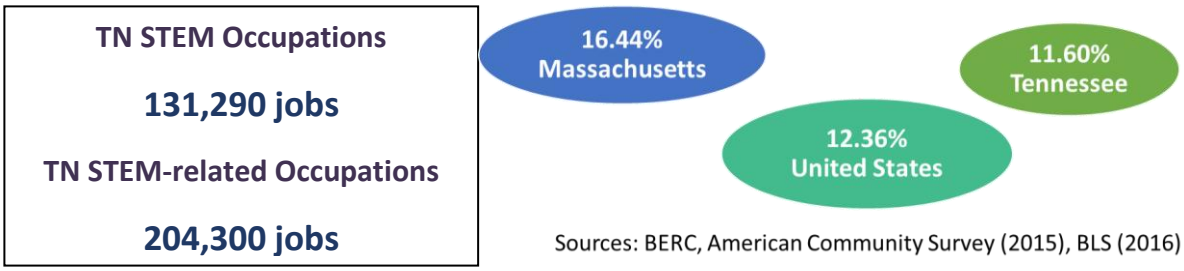
(2) Not all individuals in STEM occupations have STEM degrees. As will be highlighted in the following chapters, the STEM survey indicates that about 77 percent of STEM workers in Tennessee have STEM degrees.
The remaining 23 percent have degrees in other fields or no degree beyond high school. This means either companies are facing difficulty hiring employees with the right credentials or STEM degree-holders are not seeking opportunities in their areas of expertise.

Understanding and analyzing the STEM workforce within a state context requires an understanding of supply and demand dynamics and pipeline issues. The Business and Economic Research Center (BERC) invited businesses, mayors, school administrators, and economic development professionals across Tennessee to assess STEM workforce challenges and opportunities in shaping Tennessee's future. In addition to the BERC survey, BERC contracted with Qualtrics to conduct business surveys for this project.

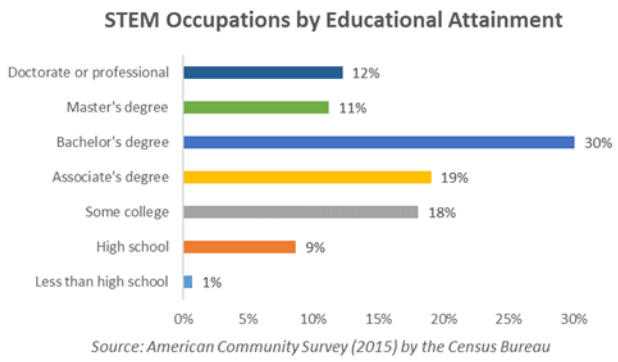
The rest of the report is organized as follows. Chapter 2 looks at STEM workforce indicators from a comparative perspective. Chapters 3–5 address the outlook of community stakeholders on STEM workforce supply, pipeline issues, infrastructure, and government as related to the STEM workforce. Chapter 6 focuses on STEM challenges faced by businesses. Chapter 7 presents strategic solutions to STEM workforce challenges. Chapter 8 looks at future expectations and top occupations and skill sets for the Tennessee STEM workforce. Chapter 9 concludes the report.

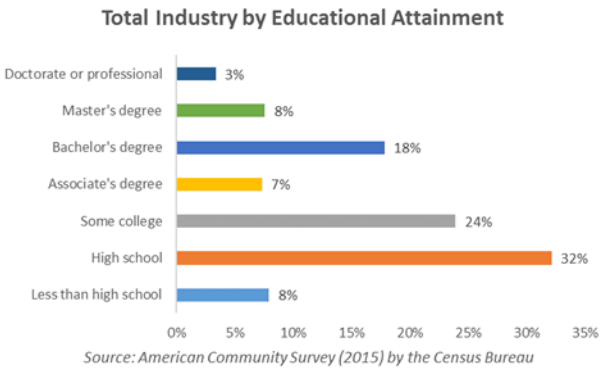
Chapter 2: STEM Workforce by the Numbers

How many STEM and STEM-related jobs does Tennessee have? What are their characteristics? According to BERC estimates using American Community Survey (2015) and BLS data (2016), Tennessee has 335,590 STEM and STEM-related jobs. What does this number mean for Tennessee? It means that in 2016, about 11.60 percent of all jobs were STEM and STEM-related occupations. The size of Tennessee's STEM and STEM-related workforce is smaller compared with the national average and well behind some leading states, such as Massachusetts. In the same year, according to BERC estimates, 12.36 percent of all jobs in the United States and 16.44 percent in Massachusetts were in STEM and STEM-related occupations. Increasing Tennessee's STEM workforce to the U.S. average or to the Massachusetts state average would mean adding 21,991 or 140,027 STEM and STEM-related jobs to the economy, respectively.

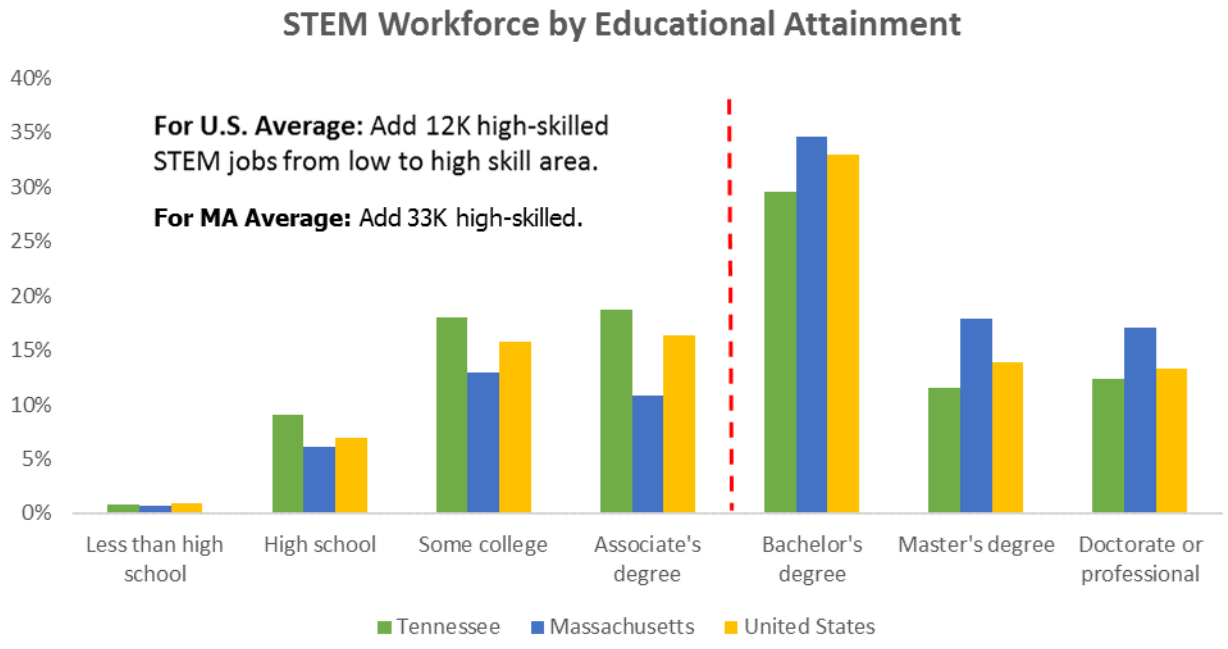


What is the educational attainment level of the STEM workforce compared with all industries? Overall, the STEM workforce has a higher educational attainment level than the average level in Tennessee. The share of graduate degree-holders in all occupations in Tennessee is 11 percent, significantly lower than that of STEM occupations (23 percent). At the bachelor's degree level, the difference is equally striking: 30 percent of STEM employees have a bachelor's degree, compared with 18 percent of employees in all industries combined. A similar pattern is visible in the category of "some college or associate's degree": 37 percent of STEM employees have either some college or an associate's degree, compared with 31 percent of employees in all industries. The trend continues for the last two categories: 10 percent of STEM employees have only a high school education or less, compared with close to a half (40 percent) of all workers in Tennessee.





The STEM workforce in Tennessee also can be characterized as having an oversupply of low-skilled workers. In all areas beyond some college, there is a non-trivial gap between Tennessee and the United States or the state of Massachusetts. The gap suggests that to catch up with the U.S. average, Tennessee should shift about 12,000 low-skilled jobs to high-skilled jobs either through lifelong learning or replacement of retiring workers. This number increases to 33,000 jobs in order for Tennessee to reach the education attainment level of the STEM workforce in Massachusetts.



Source: BERC and American Community Survey (2015)

For example, only 25 percent of recreational therapists in Tennessee have a bachelor's degree or above, compared to 71.67 percent of individuals in this occupation in the U.S. (a gap of 46.67 percentage points.). For computer

hardware engineers, the gap between the U.S. and Tennessee is 40.59 percentage points. This trend is consistent for most computer-related occupations such as computer support specialists (13.17 percentage points), network and computer systems administrators (10.51 percentage points), and computer systems analysts (10.11 percentage points). Other healthcare-related occupations also suffer from low educational attainment compared to the U.S. average. Following is a table with the top 13 occupations with the highest skill gap between Tennessee and the U.S.

SOC	Occupations	US Bachelor's and Above	TN Bachelor's and Above	Skill Gap (Percentage Points)
291125	Health recreational therapists	71.67%	25.00%	46.67%
172061	Computer hardware engineers	73.93%	33.33%	40.59%
151134	Web developers	63.88%	37.50%	26.38%
192021	Atmospheric and space scientists	76.00%	50.00%	26.00%
194031	Chemical technicians	33.33%	9.52%	23.81%
291199	Health diagnosing and treating practitioners, all other	83.53%	60.00%	23.53%
299000	Other healthcare practitioners and technical occupations	61.70%	42.86%	18.84%
291031	Dietitians and nutritionists	72.47%	55.00%	17.47%
172081	Environmental engineers	82.62%	66.67%	15.95%
151150	Computer support specialists	45.71%	32.54%	13.17%
173010	Drafters	26.43%	15.38%	11.04%
151142	Network and computer systems administrators	50.51%	40.00%	10.51%
151121	Computer systems analysts	71.31%	61.19%	10.11%
Sources: BERC and American Community Survey (ACS) 2015 through IPUMS.org				

Such a large gap across several STEM occupations may affect Tennessee's long-term competitiveness unless new generations make up the difference.

Are new generations helping to close the educational attainment gap in STEM occupations in Tennessee? A look at the educational attainment level by age cohort in STEM occupations suggests intergenerational differences are closing the educational attainment gap between Tennessee and the U.S. However, educational attainment gaps by age cohort are larger than for Tennessee as a whole, which suggests the educational attainment level of the Tennessee STEM workforce may not catch up with the nation in the short run. The next section summarizes further differences between Tennessee and selected states from a comparative perspective.

US				MA				TN			
Age	<College	College+	GAP	**Age**	<College	College+	GAP	**Age**	<College	College+	GAP
25-34	33.92%	66.08%	32.16%	**25-34**	18.12%	81.88%	63.76%	**25-34**	41.55%	58.45%	16.90%
35-44	36.04%	63.96%	27.92%	**35-44**	24.55%	75.45%	50.90%	**35-44**	43.30%	56.70%	13.39%
45-54	40.65%	59.35%	18.70%	**45-54**	32.07%	67.93%	35.86%	**45-54**	48.76%	51.24%	2.47%
55-64	43.19%	56.81%	13.62%	**55-64**	36.17%	63.83%	27.67%	**55-64**	46.90%	53.10%	6.20%
65-74	40.35%	59.65%	19.29%	**65-74**	31.45%	68.55%	37.11%	**65-74**	50.00%	50.00%	0.00%
75-84	36.00%	64.00%	28.00%	**75-84**	29.17%	70.83%	41.67%	**75-84**	51.52%	48.48%	-3.03%
85+	35.21%	64.79%	29.58%	**85+**	44.44%	55.56%	11.11%	**85+**	57.14%	42.86%	-14.29%

Keys:
Age: age cohort
<College: Less than college education
College+: Bachelor's and above
Gap: "College+" minus "<College"
Sources: BERC and American Community Survey (ACS) 2015 through IPUMS.org

How does Tennessee compare with other selected states on STEM-related indicators? To present a balanced perspective, this report includes a set of STEM-related indicators that allow for state-by-state comparison. A total of nine states are compared in the areas of STEM pipeline, higher-education dynamics, workforce, R&D and innovation, high-tech, venture capital, and entrepreneurship.

Pipeline. Among nine states, Tennessee is among those with the lowest expenditure per student for elementary and secondary public schools, along with Mississippi, North Carolina, Texas, and Alabama, spending only $8,354, $8,097, $8,160, $8,213, and $8,577, respectively. Massachusetts ($14,844) and Virginia ($10,656) have the highest. The per-student annual spending gap between Tennessee and Massachusetts is $6,490.

Tennessee is among states with the lowest percentage of public-school students taking Advanced Placement exams (20.4 percent). The gap between Tennessee and Virginia, for example, is 25.9 percentage points in this category.

Pipeline	Expenditures per pupil for elementary and secondary public schools, by state: 2012	Public school students taking Advanced Placement exams 2014 (%)	Eighth Grade math proficiency 2013 (%)	Eighth Grade science proficiency 2011 (%)
Tennessee	$8,354	20.4	28	31
Alabama	$8,577	29.2	20	19
Georgia	$9,272	41.5	29	30
Kentucky	$9,327	35.4	30	34
Massachusetts	$14,844	41.7	55	44
Mississippi	$8,097	15.3	21	19
North Carolina	$8,160	34.4	36	26
Texas	$8,213	39.1	38	32
Virginia	$10,656	46.3	38	40

National Science Board 2016. Science and Engineering Indicators 2016. Artlington, VA: National Science Foundation (NSB 14-01)

In the areas of math and science proficiency in eighth grade, results are mixed: while Tennessee has one of the lowest scores in math proficiency, its standing in science among nine states is average. The math proficiency gap between Tennessee and Massachusetts is 27 percentage points. *The data suggest that students in Tennessee are not succeeding in rigorous math education and Advanced Placement tests.*

Higher education. All higher-education indicators reported here suggest both challenges and opportunities for Tennessee. The main challenge will be to increase the number of graduates holding science and engineering degrees and the overall number of people with a postsecondary education. For example, the gap between Tennessee and Massachusetts in those holding a postsecondary degree is 18.3 percentage points. On a per-capita basis, Tennessee has fewer individuals with a bachelor's degree in science and engineering compared with Alabama, North Carolina, Virginia, and Massachusetts.

Higher Education (STEMconnectors)

	Bachelor's degrees in science and engineering conferred per 1,000 individuals 18-24 years old 2013 (%)	Science and engineering degrees as a percentage of higher education degrees conferred 2013 (%)	Average undergraduate charge as percent of disposable personal income 2014 (%)	State expenditures on student aid per full-time undergraduate student 2013	Postsecondary degree-holders among individuals 25-44 years old 2013(%)
Tennessee	15.1	24.9	43.5	$1,968	36.6
Alabama	17.6	27.0	50.6	$51	34.3
Georgia	15.7	30.6	46.0	$1,699	38.8
Kentucky	14.7	25.8	50.9	$1,365	36.6
Massachusetts	32.2	34.2	43.3	$339	54.9
Mississippi	11.6	25.0	45.7	$333	32.4
North Carolina	19.2	33.9	42.9	$1,315	41.3
Texas	12.8	29.2	39.7	$1,006	35.8
Virginia	**24.5**	**34.9**	**45.5**	**$763**	**47.9**

National Science Board 2016. Science and Engineering Indicators 2016. Arlington, VA: National Science Foundation (NSB 14-01)

College education is relatively more affordable in Tennessee than in the other eight states compared here. The lottery scholarship is making college even more affordable. It is important to mention Tennessee's recent Drive to 55 effort to increase its postsecondary participation rate. It is too early to assess the effort's impact; however, it is likely that this policy may change the higher education dynamics over the next four to five years.

Workforce (marketplace). Tennessee has an oversupply of low-skilled STEM workers. Tennessee has the third-lowest percentage of science and engineering occupations among all occupations compared with eight other states. Tennessee is performing better than Kentucky and Mississippi but lagging far behind North Carolina and Texas. In the four other categories,

Tennessee is either one of the worst performers or has the second-lowest score among nine states.

Workforce	Individuals in science and engineering occupations as a percentage of all occupations 2014 (%)	Engineers as a percentage of all occupations 2014(%)	Computer specialists as a percentage of all occupations 2014 (%)	Technical workers as a percentage of all occupations 2014 (%)	Life and physical scientists as a percentage of all occupations 2014 (%)
Tennessee	3.20	1.06	1.60	1.17	0.16
Alabama	4.00	1.63	1.88	1.34	0.20
Georgia	4.30	0.98	2.80	NA	NA
Kentucky	3.00	0.83	1.66	0.92	0.18
Massachusetts	6.90	1.64	3.84	1.87	0.72
Mississippi	2.30	0.79	NA	1.01	0.22
North Carolina	4.50	0.96	2.66	1.29	0.32
Texas	4.80	1.39	2.81	1.56	0.16
Virginia	7.50	1.42	5.21	1.57	NA

National Science Board 2016. Science and Engineering Indicators 2016. Arlington, VA: National Science Foundation (NSB 14-01)

R&D and Innovation. Is Tennessee on par with other states in terms of research and development (R&D) spending and creativity? A review of four major indicators implies that state agencies and businesses are not spending enough relative to eight other states. In patents per capita, Tennessee is as competitive as other referenced states. Tennessee and Massachusetts still see a difference of 16.2 patents per capita in science and engineering occupations.

R&D and Innovation	R&D as a percentage of gross domestic product 2012 (%)	Business-performed R&D as a percentage of private-industry output 2013 (%)	State agency R&D expenditures per employed worker 2013	Patents awarded per 1,000 individuals in science and engineering occupations 2014 (%)
Tennessee	1.54	0.56	12	12.5
Alabama	2.10	0.96	68	6.6
Georgia	1.36	1.01	28	15.4
Kentucky	0.96	0.82	108	11.7
Massachusetts	5.63	4.44	10	28.7
Mississippi	1.11	0.24	47	6.2
North Carolina	2.10	2.01	66	18.6
Texas	1.43	1.11	119	18.0
Virginia	2.27	1.20	57	7.6

National Science Board 2016. Science and Engineering Indicators 2016. Arlington, VA: National Science Foundation (NSB 14-01)

High-tech, entrepreneurship, and venture capital. Tennessee has experienced significant growth over recent years in high-technology sectors.

However, (1) the growth is uneven across Tennessee, and (2) the economic impact has yet to show up in the trend data. Both establishment and employment shares of high-tech industries in the overall economy show relatively low performance for Tennessee compared with eight other states. Likewise, in venture capital amounts and deals, there is still room to grow.

High Tech, Entrepreneurship, and Venture Capital

	High-Technology establishments as a percentage of all business and establishments 2012 (%)	Employment in high-technology establishments in total employment 2012 (%)	Venture capital deals as a percentage of high-technology business establishments 2012 (%)	Venture capital disbursed per venture capital deal 2014 (millions)
Tennessee	6.81	9.55	0.55	1.71
Alabama	6.91	10.25	0.09	3.67
Georgia	10.08	13.41	0.25	8.27
Kentucky	6.63	8.38	0.13	3.62
Massachusetts	10.26	15.25	2.43	11.82
Mississippi	6.09	7.28	0.06	0.00
North Carolina	8.54	11.32	0.19	6.33
Texas	9.87	13.37	0.32	8.05
Virginia	12.65	17.89	0.32	6.35

National Science Board 2016. Science and Engineering Indicators 2016. Arlington, VA: National Science Foundation (NSB 14-01)

Key takeaways. Tennessee has several major challenges related to its STEM workforce. Some of these major challenges, as data suggests, include:

- addressing gaps and issues in the K-12 system;
- increasing degree production and encouraging lifelong learning through continuing education to eliminate skill gaps in the market;
- hiring the right person for STEM jobs, which will pull some STEM degree-holders from other occupations into STEM occupations; and
- addressing critical gaps in R&D spending.

If addressed carefully, these challenges may turn into opportunities for Tennessee to increase its competitiveness. For example, aligning the educational attainment level of the STEM workforce in Tennessee with the United States produces two major benefits to Tennessee:

- This alignment increases the capabilities of the STEM workforce, which is key to sustainable competitive advantage.
- Addressing the skill gap and training additional individuals will increase household income through wages and salaries. This will further impact the economy through multipliers, creating a significant amount of economic activity.

Chapter 3: Business Perceptions of STEM Dynamics in Tennessee

Who are the critical players in the STEM workforce debate? The key players in analyzing and understanding STEM workforce dynamics are businesses, mayors, local economic development officials, and schools administrators. As employers, community leaders, parents, educators, and administrators, their insights into the opportunities and challenges of the STEM workforce may have important policy implications for future economic directions in Tennessee.

To get these stakeholders' feedback, BERC designed and administered a comprehensive STEM survey in 2017. In addition, BERC contracted with Qualtrics to conduct business surveys to increase the sample size. Both online and mail-in surveys resulted in a total of 269 responses across Tennessee. There were responses from all nine regions of Tennessee, although northern middle Tennessee (20 percent), southeast Tennessee (17 percent), east Tennessee (14 percent), and southern middle Tennessee (13 percent) were better represented than other regions. Participation rates in southwest, Upper Cumberland, and northeast Tennessee were 5 to 7 percent.

In terms of industry affiliation, 33 percent of responses were from professional and business services, 16 percent from advanced manufacturing, 11 percent from healthcare, and 11 percent from education. The remaining 29 percent were from state and local government; transportation, logistics, and distribution services; goods production; chemical products and plastics; chamber/economic development; energy technologies; automotive; financial activities; and other.

Some of the major characteristics of respondents:

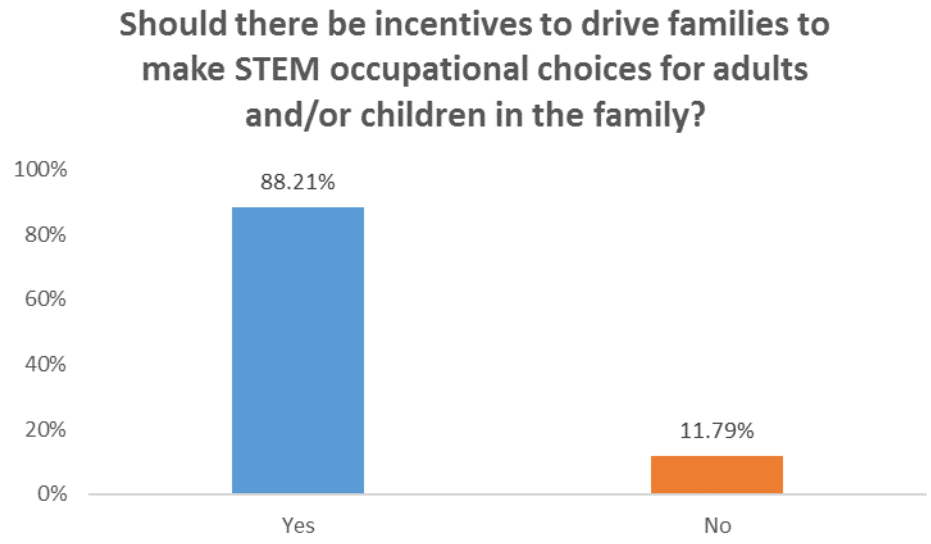
- Average employment of companies reported is 379.
- Of these companies' employment, an average of 39 percent of jobs are STEM or STEM-related.
- Average annual spending for STEM R&D activities of respondents is nearly $210,000.
- An average 57 percent of respondents indicate they participate in innovative activities such as research and development for the commercialization of patents.
- Total STEM-related R&D expenditures are nearly $52,000,000.
- Approximately 35 percent of respondents participate in the export of goods and services.

This section primarily focuses on three major areas: STEM supply, STEM pipeline, and infrastructure and government.

STEM Supply

What factors affect STEM supply? What roles do families play in increasing the number of people interested in STEM fields? What roles do educators play? What are the major challenges affecting the supply of STEM workers? Answers to these questions are organized by addressing the role of families and educators as well as other factors affecting the STEM workforce supply. A detailed review of associated challenges follows.

What roles should families play? Should parents be given incentives to make STEM occupational choices for adults or children in the family? Nearly 88 percent of respondents said yes to this question.

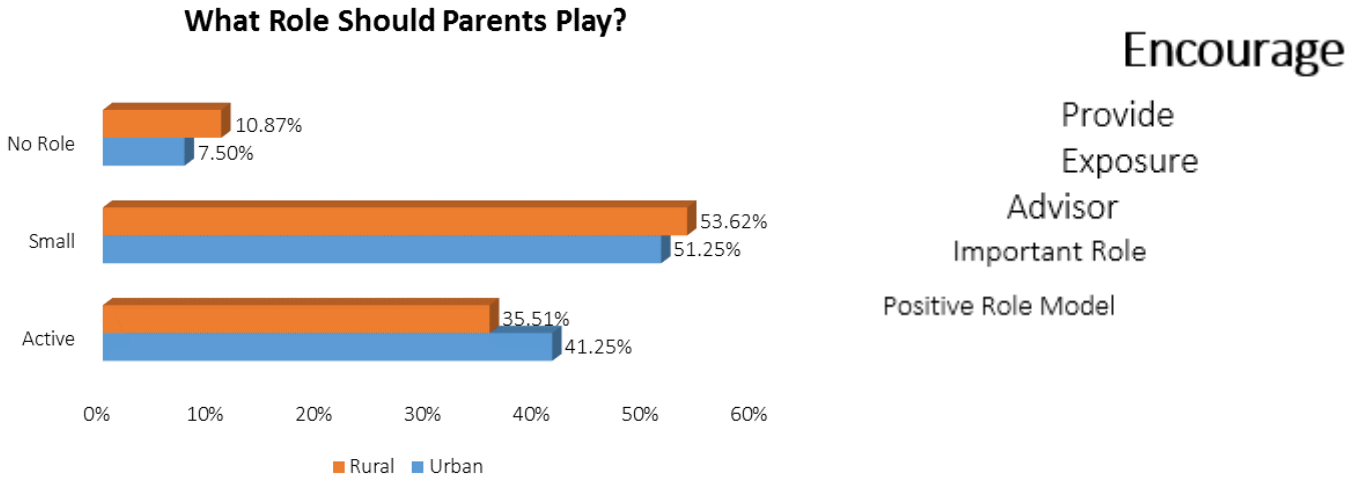


What specific role should parents play? BERC received over 220 comments from community leaders providing a rich menu of options for parents. The particularly critical ones are provided in order of importance below (see appendix for details). A majority of survey respondents indicated parents should have a passive role. A review of comments shows the community believes parents should act in a variety of roles. The most highly discussed key word was encouragement. Nearly 45 percent of responses indicated parents should be encouragers. Specifically respondents indicated that parents should 1) give general encouragement to their children, 2) encourage children to study STEM subjects, and 3) encourage their children to explore their passion, whether STEM-related or not.

The second most discussed role is to provide exposure. This role has two components. Many respondents indicated parents should educate their children

on STEM subjects, while others indicated parents should place their children in STEM enrichment programs.

The third most highly mentioned key role for parents is that of advisor. These respondents mention the importance of parents as advisors providing guidance. The responses overwhelmingly mention that parents should guide children into these careers, act as helpers, and oversee their children's progress and goals.



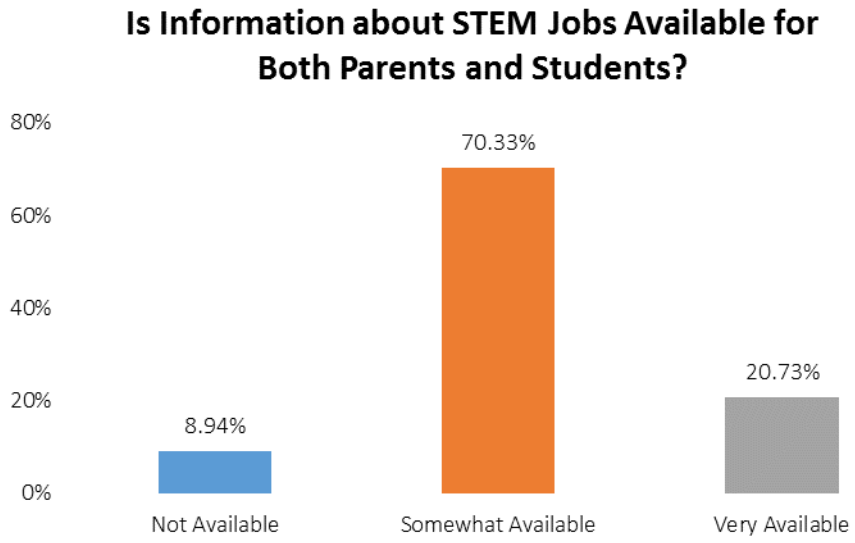
To consider rural-urban differences, BERC reclassified responses by region. Regions considered urban include the greater Memphis area, northern middle Tennessee, east Tennessee, and southeast Tennessee. The other five regions are reclassified as rural. When categorizing the responses by urban versus rural, several regional differences occur. Overall, 41 percent of respondents from urban areas assign an active role to parents in directing their students, compared with 36 percent of respondents from rural areas.

What roles should educators play? BERC received more than 230 comments on the role educators should play in addressing STEM workforce supply issues. The top five discussions center around providing a proper education, developing STEM-specific curricula, encouraging and supporting students, introducing students to STEM, and increasing STEM focus. The rural-urban difference with regard to the role of educators in the supply of STEM workers is somewhat significant, with 47% of rural respondents valuing a proper STEM education and 28% stressing the need for developing a STEM-specific curricula. Conversely, the urban respondents seem to more evenly value proper STEM education (37%), the development of a STEM-specific curricula (16%), encouragement and support for students (14%), the introduction of students to STEM (14%), and increasing STEM focus (15%).

Is the educational system encouraging students to pursue a STEM degree? Only a quarter of respondents indicated there is strong encouragement. About 9 percent of respondents see no encouragement at all, while 67 percent see some encouragement.

How much of an emphasis is put on educators to teach STEM skills? Only 27% of the respondents see strong emphasis, while 19% indicate either weak or very weak emphasis on educators to teach STEM skills. Although not quite significant, these numbers represent a slight improvement from prior findings.

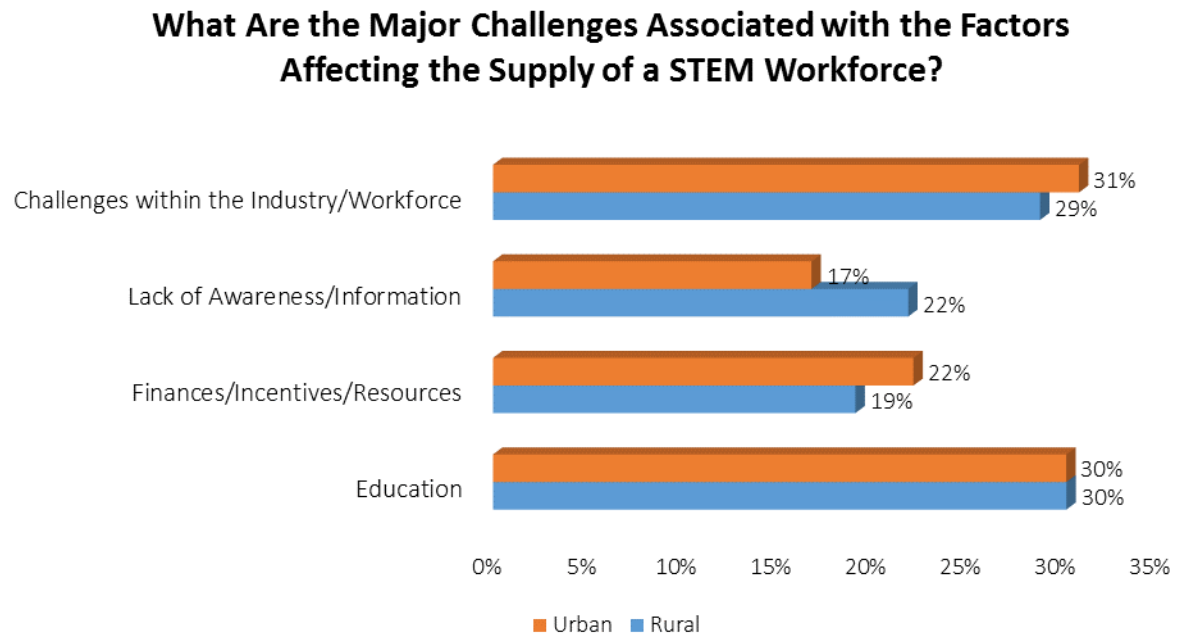
Information about STEM jobs. Do we have knowledge about STEM occupations? Respondents report a lack of information on STEM jobs readily available to parents and students. Only 21 percent claimed otherwise.



Major challenges associated with the supply of STEM workforce. The final question regarding the supply of the STEM workforce was about the challenges Tennessee faces. Survey respondents generously contributed to this section with more than 400 comments. Of these comments, the following six stand out:

- *poor primary and secondary education systems;*
- *lack of knowledge about programs;*
- *lack of interest and ability;*
- *lack of emphasis on the necessity of difficult subjects;*
- *misconception of what STEM is; and*
- *lack of parents' and teachers' emphasis on pursuit of math and science.*

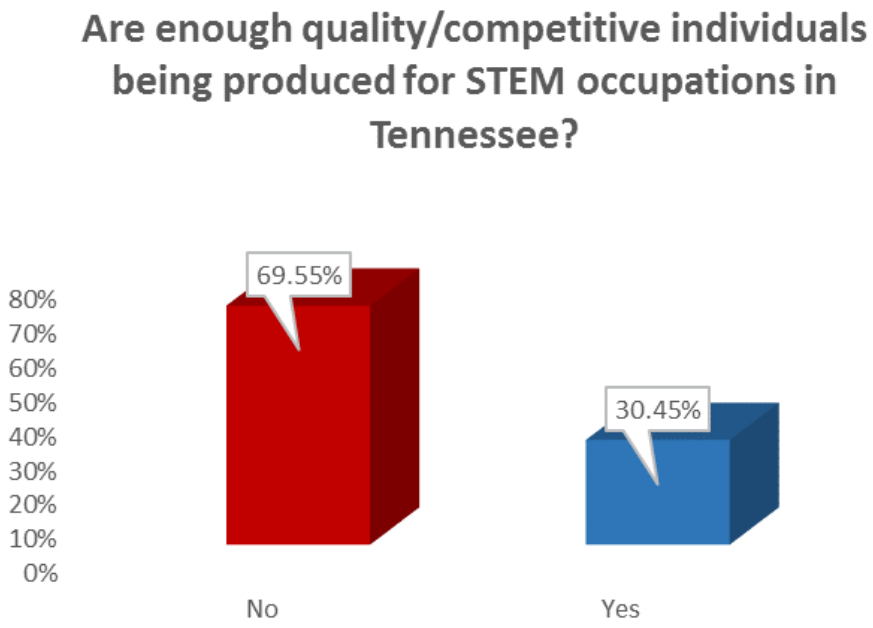
Is there a rural/urban difference on this issue? BERC identified four major themes from the comments. Community stakeholders from both urban and rural regions identified the education system as a primary challenge in increasing the supply of STEM workers. This issue is equally a challenge for both rural and urban regions. The second reason Tennessee has challenges in STEM workforce supply, according to these responses, is lack of awareness. Rural regions identified this as a reason more often than urban areas. The third critical issue is related to problems with the STEM industry itself. According to community stakeholders*, the primary reason for STEM workforce supply challenges is the lack of coordination between industry and educators.* Furthermore, a lack of sufficient resources and incentives leads to a lack of opportunities in many STEM areas.



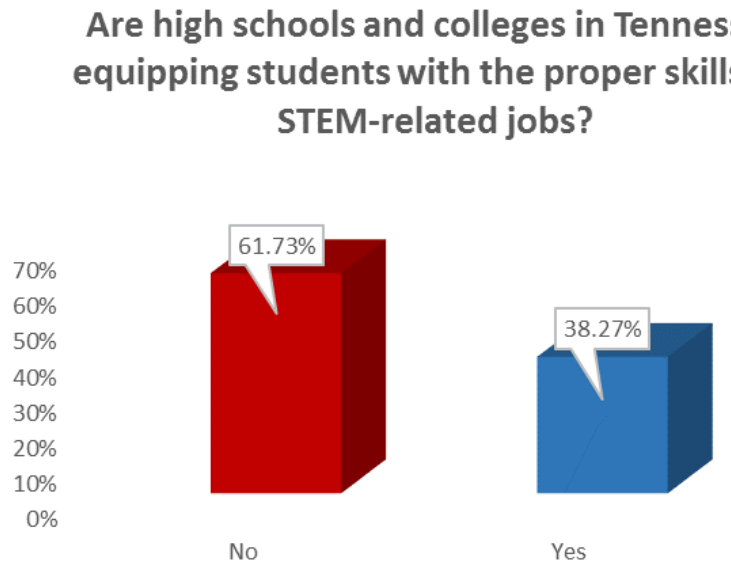
Chapter 4: STEM Pipeline and Challenges

This chapter focuses on the STEM workforce pipeline and its challenges. It primarily looks at whether the educational system produces the necessary number and quality of graduates to meet the demand in the market.

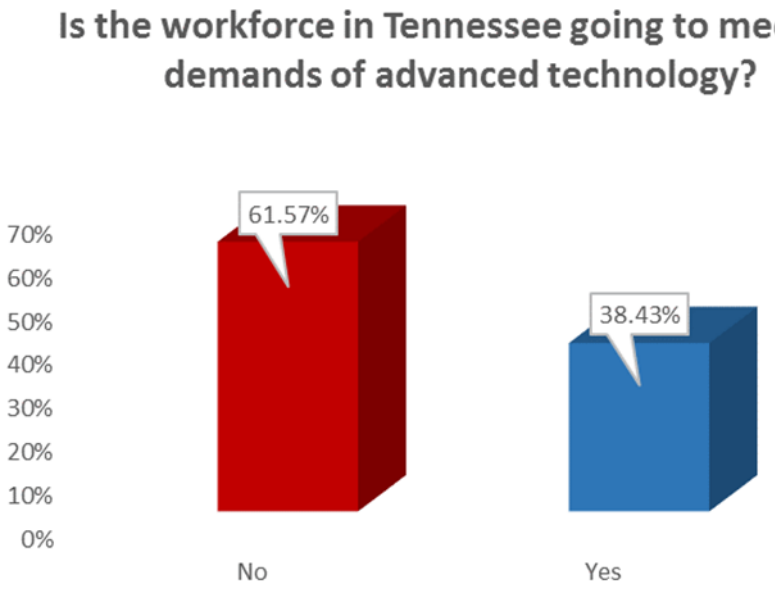
Are enough quality/competitive individuals produced for STEM occupations in Tennessee? An overwhelming percent of community stakeholders (nearly 70 percent) indicated the Tennessee education system does not produce enough quality/competitive individuals. Only 30 percent suggested otherwise.



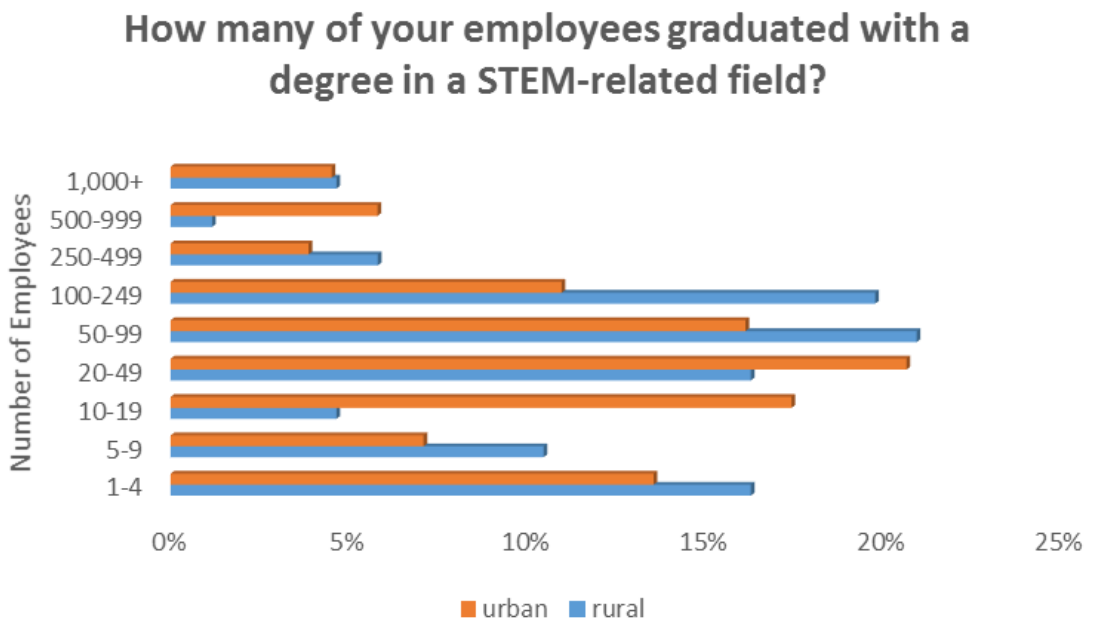
Are high schools and colleges in Tennessee equipping students with the proper skills for STEM-related jobs? This is a more targeted question assessing the performance of high schools and colleges in Tennessee. The answers were similar to those of the previous question: over 60 percent of community stakeholders said *no*. About 38 percent of respondents indicated the school system is producing enough high-quality graduates in Tennessee. These numbers represent a slight improvement over the previous year.



Is the workforce in Tennessee going to meet the demands of advanced technology? This question goes to the heart of efforts in Tennessee to promote the advanced manufacturing and healthcare information technology sectors. Does Tennessee have the necessary infrastructure to produce a skilled workforce to meet the technological challenge? Three out of five community stakeholders think the Tennessee workforce is not ready to meet advanced technology demands.



How many employees in STEM occupations have STEM degrees? In previous chapters this report discussed the implications of degree mismatch in STEM occupations and the oversupply of low-skilled STEM workers in Tennessee. The survey included a question regarding the degrees of current STEM employees. According to survey results, about 38.61 percent of all employees are in a STEM or STEM-related occupation. Moreover, about 77.34 percent of STEM workers have a STEM degree.



STEM pipeline–related challenges. What challenges are related to the STEM pipeline? Why should we care? Chapter 2 presented a host of indicators regarding the STEM pipeline in Tennessee. The STEM pipeline faces a series of challenges including math proficiency. Community stakeholders see other, similar challenges:

- The first issue is getting students interested in STEM fields.
- The second critical challenge is transition—the lack of connection between education and employment.
    - The lack of communication between business and higher education is closely associated with this transition challenge, which affects the STEM pipeline and, in turn, Tennessee's sustainable economic competitiveness.
- Other critical challenges include
    - lack of funding for STEM training,
    - lack of cultural awareness,
    - demand exceeding supply,

  - need for companies to continue to adjust to STEM innovations,
  - lack of available information about existing STEM programs, and
  - lack of knowledge and skill among workers, trainers, and educators.

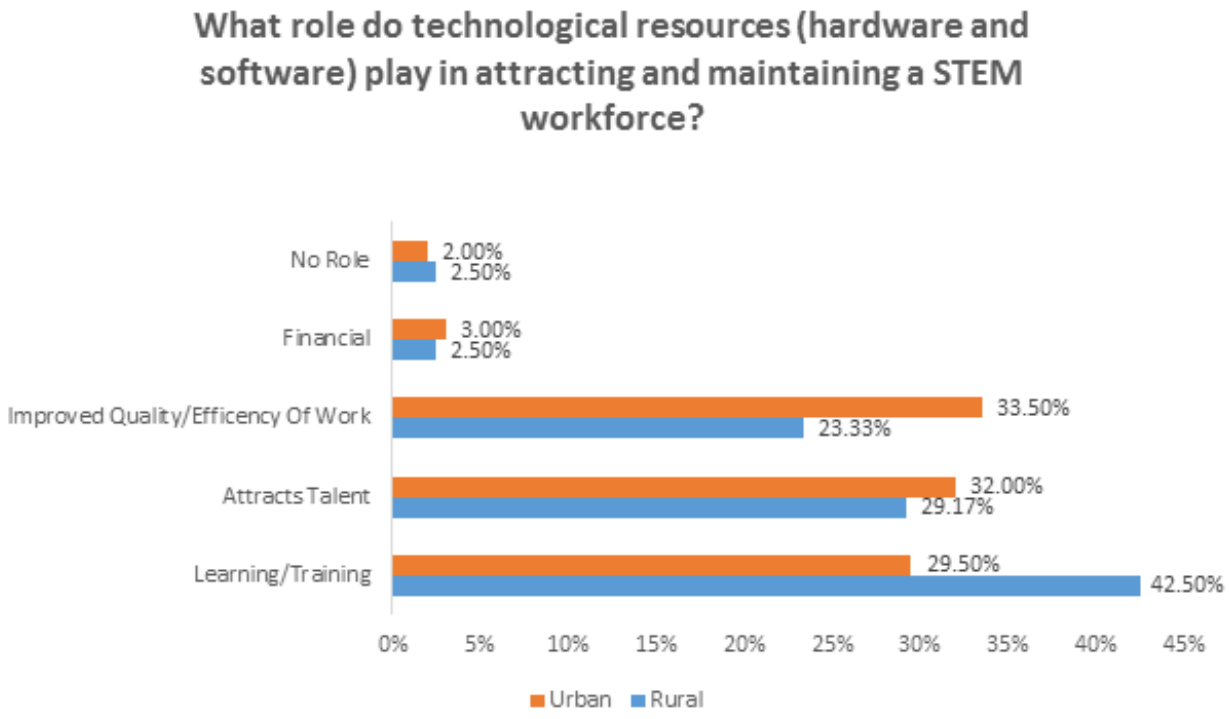
How do some of these challenges appear across the rural/urban divide? For the sake of simplicity, we collapsed all comments into four major categories across the rural/urban divide:

- market problems,
- education problems,
- lack of knowledge/interest, and
- community problems.

The largest rural/urban divide is in the area of *community problems or culture, with nearly a 57 percentage point difference. Urban respondents are more likely to suggest that cultural issues lead to major road blocks in the development of STEM fields.* The second category refers to the poor quality of the educational system, which is *more pronounced in urban areas*. Finally, the lack of awareness and interest as well as market and industry issues are challenges prevalent in both rural and urban segments.

Chapter 5: Infrastructure and Government Challenges

What role do infrastructure and government play in addressing challenges facing the STEM workforce in Tennessee? The survey included several open-ended questions on resources, incentives, programs, funding, partnerships, and overall challenges. What role do technological resources (hardware and software) play in attracting and maintaining a STEM workforce? Not surprisingly, answers to this question centered on the following: these resources (1) are critical for STEM workers, (2) help attract students to STEM fields, (3) virtually drive business competitiveness and profitability, and (4) improve proficiency and efficiency among both businesses and individuals.



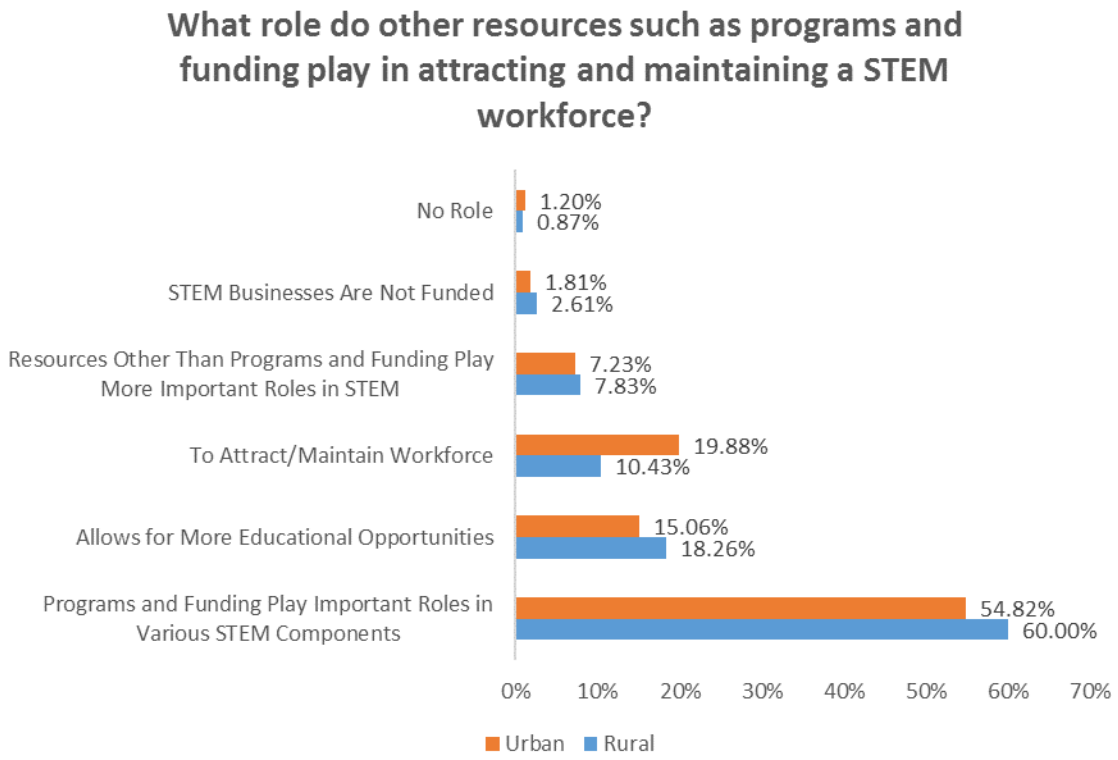
Technological resources play an important role in attracting talent and improving quality and efficiency of work. The most striking difference between rural and urban areas lies in the valuation of learning and training opportunities. Rural areas value educational opportunities by 13 percentage points more than urban areas.

What role do other resources such as programs and funding play in attracting and maintaining a STEM workforce? In response to this question,

- 57 percent of comments indicated funding and programming are critical for various components in maintaining a workforce,
- 16 percent highlighted the importance of these resources in attracting and retaining students, and
- 16 percent mentioned the role of these programs in ensuring a steady supply of skilled workers.

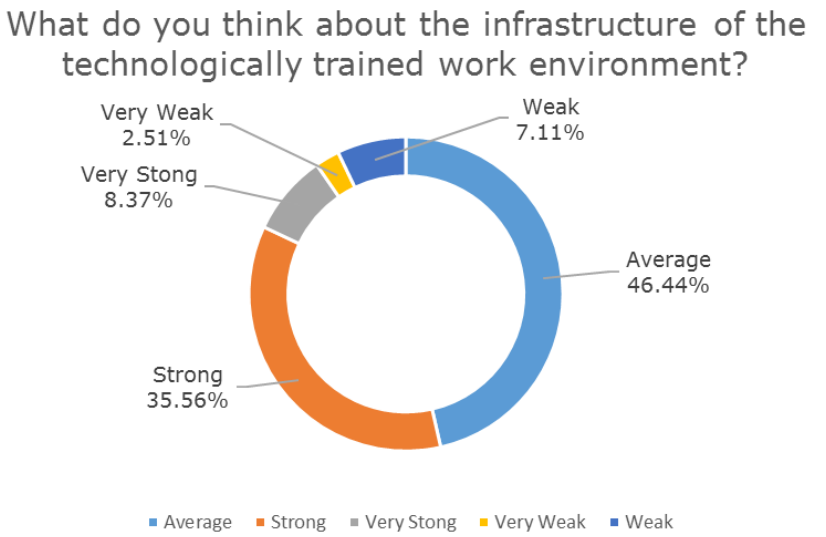
Why are these programs so critical for a STEM workforce? Respondents explained these programs and funding:

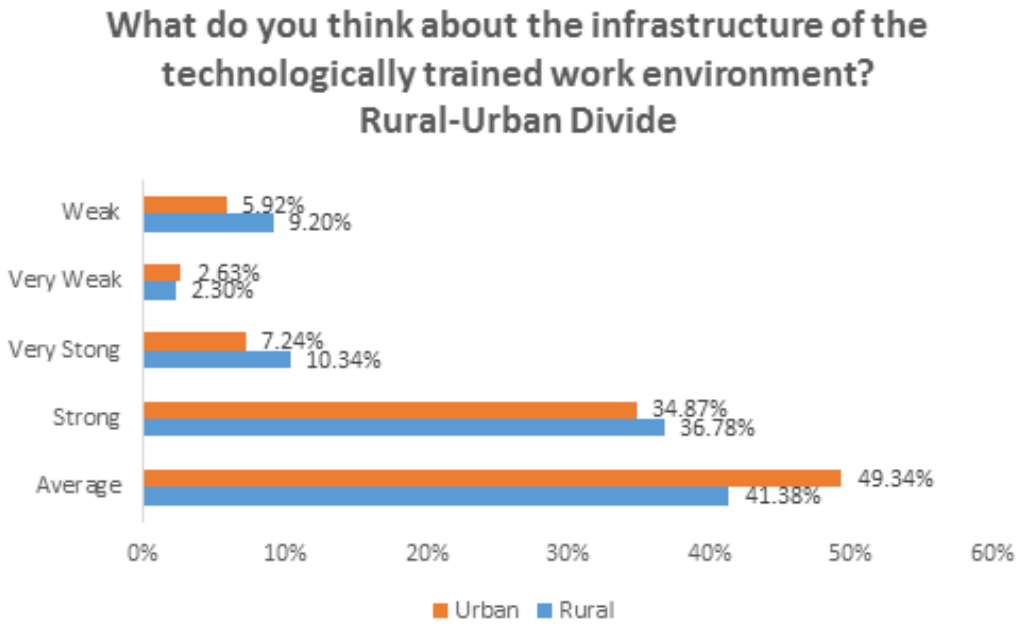
- provide early exposure to STEM,
- build the STEM workforce,
- make education more affordable,
- enable potential STEM candidates, and
- encourage STEM engagement.



Does the impact of these programs and funding sources differ across the urban/rural divide? In rural regions, such programs and funding sources are particularly important in attracting and retaining a STEM workforce.

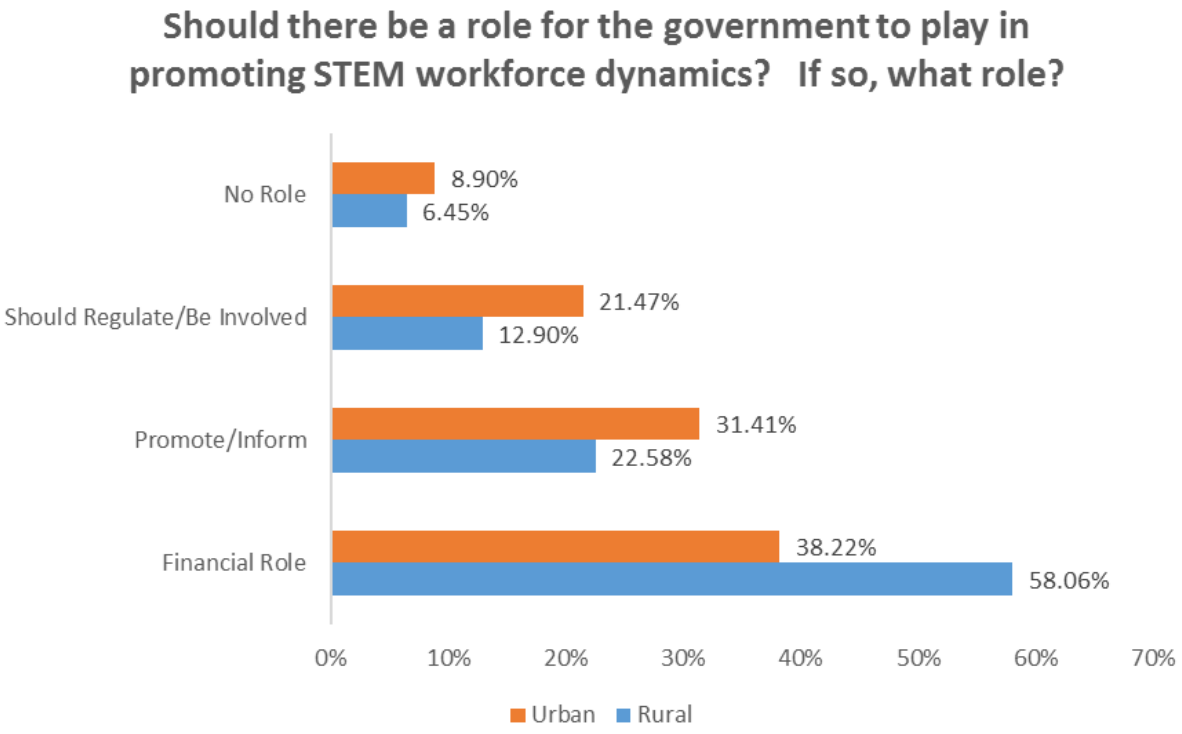
What do you think about the technology infrastructure? About 46 percent of respondents rated Tennessee's technologically trained work environment as average. Only about 10 percent suggested it is weak or very weak. Nearly 36 percent rate it as strong or very strong. As highlighted in the chart below, the rural/urban divide is less pronounced on this issue.





Role of government. What role should government play in promoting STEM workforce dynamics? This question received somewhat mixed responses from rural and urban stakeholders. Nearly half of the comments assigned a funding and grant agency role to the government. About 8 percent indicated government should have no role in the STEM workforce area. Other major roles of government in promoting STEM workforce dynamics cited were providing leadership, incentives, educational opportunities, and regulations.

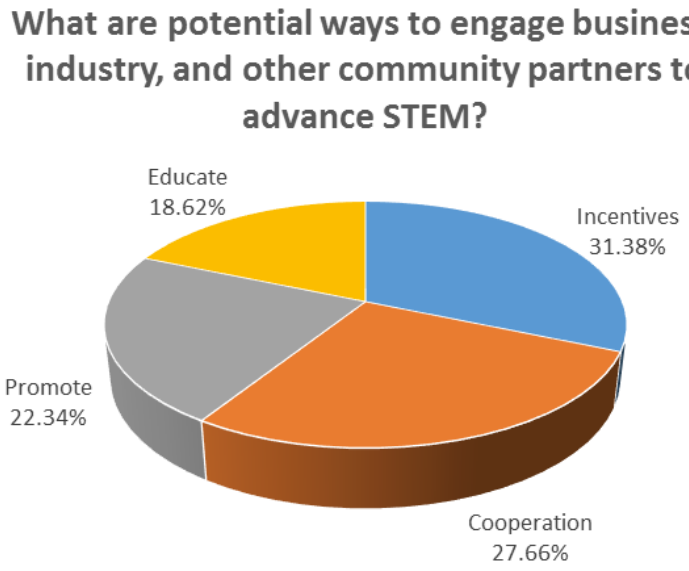
The desired role of government varies greatly across the urban/rural divide. For example, about 13 percent of comments from rural areas suggest government should regulate or be involved in the STEM workforce area. A higher number of comments from urban areas suggested similar government roles. Fewer rural respondents see the government as an entity to promote STEM workforce dynamics compared to those in urban areas. The vast majority of rural stakeholders (60 percent) perceive the government as a funding agency for the STEM workforce, compared to only 38 percent in urban areas.

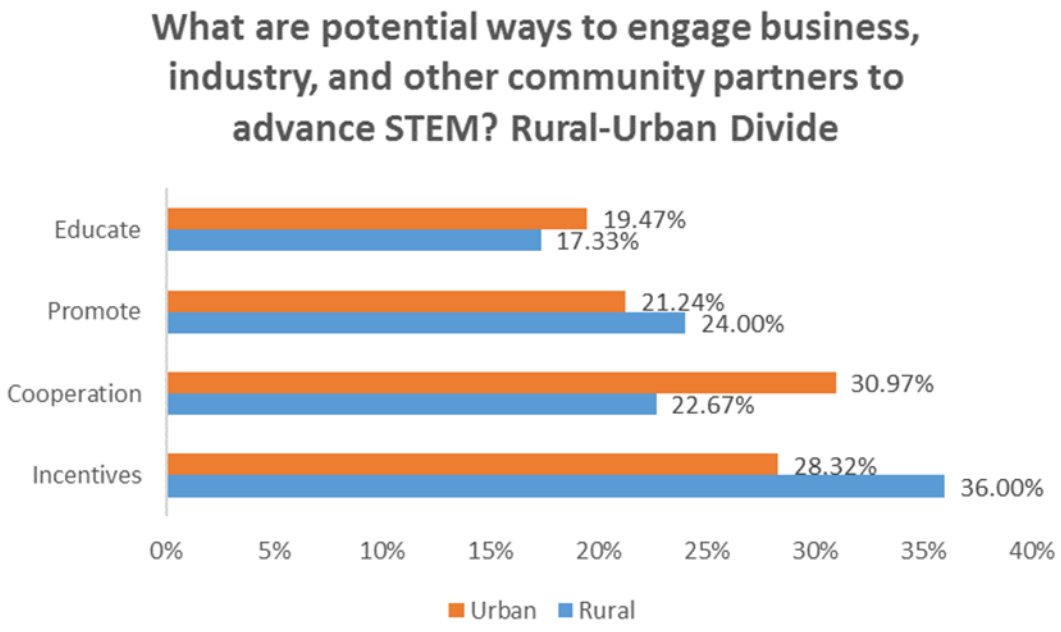


What are potential ways to engage business, industry, and other community partners in advancing STEM? All respondents believe in engaging different stakeholders in advancing STEM. Most recommendations could be grouped into the following broad categories:

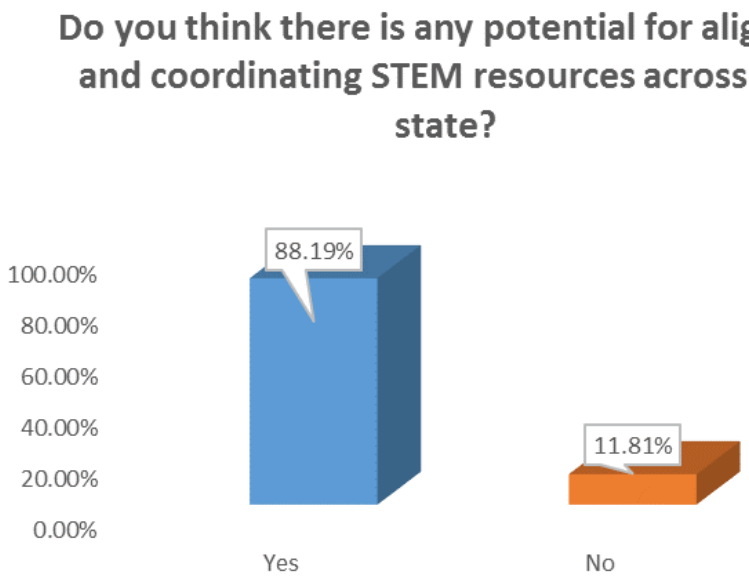
- incentives,
- cooperation,
- promotion, and
- education.

More specifically, they include connections between educational institutions and workforce needs, visibility, mentorships, business-education partnerships, career connections, incentives for collaboration, industry presence in schools, regional skill panels, and STEM tax incentives. When we look at the rural/urban divide, education and cooperation is more pronounced in urban regions, whereas respondents from rural regions place more emphasis on promotion and incentives.





Do you think there is potential for aligning and coordinating STEM resources across the state? About 88 percent of respondents indicated there is potential for coordination of STEM resources across the state.



What major challenges are associated with the STEM infrastructure and the government's role in promoting STEM workforce dynamics? This question received close to 300 different comments, each highlighting a particular aspect of government, STEM industries, financial resources, and educational systems.

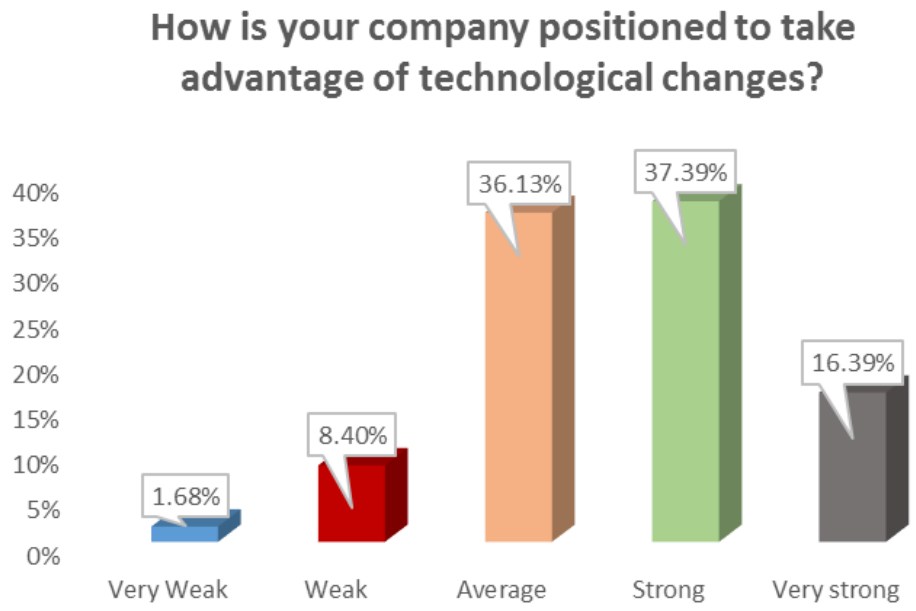
The comments were often critical of the role of government in advancing STEM dynamics. For example, many comments highlighted the lack of clear governmental vision and leadership in STEM areas.

What are the major challenges associated with the STEM infrastructure and the government's role in promoting STEM workforce dynamics?				
	All Responses	Urban	Rural	Urban-Rural Gap (Percentage Points)
STEM Industry	35.71%	34.22%	38.32%	-4.09%
Financial	25.51%	25.67%	25.23%	0.43%
Government	13.61%	12.83%	14.95%	-2.12%
Education	12.93%	13.90%	11.21%	2.69%
Cooperation	8.50%	9.63%	6.54%	3.08%
No Challenges	3.74%	3.74%	3.74%	0.00%

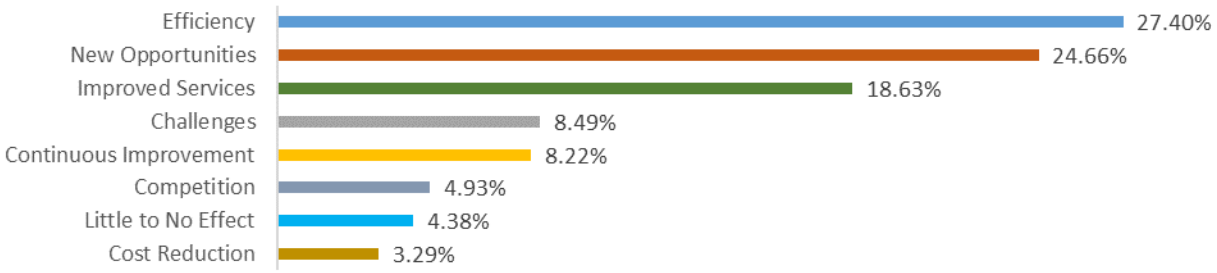
Chapter 6: Challenges to Businesses

Are businesses in Tennessee positioned to take advantage of technological changes? The STEM survey fielded several questions about challenges to businesses associated with STEM-related issues. Many businesses rate themselves as average (36 percent) or strong (37 percent) in taking advantage of technological changes.

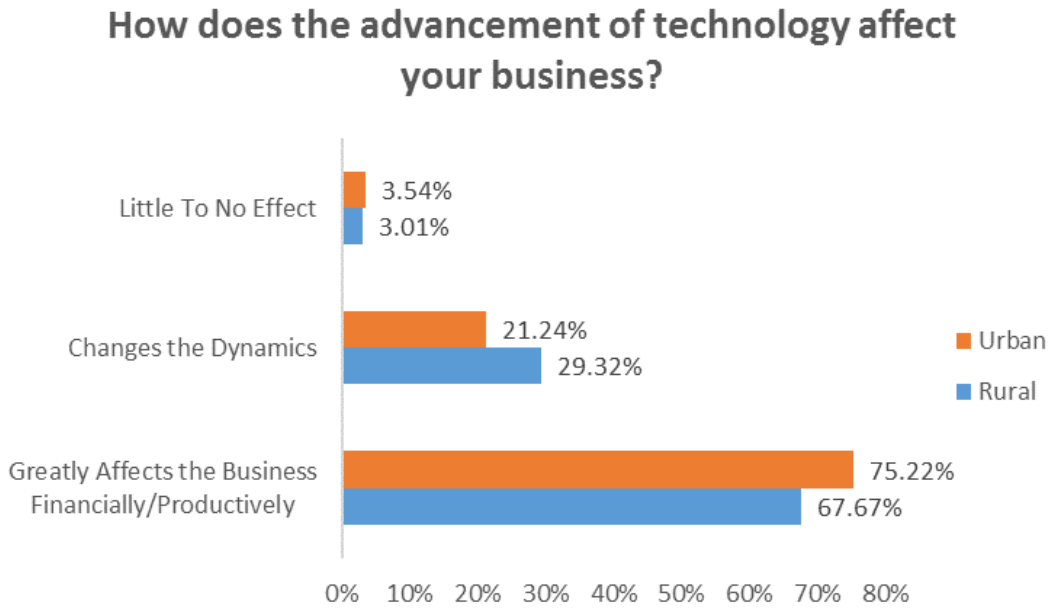
About 10 percent rate themselves as weak or very weak. Combined, more than three in every four companies consider themselves fairly or strongly positioned to take advantage of technological changes.



How does the advancement of technology affect your business? Community stakeholders indicated that advancement of technology most affected their businesses in the area of efficiency. Also cited as significant were new opportunities, followed by improved services, continuous improvement, and cost reduction. A significant number of respondents also reported the advancement of technology brought them new challenges. A few mentioned the advancement of technology had little to no effect on their businesses.

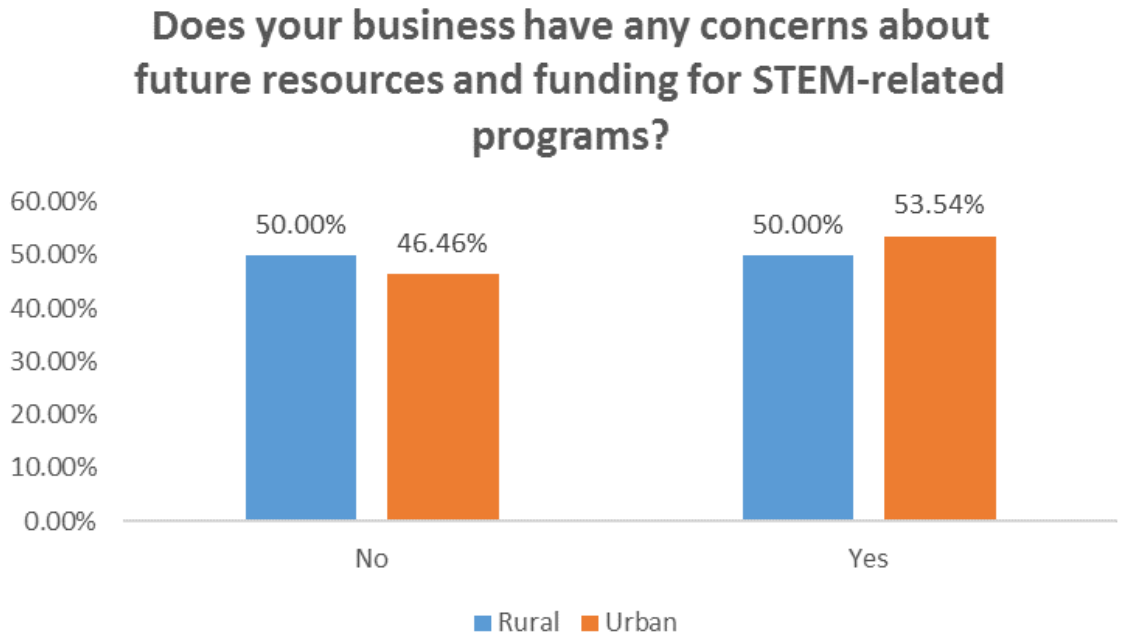


Both urban and rural respondents agree the advancement of technology greatly affects their business either financially or in terms of productivity. More rural than urban respondents indicated technology would change the dynamics of their business. A small percentage of both urban and rural respondents indicated technology would have little to no effect on their business.



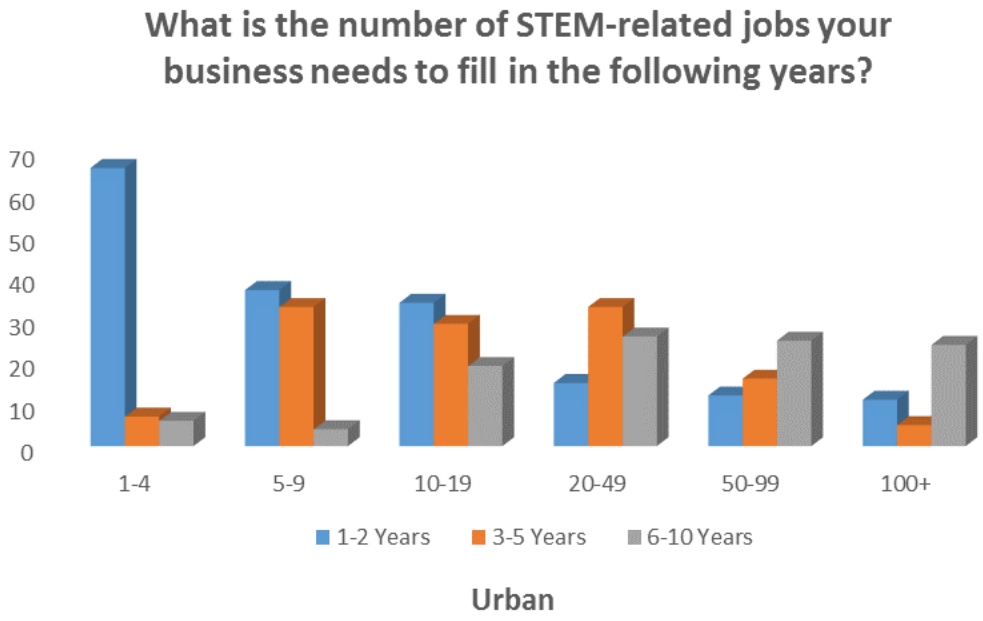
Does your business have any concerns about future resources and funding for STEM-related programs? Community stakeholders responded that they had several concerns about future resources and funding for STEM-related programs. About 26 percent indicated funding was a concern, while 21 percent were concerned about the absence of a properly trained workforce. Four percent were concerned about keeping up with technological advancements, and one percent cited the lack of cost-effective infrastructure. On the other hand, 47 percent of respondents said they had no concerns about future resources and funding for STEM-related programs.

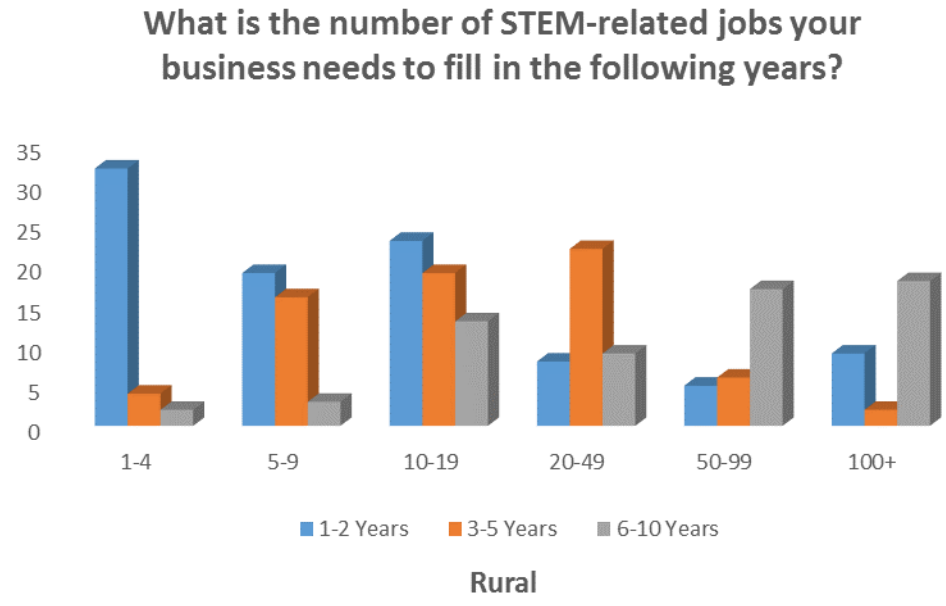
Looking at this issue in a regional context reveals no significant difference in the perceptions of urban and rural respondents. Though more rural than urban respondents indicated no future concerns and more urban than rural respondents had future concerns, differences were not significant.



What is the number of STEM-related jobs your business needs to fill in the following years?

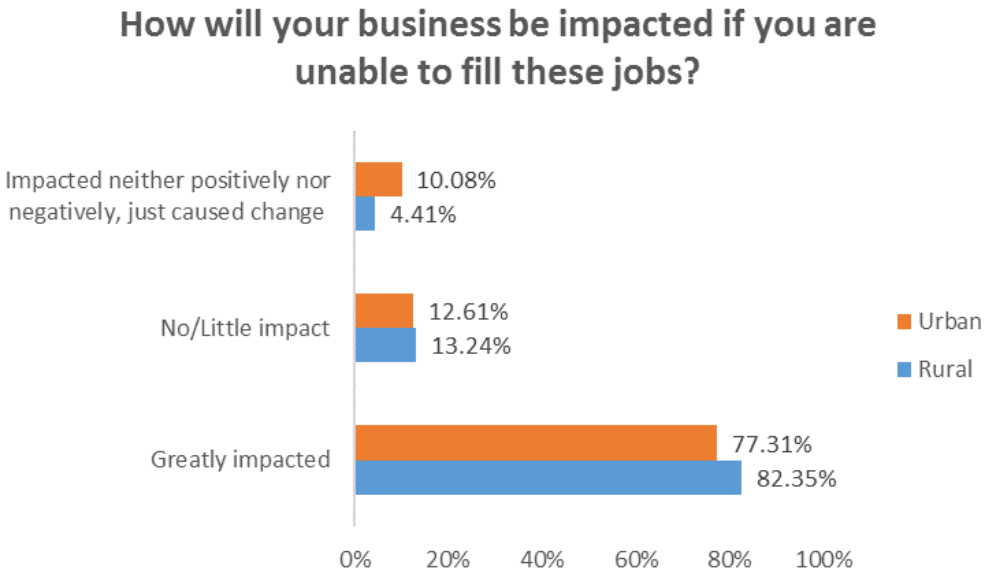
Survey respondents indicated they expect to see about **10 percent** growth in STEM-related jobs at their companies over the next six to ten years.



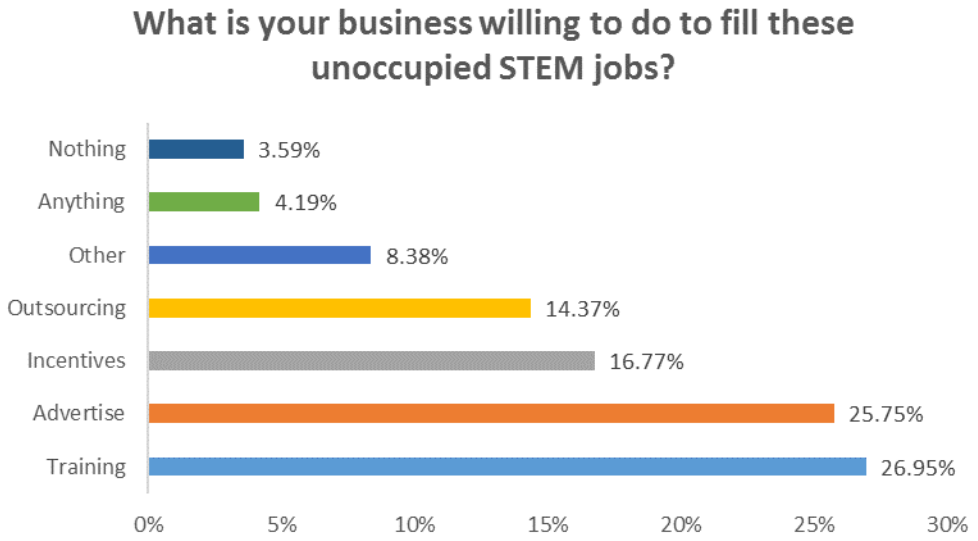


What happens if these businesses cannot fill these STEM-related positions? Top answers to this question include "little to no growth," "company will be left behind," "little to no impact," "increase in job training," and "decrease in customer and patient care."

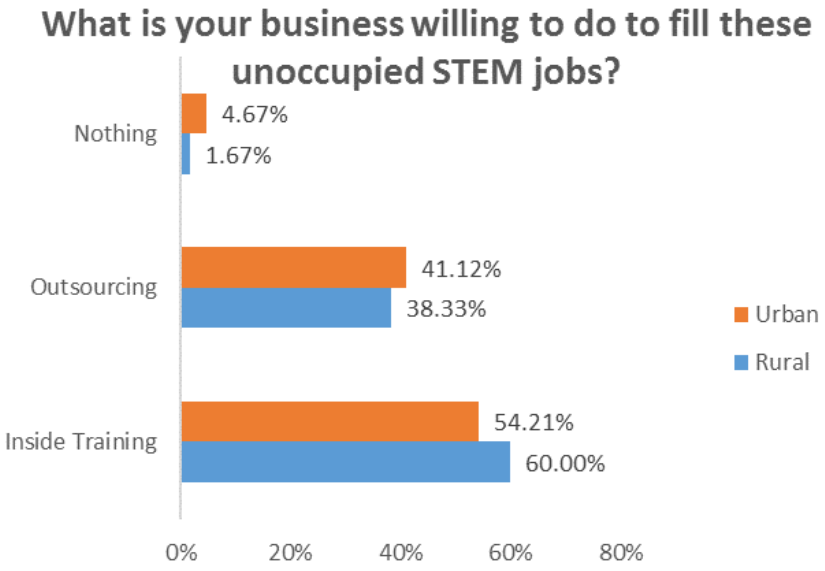
What is the rural/urban difference on this question? About 82 percent of rural businesses and 77 percent of urban businesses indicated their businesses will be greatly impacted if these STEM positions go unfilled—a 5 percentage point difference. This is consistent with the gap between urban and rural respondents who said impact will be neutral, neither positive nor negative, if these jobs are left unfilled.



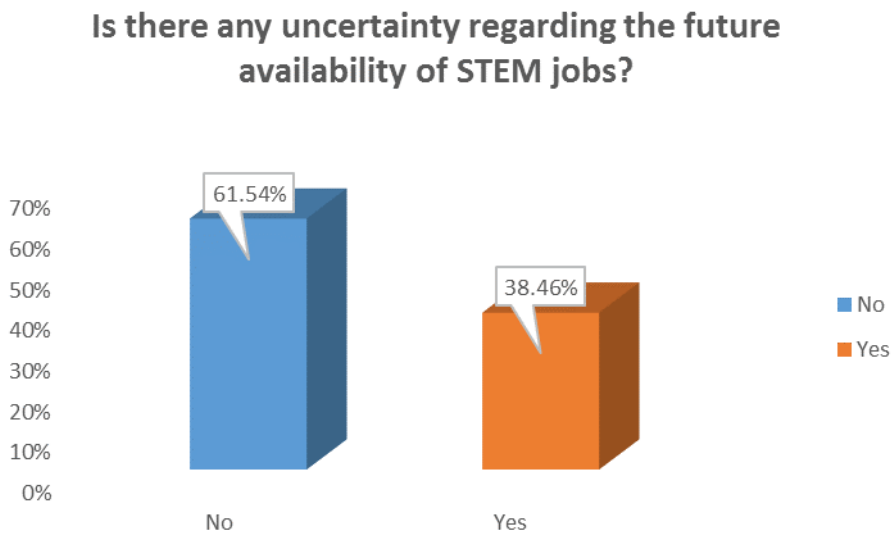
A subsequent question on the subject was "What is your business willing to do to fill these unoccupied positions?" The top five answers include "provide training," "advertise opportunities," "provide incentives," "utilize outsourcing," and "other."



What is the rural/urban divide on this question? A significant percent of businesses in both rural and urban areas suggest inside training with a 6 percentage-point difference between rural and urban businesses. Outsourcing is the second option chosen by both rural and urban areas to alleviate the unfilled STEM job issue.



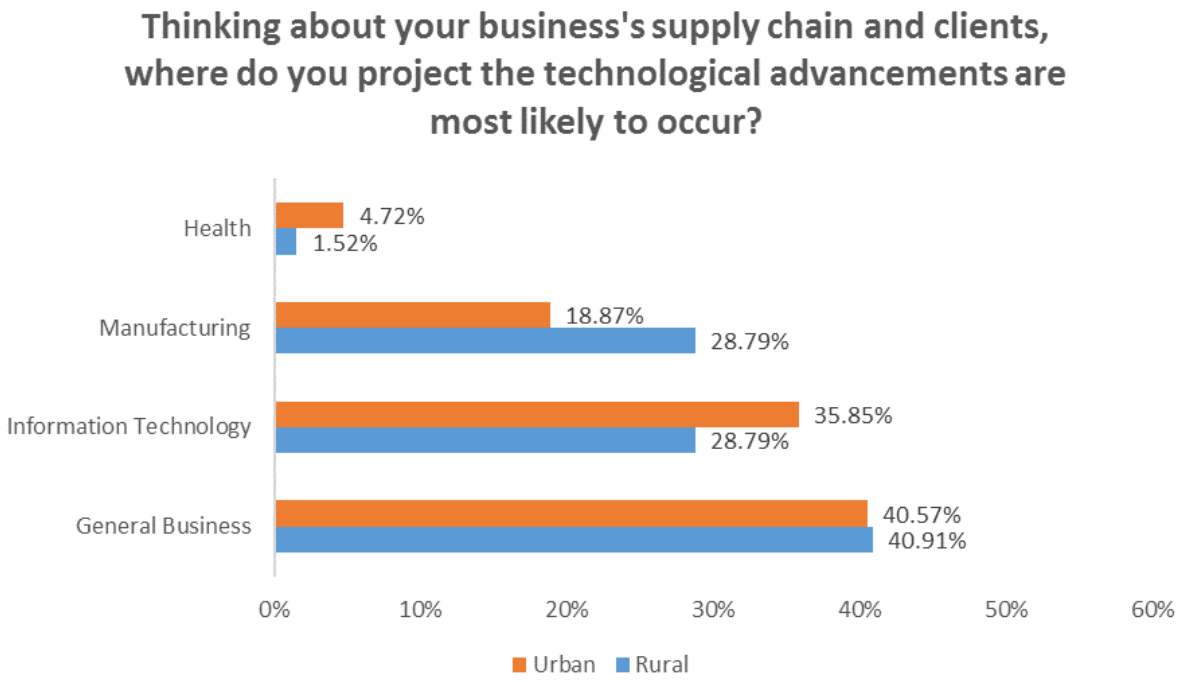
Is there any concern regarding the future availability of STEM jobs? The majority of businesses see some uncertainty, but 38 percent think otherwise.



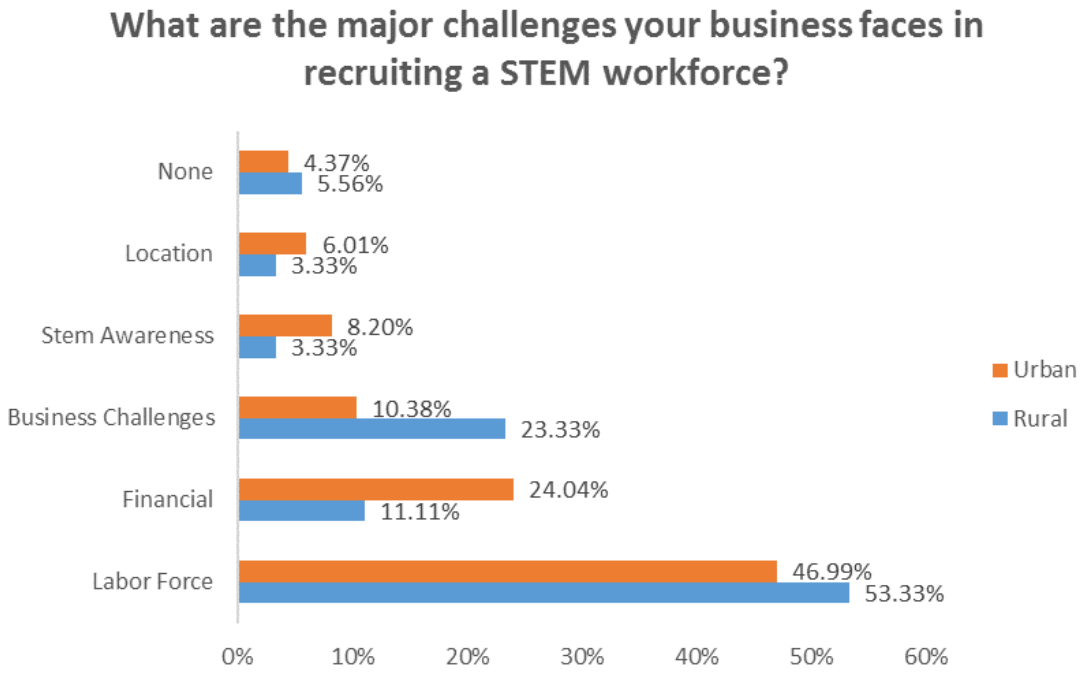
Where do businesses see technological development in their supply chain? A glance at responses suggests four major areas:

- health care,
- manufacturing,
- information technology, and
- general business.

There is some rural/urban difference across these categories. For example, 29 percent of rural responses indicated manufacturing will be a sector experiencing technological shift, while only 19 percent of businesses from urban regions agree. Information technology is expected to experience a larger shift in urban areas than rural ones. Rural and urban areas agree that most change will occur in general business.



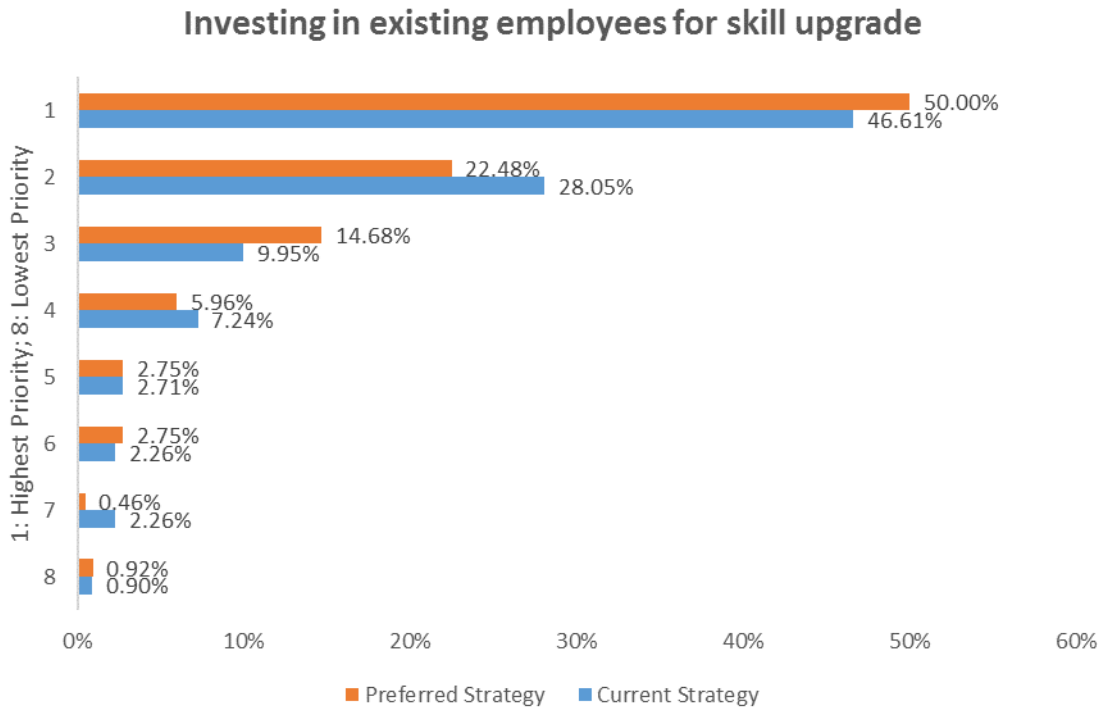
Finally, the survey asked about major challenges community stakeholders face in recruiting a STEM workforce. Critical "labor force challenges" are more pronounced in rural than in urban areas. Urban businesses face more challenges associated with finances, STEM awareness, and location.



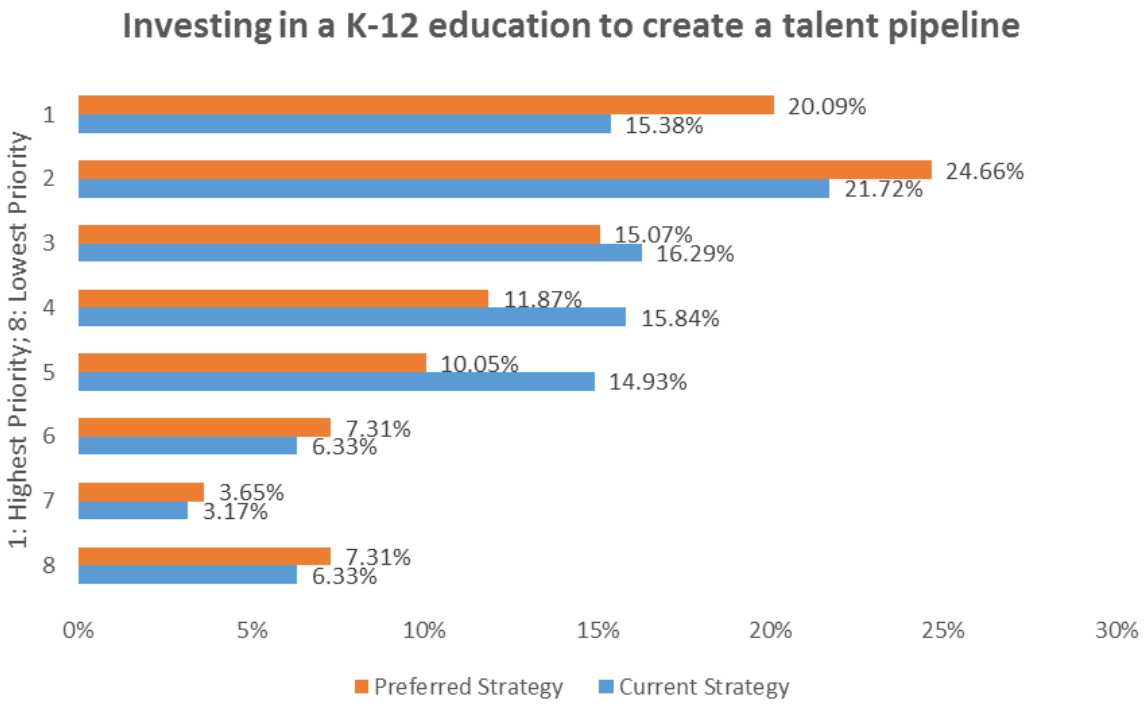
Chapter 7: Strategic Solutions to STEM Workforce Challenges

When facing skilled workforce challenges, please assess your company's strategy. Given the challenges faced by businesses in the STEM field, employers were asked what measures they have taken or are willing to take in order to solve the issue. The strategic options were ranked by the highest (value: 1) to the lowest priority (value: 8). Further, the options were broken down by the current and preferred strategy of the company.

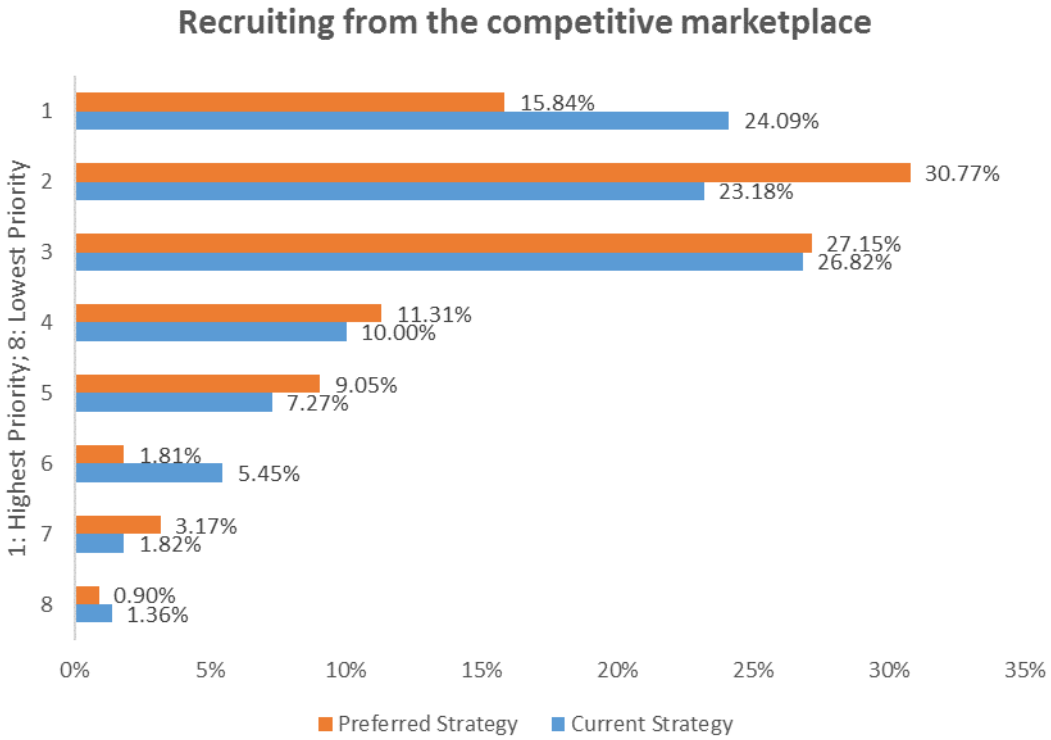
Investing in existing employees for skill upgrade. This option involves training, mentorship, and educational opportunities for current employees. Overall, the majority of employers perceive this to be the highest priority and are currently applying it to their workforce.



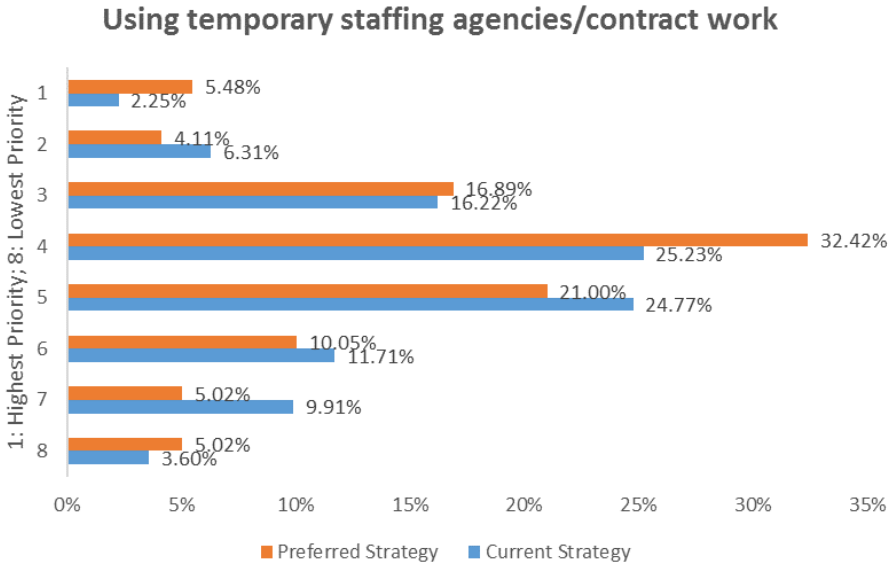
Investing in a K-12 education to create a talent pipeline.
The second top priority for employers is securing an educational pipeline that produces a quality workforce. This involves the promotion of STEM education throughout a child's education. The educational pipeline also focuses on quality mentorship and programs for students who are interested in STEM.



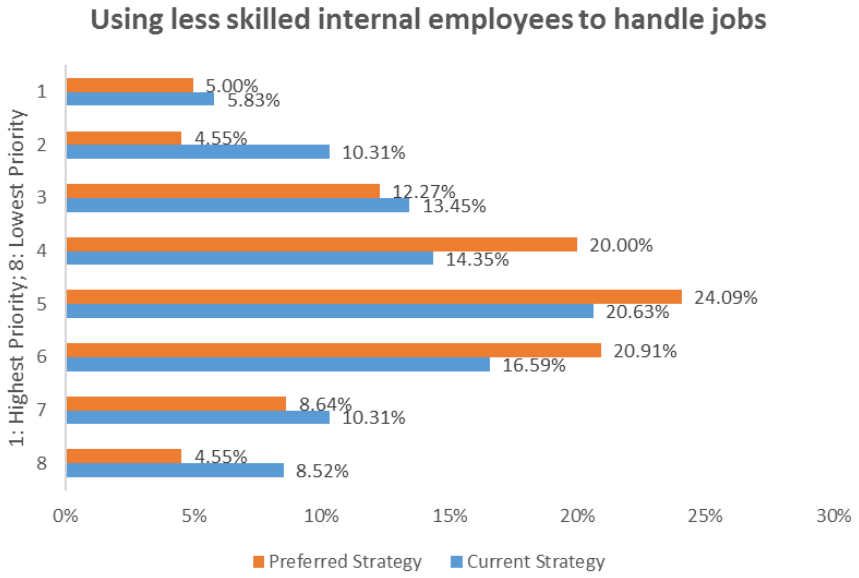
Recruiting from the competitive market. Ensuring that an adequate workforce is available for recruiting is of moderate importance to employers.



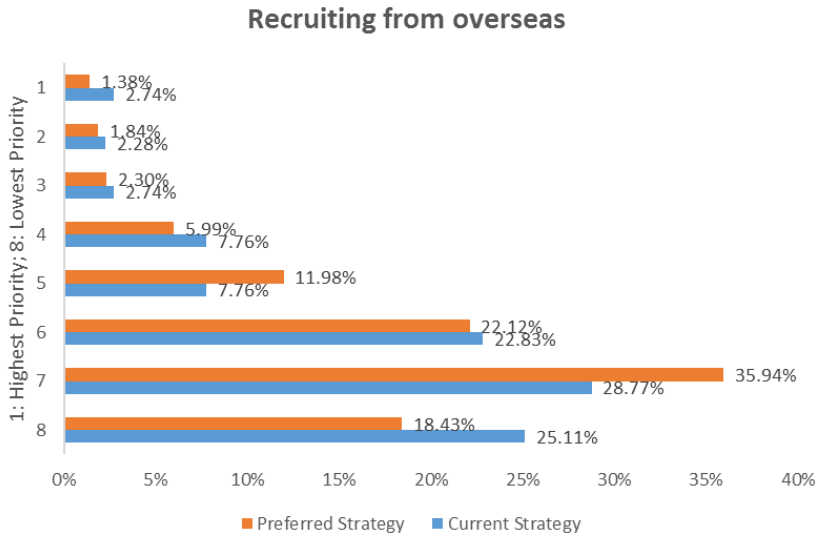
Using temporary staffing agencies or contract work. If a company is lacking the ability to internally recruit or find qualified workers, it will make use of staffing agencies or external specialized workers. This measure is of moderate importance to employers.



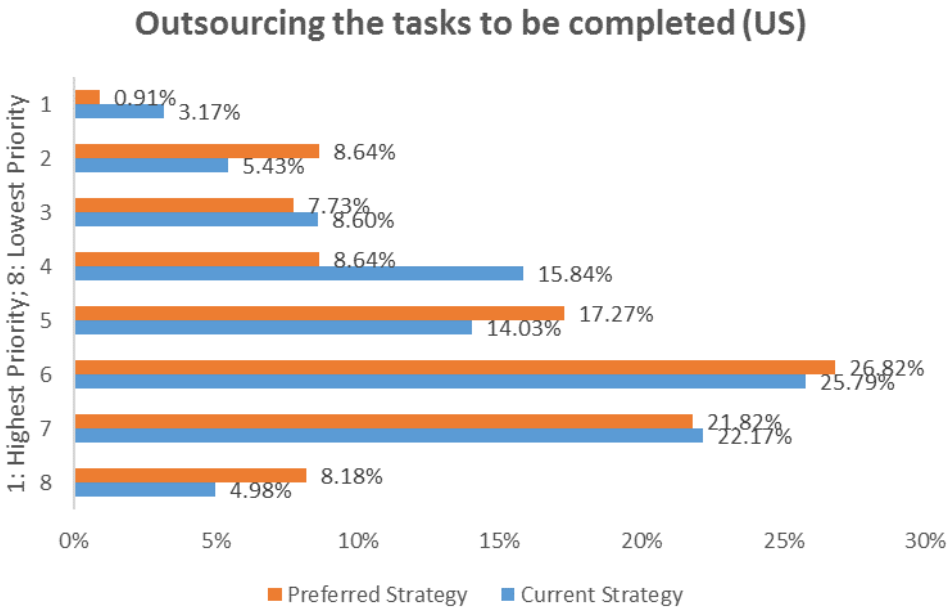
Using less skilled internal employees to handle jobs. Less skilled employees are an alternative to finding qualified STEM workers. Such measures are designed to be only temporary, and are considered of moderate to low priority by most employers.



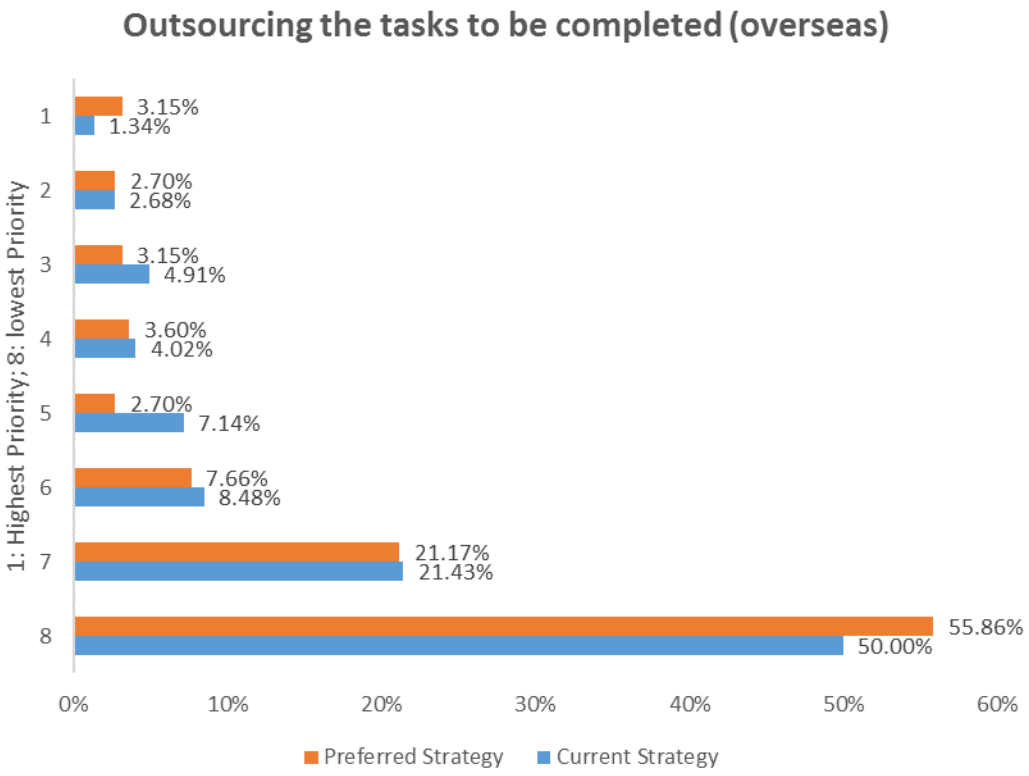
Recruiting from overseas. International recruitment for qualified workers is yet another strategy option, but it could be costly for companies. It is of low importance to employers.



Outsourcing the tasks to be completed. Outsourcing both domestically and internationally is considered the lowest priority to employers. Companies will exhaust internal possibilities before seeking external alternatives.

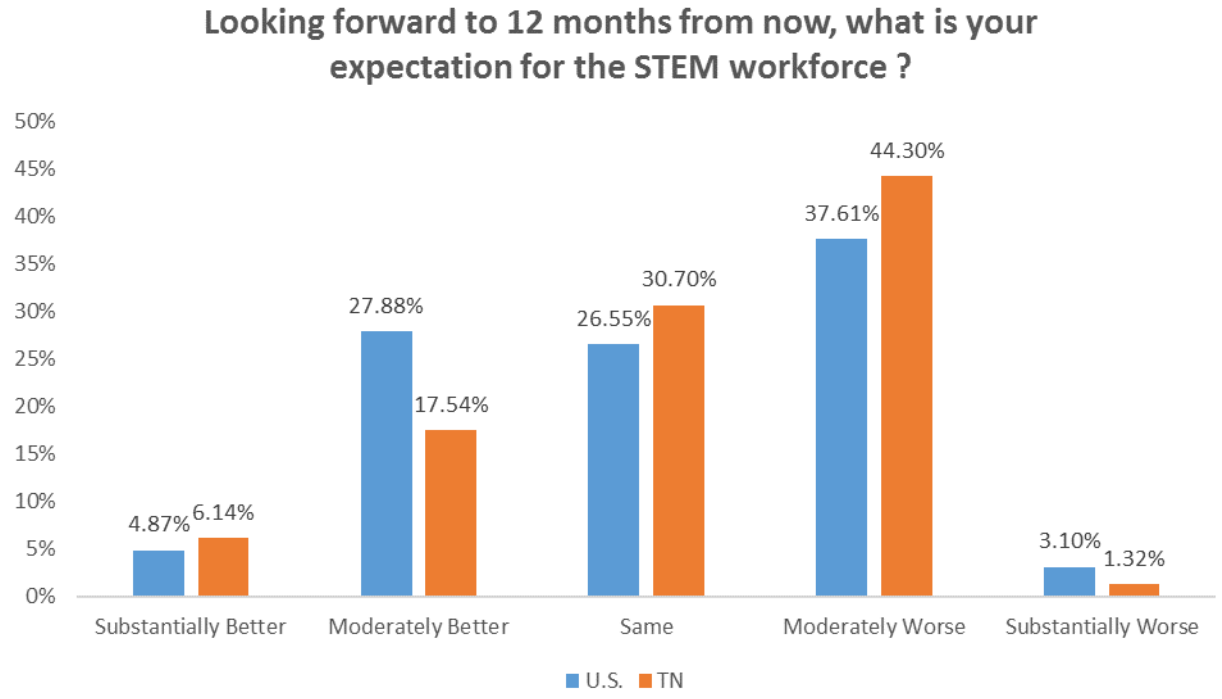


International outsourcing is the last resort to solve STEM workforce challenges.

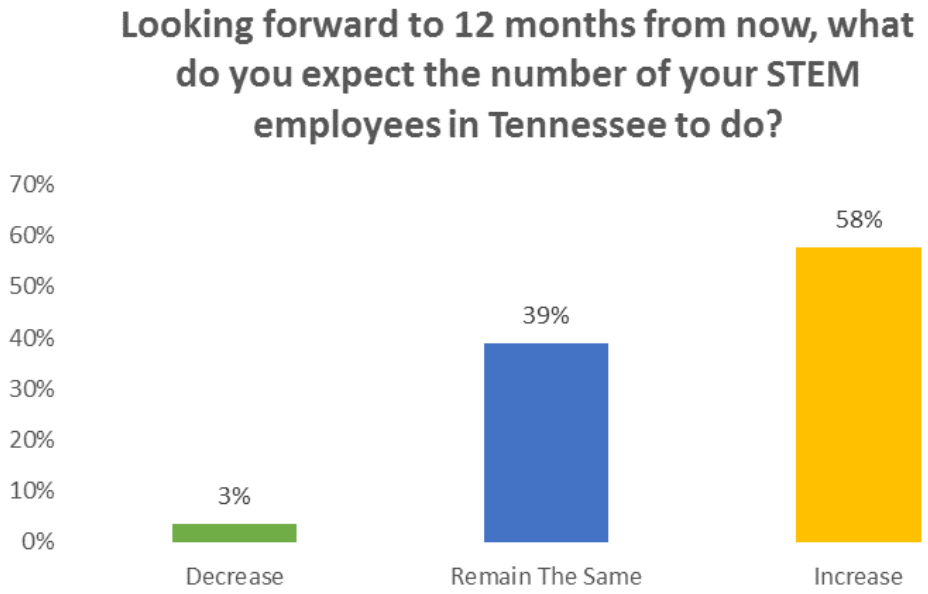


Chapter 8: Future Expectations and Top Occupations/Skill Sets

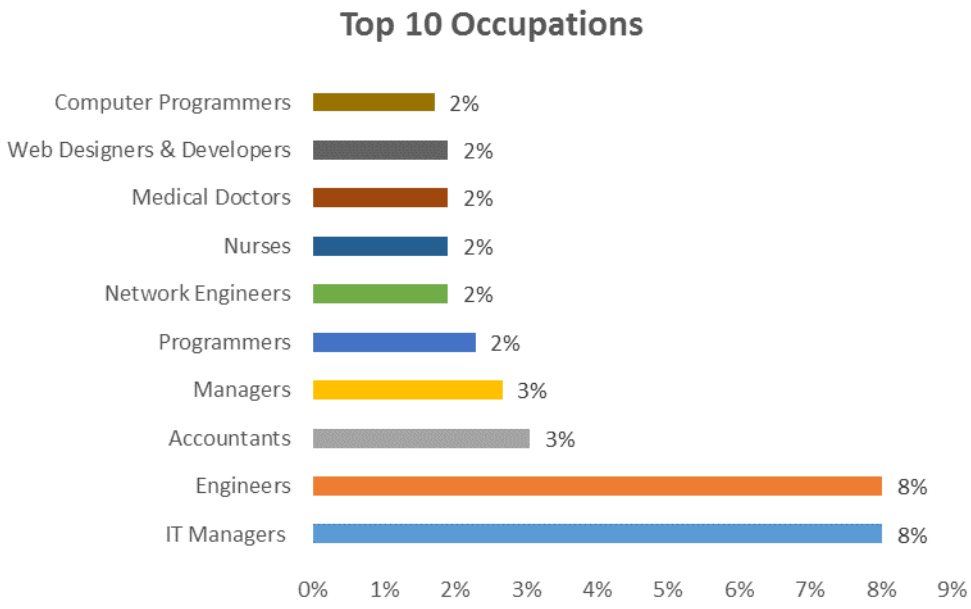
Looking forward to 12 months from now, what are your expectations for the U.S. economy and the Tennessee economy? According to respondents, 24 percent saw the Tennessee economy improving in the next year, and 33 percent saw the U.S. economy improving. The majority in both Tennessee (44.30%) and the U.S. (37.61%) expect the economy to get moderately worse.



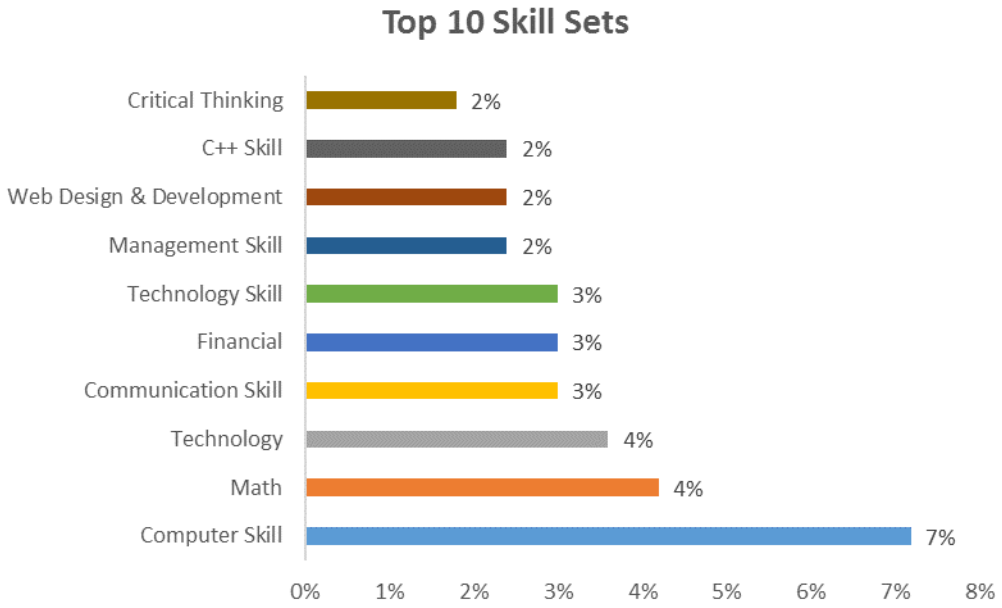
Looking forward to 12 months from now, how do you expect the number of your STEM employees in Tennessee to change? Community stakeholders believed the number of their STEM employees would increase or remain the same in the next year. Thirty-nine percent said it would remain the same, and 58 percent responded that it would increase.



Please identify up to 10 occupations/skill sets that your company is in need of (currently or in the near future). Information technology managers and engineers were the most needed occupation out of more than 500 responses. The technology field is expected to have the occupations most in demand: programmers, network engineers, web designers and developers, and computer programmers. The medical field will require more nurses and physicians. Accountants and managers will be in high demand as well.



The top skill sets required include computer skills and mathematical abilities. Technological proficiency involving web design/development and coding skills (C++) are or will be needed. Mathematical, financial, and management skills as well as critical thinking will also be in demand.



Chapter 9: STEM Exposure Index

Creating an index and updating it annually require timely data at the county level. When dealing with STEM workforce dynamics, measurement at the county level is a challenging issue. This report utilizes the limited existing data on STEM workforce dynamics to present a Tennessee STEM Exposure or Concentration Index by county.

The STEM Exposure Index includes six indicators:

- STEM jobs as percent of total county jobs
- STEM jobs as percent of Tennessee STEM jobs
- Average ACT math score
- Average ACT science score
- College-going rate
- Patents per 1,000 employees (2004–13)

The following table shows the weight of each indicator and the reason for inclusion. The procedure to calculate the final index includes three major steps: (1) calculating averages and standard deviations for each indicator, (2) normalizing each indicator using average and standard deviation scores, and (3) applying the weights to create a final index for each indicator.

Indicators	Weights	Reason for Inclusion	Data Source
STEM Jobs as percent of total county jobs	37.5%	County level STEM intensity	BERC calculations from ACS, ES202
STEM Jobs as percent of Tennessee STEM jobs	37.5%	Tennessee level STEM intensity	BERC calculations from ACS, ES202
Average ACT math score	5.0%	STEM readiness	Tennessee Department of Education
Average ACT science score	5.0%	STEM readiness	Tennessee Department of Education
College going rate (%)	5.0%	College Bound	Drive55.org
Patents per 1000 employees (2004-13)	10.0%	Creativity	www.uspto.gov
Total weights	100%		

According to BERC calculations, Williamson, Knox, and Washington counties occupy the top three spots in the STEM Exposure Index. Other counties with high scores include Davidson, Anderson, Sullivan, Hamilton, and Shelby. Rutherford County makes the top 14. Counties and their index values are listed below.

County Code	County	Percent of County STEM & STEM-Related Jobs in Total Tennessee STEM & STEM-Related Jobs (%)	STEM & STEM-Related Employment as Percent of Total County Employment (%)	ACT Math (Average Score)	ACT Science (Average Score)	College Going Rate (%)	Patents Per 1,000 Employment	STEM Exposure Index 2016	Rank
187	Williamson	4.75%	12.47%	23.10	23.40	82.7%	4.50	0.897	1
93	Knox	8.91%	11.67%	19.90	20.70	69.9%	5.37	0.891	2
179	Washington	2.70%	13.57%	20.22	20.50	71.8%	2.72	0.819	3
37	Davidson	19.40%	12.92%	18.20	19.00	57.8%	1.80	0.817	4
1	Anderson	1.74%	13.47%	20.36	21.11	65.6%	7.84	0.805	5
163	Sullivan	2.60%	11.63%	20.32	20.79	67.8%	9.02	0.787	6
65	Hamilton	7.00%	11.00%	18.60	19.20	68.1%	1.64	0.757	7
157	Shelby	17.10%	10.70%	16.80	17.30	59.9%	4.56	0.729	8
145	Roane	1.11%	18.92%	18.50	19.10	65.5%	2.92	0.716	9
113	Madison	2.45%	13.12%	17.20	17.80	56.9%	3.27	0.700	10
83	Houston	0.07%	14.33%	17.90	20.00	69.9%	6.00	0.697	11
141	Putnam	1.34%	11.80%	19.10	20.00	60.2%	4.96	0.687	12
165	Sumner	1.76%	10.67%	19.60	20.40	71.0%	3.13	0.657	13
149	Rutherford	3.76%	9.83%	19.40	20.20	63.9%	1.71	0.649	14
39	Decatur	0.20%	17.32%	17.50	18.90	75.3%	1.96	0.645	15

Note 1: STEM & STEM-related jobs are estimates from total Tennessee STEM and STEM-related jobs.

What are the characteristics of the top ranking counties? Top ranking counties usually have a relatively large share of STEM and STEM-related workforce in their economies; their STEM and STEM-related workforce represents a large share of Tennessee's total STEM and STEM-related workforce; average ACT math and science scores are relatively high; the college-going rate is relatively higher; and these counties have a relatively large number of patents per capita. For example, Williamson County's STEM and STEM-related workforce is about 13 percent of total employment in the county, and its STEM and STEM-related workforce represents about five percent of total STEM and STEM-related workforce in Tennessee. Average ACT math and science scores are 23.10 and 23.40, respectively, in Williamson County. Tennessee's average scores in these categories are 18.41 and 19.2, respectively. The college-going rate of nearly 83 percent in Williamson County is significantly higher than Tennessee's average of 60 percent. Finally, Williamson County patents per capita total 4.50, double Tennessee's average of 2.14.

County	STEM Exposure Index 2016	Rank	County	STEM Exposure Index 2016	Rank
Williamson	*0.90*	*1*	Obion	0.44	49
Knox	*0.89*	*2*	Unicoi	0.43	50
Washington	*0.82*	*3*	Bledsoe	0.43	51
Davidson	*0.82*	*4*	Cumberland	0.43	52
Anderson	*0.81*	*5*	Campbell	0.42	53
Sullivan	*0.79*	*6*	Henderson	0.42	54
Hamilton	*0.76*	*7*	Pickett	0.42	55
Shelby	*0.73*	*8*	Crockett	0.41	56
Roane	*0.72*	*9*	Robertson	0.40	57
Madison	*0.70*	*10*	Grundy	0.40	58
Houston	0.70	11	Tipton	0.40	59
Putnam	0.69	12	Humphreys	0.40	60
Sumner	0.66	13	Van Buren	0.39	61
Rutherford	0.65	14	Benton	0.39	62
Decatur	0.64	15	Haywood	0.39	63
Perry	0.62	16	Franklin	0.39	64
Wayne	0.61	17	Warren	0.39	65
Hardeman	0.59	18	Scott	0.37	66
Coffee	0.59	19	McNairy	0.37	67
Fentress	0.57	20	Rhea	0.37	68
Carroll	0.56	21	McMinn	0.36	69
Clay	0.55	22	Johnson	0.36	70
Greene	0.55	23	Lawrence	0.36	71
Montgomery	0.55	24	Cheatham	0.36	72
Overton	0.54	25	Loudon	0.35	73
Hickman	0.53	26	Jackson	0.34	74
Maury	0.51	27	Claiborne	0.34	75
Hamblen	0.51	28	Meigs	0.33	76
Lewis	0.49	29	Cannon	0.33	77
Carter	0.49	30	Monroe	0.33	78
Hawkins	0.48	31	Dekalb	0.33	79
Macon	0.48	32	Fayette	0.33	80
Henry	0.48	33	Marion	0.33	81
Morgan	0.48	34	Polk	0.32	82
Hardin	0.47	35	Marshall	0.31	83
Trousdale	0.47	36	Moore	0.31	84
Sequatchie	0.47	37	Jefferson	0.31	85
Chester	0.47	38	Bedford	0.30	86
Blount	0.47	39	Sevier	0.30	87
Dyer	0.47	40	Cocke	0.30	88
Wilson	0.47	41	Giles	0.30	89
Weakley	0.45	42	Lauderdale	0.30	90
Gibson	0.45	43	Smith	0.29	91
White	0.45	44	Grainger	0.28	92
Hancock	0.45	45	Stewart	0.27	93
Dickson	0.45	46	Union	0.26	94
Bradley	0.44	47	Lake	0.18	95
Lincoln	0.44	48			

Chapter 10: Conclusion

This is the second report highlighting critical challenges facing the STEM workforce in Tennessee. Community stakeholders provided a detailed assessment of STEM supply, STEM pipeline, infrastructure, the role of government, and challenges to businesses. Based on these reviews as well as the state-level assessment of STEM indicators, this report draws the following conclusions:

- *Characteristics of STEM workforce.* Tennessee's STEM workforce, characterized by an oversupply of low-skilled STEM workers compared with the nation, is not competitive.

- *Community stakeholders on STEM workforce dynamics.* Nearly three in four community stakeholders BERC surveyed indicated the STEM workforce challenge for Tennessee is real and involves not only parents and children but also the STEM industry itself, educators, and government. Efforts in this area are fragmented without clear direction from industry, higher education, or government.

Addressing the STEM workforce challenge is critically important for Tennessee for two major reasons:

- *Building the capacity for innovation and creativity.* A STEM workforce is highly educated relative to other occupations in an economy. For Tennessee, the advanced manufacturing and healthcare industries have become major drivers of economic growth. To build sustainable economic growth, Tennessee should build the capacity of its workforce.

- *Fueling the economy with additional household income.* Addressing the low-skill problem and moving Tennessee's STEM concentration to the national level alone would create significant economic impact throughout communities across Tennessee.

These benefits are associated with only a small fraction of the significant societal benefits that may be created by addressing the multiple and complex STEM workforce challenges discussed in this report. For example, creating business efficiency through increasing the capacity of the STEM workforce is not quantified in this report.

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Appendix

Survey Administration

In order to administer the business survey, BERC performed the following tasks. First, the number of STEM and STEM-related occupations was derived from the 2010 Standard Occupational Classification (SOC) manual and cross-referenced with Tennessee industry employment data from the American Community Survey. Then, this matrix was used to estimate the number of STEM and STEM-related jobs in Tennessee. Next, the sum of the number of STEM and STEM-related employees in each industry was divided by the total number of STEM employees in Tennessee to determine the distribution of STEM occupations across Tennessee's industries. Using this distribution, BERC targeted the industries with the highest percentages of STEM occupations. The companies that received the survey were pulled at random from a list of companies matching BERC's industry search parameters in ReferenceUSA, a business database. BERC made sure the random assortment of companies was an accurate reflection of business size and location. BERC also targeted several economic development officials, mayors, and schools for participation in the survey. After the design of the survey was complete, BERC mailed each potential respondent a letter describing the study and the survey process. In addition, BERC contracted with Qualtrics to conduct additional business surveys to increase the sample size. As a result, 269 respondents from all nine regions of Tennessee participated in the survey.

Selecting STEM Occupations

BERC selected STEM occupations according to the U.S. Census Bureau's classification. The Census Bureau's classifications are based on the 2010 SOC manual. According to the listing, there are 63 specific STEM occupations and 35 STEM-related occupations. These two groups are displayed in the tables below.

STEM Occupations		
Occupation 2010 Description	Census Code	SOC Code
Management, Business, and Financial Occupations:	***0010-0950***	***11-0000 - 13-0000***
Computer and information systems managers	0110	11-3021
Architectural and engineering managers	0300	11-9041
Natural sciences managers	0360	11-9121
Computer and Mathematical Occupations:	***1000-1240***	***15-0000***
Computer and information research scientists	1005	15-1111
Computer systems analysts	1006	15-1121
Information security analysts	1007	15-1122
Computer programmers	1010	15-1131
Software developers, applications and systems software	1020	15-113X
Web developers	1030	15-1134
Computer support specialists	1050	15-1150
Database administrators	1060	15-1141
Network and computer systems administrators	1105	15-1142
Computer network architects	1106	15-1143
Computer occupations, all other	1107	15-1199
Actuaries	1200	15-2011
Mathematicians	1210	15-2021
Operations research analysts	1220	15-2031
Statisticians	1230	15-2041
Miscellaneous mathematical science occupations	1240	15-2090
Architecture and Engineering Occupations:	***1300-1560***	***17-0000***
Surveyors, cartographers, and photogrammetrists	1310	17-1020
Aerospace engineers	1320	17-2011
Agricultural engineers	1330	17-2021
Biomedical engineers	1340	17-2031
Chemical engineers	1350	17-2041
Civil engineers	1360	17-2051
Computer hardware engineers	1400	17-2061
Electrical and electronics engineers	1410	17-2070
Environmental engineers	1420	17-2081
Industrial engineers, including health and safety	1430	17-2110
Marine engineers and naval architects	1440	17-2121
Materials engineers	1450	17-2131
Mechanical engineers	1460	17-2141
Mining and geological engineers, including mining safety engineers	1500	17-2151
Nuclear engineers	1510	17-2161
Petroleum engineers	1520	17-2171
Engineers, all other	1530	17-2199
Drafters	1540	17-3010
Engineering technicians, except drafters	1550	17-3020
Surveying and mapping technicians	1560	17-3031

STEM Occupations (cont'd)		
Occupation 2010 Description	Census Code	SOC Code
Life, Physical, and Social Science Occupations:	***1600-1965***	***19-0000***
Agricultural and food scientists	1600	19-1010
Biological scientists	1610	19-1020
Conservation scientists and foresters	1640	19-1030
Medical scientists	1650	19-1040
Life scientists, all other	1660	19-1099
Astronomers and physicists	1700	19-2010
Atmospheric and space scientists	1710	19-2021
Chemists and materials scientists	1720	19-2030
Environmental scientists and geoscientists	1740	19-2040
Physical scientists, all other	1760	19-2099
Economists	1800	19-3011
Survey researchers	1815	19-3022
Psychologists	1820	19-3030
Sociologists	1830	19-3041
Urban and regional planners	1840	19-3051
Miscellaneous social scientists and related workers	1860	19-3090
Agricultural and food science technicians	1900	19-4011
Biological technicians	1910	19-4021
Chemical technicians	1920	19-4031
Geological and petroleum technicians	1930	19-4041
Nuclear technicians	1940	19-4051
Social science research assistants	1950	19-4061
Miscellaneous life, physical, and social science technicians	1965	19-4090
Sales and Related Occupations:	***4700-4965***	***41-0000***
Sales engineers	4930	41-9031

STEM-Related Occupations		
Occupation 2010 Description	Census Code	SOC Code
Management, Business, and Financial Occupations:	***0010-0950***	***11-0000 - 13-0000***
Medical and health services managers	0350	11-9111
Architecture and Engineering Occupations:	***1300-1560***	***17-0000***
Architects, except naval	1300	17-1010
Healthcare Practitioners and Technical Occupations:	***3000-3540***	***29-0000***
Chiropractors	3000	29-1011
Dentists	3010	29-1020
Dietitians and nutritionists	3030	29-1031
Optometrists	3040	29-1041
Pharmacists	3050	29-1051
Physicians and surgeons	3060	29-1060
Physician assistants	3110	29-1071
Podiatrists	3120	29-1081
Audiologists	3140	29-1181
Occupational therapists	3150	29-1122
Physical therapists	3160	29-1123
Radiation therapists	3200	29-1124
Recreational therapists	3210	29-1125
Respiratory therapists	3220	29-1126
Speech-language pathologists	3230	29-1127
Exercise physiologists	3235	29-1128
Therapists, all other	3245	29-1129
Veterinarians	3250	29-1131
Registered nurses	3255	29-1141
Nurse anesthetists	3256	29-1151
Nurse midwives	3257	29-1161
Nurse practitioners	3258	29-1171
Health diagnosing and treating practitioners, all other	3260	29-1199
Clinical laboratory technologists and technicians	3300	29-2010
Dental hygienists	3310	29-2021
Diagnostic related technologists and technicians	3320	29-2030
Emergency medical technicians and paramedics	3400	29-2041
Health practitioner support technologists and technicians	3420	29-2050
Licensed practical and licensed vocational nurses	3500	29-2061
Medical records and health information technicians	3510	29-2071
Opticians, dispensing	3520	29-2081
Miscellaneous health technologists and technicians	3535	29-2090
Other healthcare practitioners and technical occupations	3540	29-9000

Responses to Open-Ended Questions

What role should parents play?
Parents should have an active role.

Parents should have a very important role in the STEM occupational choices.
Parents should get children involved in the math, engineering fields at an early age.
Parents should be aware of available opportunities and encourage kids to try things at a young age. It is up to the activity to retain them as they get older.
Parents should encourage kids to pursue STEM related field.
Parents should provide constant encouragement and guidance toward these jobs.
Parents should encourage children to research current and future labor market in the local area. Show child examples of how STEM is used in everyday life.
Parents should encourage students to study in areas of STEM that they enjoy and take advantage of educational opportunities that might be available that would increase their chances of being a part of STEM field.
Parents should help their children understand the importance of STEM careers and encourage them in these fields if it fits their skills.
Parents should be as involved as they can be; this can only help to educate everyone better in the long run.
Parents should encourage students to participate in STEM activities.
Parents can present cases of where a STEM occupational choice improved life of person.
Parents should push for their children to get into STEM because of where the future of jobs are headed.
Parents should be informed of the STEM programs and how their children can excel in differing career fields. With this information they can actively help their child in the decision making process on what career field will best suit them and what STEM studies they would do well in.
Parents should encourage kids who show interest in these fields or may be trying to choose their field. These are often overlooked but necessary for our development.
Parents should strongly recommend STEM classes to their children.
Parents should tell children there is a need to enter science and math related professions and education in the U.S.
Parents should encourage their children to pursue stem studies considering how hugely in demand these jobs will be in the near future.
Parents should help guide their kids into going into these fields for the future because there will be a huge demand for these types of jobs.
Parents should play the role of encouraging their daughter or son to get into the field as well as pay what they can to make sure this dream happens.
Parents should watch for indications that their child has the inclination towards these fields. Enroll kids in extracurricular activities such as summer camps geared towards STEM.

What role should parents play?
Parents should have a small role.

Parents should let children choose what field they are interested in.
Parents should provide access and encouragement to STEM field opportunities.
Parents should be advocates and adopters.
Parents should allow the children to experiment.
Parents should be advisors.
Parents should be an inspiration.
Parents should be helpers.
Parents should be attentive to their children's interest and encourage them to pursue them, not pursue what the parents think the student should do.
Parents should provide an education.
Parents should expose children to all STEM occupation options.
Parents should guide children into a good field of study for a profitable job.
Parents should help and guide the teen kids to make the choice.
Parents should lead.
Parents should be involved in helping educate their children about the options available for education. They should also help explain and guide how their choices in education will affect their career choices.
Parents should give the encouragement needed to drive their children to follow their passions and dreams.
Parents should be well informed about the types of jobs their children could potentially make as good a living at as a college graduate.
Parents should pay for opportunities.
Parents should be encouragers, enforcers, and researchers.
Parents should encourage kids to be interested in academics rather than focusing on sports so much.
Parents should encourage their children at an early age and read to them.
Parents should encourage kids from very an early age to learn and explore.
Parents should encourage their children and provide opportunities for enrichment.
Parents should be informed advisors.
Parents can influence a child's decision, in a healthy way, to help them choose a career path.
Parents should give guidance, counseling and support to their children entering into the workforce.
Parents should make sure they help with the project because they may know about the subject.
Parents should be included in any professional development about STEM to better understand it.
Parents should encourage their children.

What role should parents play?

Parents should have a small role (cont'd)

Parents should only remain as parents.
Parents should continue to encourage their children to pursue their dreams and do what they love in their career.
Parents should encourage children to study a solid career field.
Parents should encourage children to succeed in any field.
Parents should encourage kids to study what they enjoy no matter what.
Parents should allow kids to make their own choices as far as careers.
Parents should have no role.
Parents should only provide the best educational environment they can.
Parents should encourage their children in areas in which they see them excelling, whether STEM-related or not.
Parents should support students in becoming productive members of society and should encourage them to work in an area that best suits their interests and abilities.
Parents should prepare kids for the future.
Parents should supervise.
Parents should teach, correct, and order the child in proper virtue.
Parents need to have good parenting skills.

What role should educators play?

Educators should have an active role.

Educators should provide opportunities for students.
Educators should get trained in STEM areas.
Educators should encourage students.
Educators should lead STEM fields.
Educators should encourage and set realistic expectations for students.
Educators should be in charge of getting information to the parents.
Educators should develop children's aptitudes and provide solutions to shortfalls.
Educators should market and promote awareness about STEM fields. They should create exciting and innovative activities that stimulate kids to try something they may not try otherwise.
Educators should identify students with abilities that would lead them to STEM occupational choices.
Educators should teach and inspire youth to pursue potential STEM careers.
Educators should support and teach.
Educators should give guidance to their students regarding their strengths and weaknesses, counsel students as to job market demands as well as help to diversify their work option choices, and obviously, teach their students the needed relevant information so they may become productive members of the workforce
Educators should play an important role by encouraging more students to pursue STEM Education.
Educators should teach kids the importance of technology and other important fields that will be the future of the job force.
Educators should set good examples to follow.
Educators should provide education in related courses, not political viewpoints.
Educators should instill a proper appreciation for STEM fields as well as encouraging children.
Educators should make sure curriculum choices match local labor markets. Educators should offer job shadowing and education fairs that represent current and future employment opportunities.
Educators should be motivators.
Educators should provide information, facilitate learning (with directions geared to promote enthusiasm for STEM related courses/degrees), and act as mentors for students who have direct interest in STEM subjects.
Educators should find students' strengths and encourage them to pursue those areas within STEM education.
Educators should contribute to making better citizens.
Educators should help get children interested in various STEM fields of study.
Educators should arrange more visits with companies in their area to educate students about what is available there for them.

What role should educators play?
Educators should have a small role.

Educators must continue the work of the parents but in another area; they should reinforce what the parents teach at home.
Educators have a secondary role.
Educators have an important role.
Educators have the same role as parents.
Educators need to have a full understanding of STEM occupations and how career pathways to these can be established.
Educators should teach.
Educators should be coaches and mentors.
Educators should be just that. And they should be able to teach the parents about what is going on in the classrooms and better ways to help the students at home.
Educators should be role models and provide encouragement.
Educators should be supportive.
Educators should be the ones to help.
Educators should check to make sure that everything is correct and that nothing may go wrong.
Educators should follow the same guidelines as parents and encourage children based on their shown skills and interests.
Educators should have a similar role to parents. They should ensure that children understand all of the options they have available in education and how that effects career choices.
Educators should have an authoritative role with a lot of knowledge.
Educators should have more knowledge about STEM.
Educators should help them get to a level of education for STEM.
Educators should ID STEM careers and activities for their children.
Educators should make resources available for students and bring awareness of the benefits of taking these courses.
Educators should make STEM classes more appealing, more exciting.
Educators should make sure that starting at certain grades they teach side courses on the subject.
Educators should make sure that the students understand.
Educators should make sure the students know what is out there.
Educators should promote STEM education.
Educators should provide coursework in STEM areas, encouraging students.
Educators should support the children's natural abilities.
Educators should teach and mentor.
Educators should teach and not simply collect a monthly check.
Educators should teach and support.
Educators should teach children all the knowledge that they can about these fields of study so the students have knowledge going into college.
Educators should tout the benefits of STEM field jobs.
Educators should use the soft skills needed for STEM careers at the forefront. Always encourage all students that they can.
Educators should try to get their brightest students on a path to a career and thus enhance the country's future in STEM education and jobs.

What are the major challenges associated with the factors affecting the supply of a STEM workforce?

Education

Common core is a major challenge associated with the factors affecting the supply of a STEM workforce.
Educating parents is a major challenge associated with the factors affecting the supply of a STEM workforce.
Education is a major challenge associated with the factors affecting the supply of a STEM workforce.
Education is failing in STEM departments.
Educational focus on specific areas needed in the workforce is a major challenge associated with the factors affecting the supply of a STEM workforce.
Educational opportunities are a major challenge associated with the factors affecting the supply of a STEM workforce.
Experience is a major challenge associated with the factors affecting the supply of a STEM workforce.
Fear of mathematics is a major challenge associated with the factors affecting the supply of a STEM workforce.
High schools and colleges are not providing information to perform work, too theoretical.
Home life properties early in their education life are a major challenge associated with the factors affecting the supply of a STEM workforce.
Kids are a major challenge associated with the factors affecting the supply of a STEM workforce.
Knowledge is a major challenge associated with the factors affecting the supply of a STEM workforce.
Lack of education is a major challenge associated with the factors affecting the supply of a STEM workforce.
Lack of interest from counselors to listen to the students and encourage them down a path that is suitable for them rather than just trying to send everyone down the 4-year college path is a major challenge.
Lack of skills is a major challenge associated with the factors affecting the supply of a STEM workforce.
Lack of student confidence is a major challenge associated with the factors affecting the supply of a STEM workforce.
Lack of teaching is a major challenge associated with the factors affecting the supply of a STEM workforce.
No child left behind is a major challenge associated with the factors affecting the supply of a STEM workforce.
Overgeneralized courses are a major challenge associated with the factors affecting the supply of a STEM workforce.
Skills are a major challenge associated with the factors affecting the supply of a STEM workforce.
STEM classes are not offered in the schools.
STEM is not encouraged in many areas, and teachers have to work harder to make it happen (on a currently overloaded workload).
Student interest and accountability is a major challenge associated with the factors affecting the supply of a STEM workforce.
Teachers have out of date skills.
Teachers have too many standards to teach prior to STEM.
Teachers that do not care.
There is a lack of support in schools for these types of jobs.

What are the major challenges associated with the factors affecting the supply of a STEM workforce?

Finances/Incentives/Resources

Current wages for STEM jobs in the workforce area are not attractive to younger workforce.
Finance is a major challenge associated with the factors affecting the supply of a STEM workforce.
Financial limitations are a major challenge associated with the factors affecting the supply of a STEM workforce.
Funding for additional academics/coursework is a major challenge associated with the factors affecting the supply of a STEM workforce.
Funding for STEM programs in the schools is a major challenge associated with the factors affecting the supply of a STEM workforce.
Funding is a major challenge associated with the factors affecting the supply of a STEM workforce.
Having a level playing field is a major challenge associated with the factors affecting the supply of a STEM workforce.
Higher education is too expensive.
Hours are a major challenge associated with the factors affecting the supply of a STEM workforce.
Incentives are a major challenge associated with the factors affecting the supply of a STEM workforce.
Low pay is a major challenge associated with the factors affecting the supply of a STEM workforce.
Money is a major challenge associated with the factors affecting the supply of a STEM workforce.
Not enough time is a major challenge associated with the factors affecting the supply of a STEM workforce.
Pay is a major challenge associated with the factors affecting the supply of a STEM workforce.
Resources are a major challenge associated with the factors affecting the supply of a STEM workforce.
The high cost of getting into classes for these fields dissuades quite a few people.
The poor economy is a major challenge associated with the factors affecting the supply of a STEM workforce.
The cost of entry to get into these types of jobs is high considering all of the training/schooling you need.
The training and education for these types of jobs is ridiculously expensive, and most people don't want to go into massive debt.
There are few incentives for companies to use capital for automation.
There is a high cost of getting into these fields of study.
There is a high cost of getting training/schooling for these jobs.
There should be support in the community with a lot of kids, not just at home.
Tools are a major challenge associated with the factors affecting the supply of a STEM workforce.
Unmet demands is a major challenge associated with the factors affecting the supply of a STEM workforce.
Workers with funding to pursue STEM careers are a major challenge associated with the factors affecting the supply of a STEM workforce.

What are the major challenges associated with the factors affecting the supply of a STEM workforce?

Lack of Awareness/Information

A clear understanding of direction is a major challenge associated with the factors affecting supply of a STEM workforce.
Awareness is a major challenge associated with the factors affecting the supply of a STEM workforce.
Career options are not understood.
Enough people are not going into stem types of education, so there will be a shortage in thc types of jobs.
Getting the word out to people is a major challenge associated with the factors affecting the supply of a STEM workforce.
Having people actually be interested in these stem studies and jobs in general is a major challenge associated with the factors affecting the supply of a STEM workforce.
Interest is a major challenge associated with the factors affecting the supply of a STEM workforce.
It is perceived as too hard.
Knowledge about job availability is a major challenge associated with the factors affecting tl supply of a STEM workforce.
Lack of clear and systematic information and communication is a major challenge associated with the factors affecting the supply of a STEM workforce.
Lack of data is a major challenge associated with the factors affecting the supply of a STEM workforce.
Lack of information is a major challenge associated with the factors affecting the supply of a STEM workforce.
Not enough students choose to study these fields.
Parental involvement is a major challenge associated with the factors affecting the supply of STEM workforce.
Parents trying to relive their life through their child is a major challenge.
People do not want to go into these fields.
Platforms are a major challenge associated with the factors affecting the supply of a STEM workforce.
The biggest issue is having people actually be interested in going into these fields.
There is a lack of involvement in the community.
There are not enough people interested in going into these fields of study.
There are not enough people being encouraged to go into these research fields.
There is a lack of knowledge as to what opportunities are available in the field.
There is a lack of support from families in these types of jobs.
Too many students are intimidated by STEM.
Workers interested in STEM careers are a major challenge associated with the factors affecti the supply of a STEM workforce.

What are the major challenges associated with the factors affecting the supply of a STEM workforce?

Challenges within the industry/workforce

Access is a major challenge associated with the factors affecting the supply of a STEM workforce.
Appeal is a major challenge associated with the factors affecting the supply of a STEM workforce.
Availability is a major challenge associated with the factors affecting the supply of a STEM workforce.
Communication skills are a major challenge associated with the factors affecting the supply of a STEM workforce.
Contribution is a major challenge associated with the factors affecting the supply of a STEM workforce.
Factories are a major challenge associated with the factors affecting the supply of a STEM workforce.
Inconsistency is a major challenge associated with the factors affecting the supply of a STEM workforce.
Keeping abreast of changing technology is a major challenge associated with the factors affecting the supply of a STEM workforce
Lack of jobs is a major challenge associated with the factors affecting the supply of a STEM workforce.
Location of jobs is a major challenge associated with the factors affecting the supply of a STEM workforce.
Low instance of broadband is a major challenge associated with the factors affecting the supply of a STEM workforce.
Manpower is a major challenge associated with the factors affecting the supply of a STEM workforce.
Outsourcing is a major challenge associated with the factors affecting the supply of a STEM workforce.
Overworking is a major challenge associated with the factors affecting the supply of a STEM workforce.
Patents are a major challenge associated with the factors affecting the supply of a STEM workforce.
Producing results is a major challenge associated with the factors affecting the supply of a STEM workforce.
Requirements are a major challenge associated with the factors affecting the supply of a STEM workforce.
Lack of people going into the field is a major challenge associated with the factors affecting the supply of a STEM workforce.
Staffing is a major challenge associated with the factors affecting the supply of a STEM workforce.
Technology changes are a major challenge associated with the factors affecting the supply of a STEM workforce.
The economy is a major challenge associated with the factors affecting the supply of a STEM workforce
Stress is a major challenge associated with the factors affecting the supply of a STEM workforce.
There are not enough highly skilled and experienced workers available.
Travel is a major challenge associated with the factors affecting the supply of a STEM workforce.
Underemployment is a major challenge associated with the factors affecting the supply of a STEM workforce.
Uninterested management is a major challenge associated with the factors affecting the supply of a STEM workforce.

What role do technological resources (hardware and software) play in attracting and maintaining a STEM workforce?

Attracts Talent

An essential component for industry.
Attracting the right candidates for the roles.
Basic and important role to provide support.
Critical role. Without the best tech resources you obviously aren't going to attract the best STEM workforce.
Cutting edge electronics attract a new workforce.
They help a great deal in attracting and maintaining people in this field of work.
It allows for a more attractive work life by allowing to be more mobile.
It is critical. Without bandwidth, without technology, they won't come.
Most companies seem to have necessary equipment.
Seeing what is required in these fields from software available may help persuade people to be interested in said fields.
Some people may see these resources and it opens a whole new world for them in these types of jobs. It may change their mind on what they do in the future
STEM folks seek out high tech companies to work for. They are frustrated and won't work for companies that are not technologically advanced.
Updated hardware and software is critical.
Workforce is the number 1 driver for a company's site selection and/or expansion.
A very important role in the field.
Advanced technology attracts better applicants
Businesses need to be up to date with the latest technology - computers, tablets, smartphones, apps, etc. in order to maintain the STEM workforce or even a millennial workforce for that matter.
By creating jobs that are interesting and challenging.
Encourages new talent to be brought in.
Fundamental requirements.
Getting kids interested.
Gives them the tools to do their job and retains employees.
Help get students interested in STEM.
Helping attract new STEM workers.
Helps recruit strongest workforce.
If students can see what STEM classes lead to, they will be more likely to take these courses/majors.
If the resources are available, more students will take these courses.
Modern technology is needed to attract and maintain a STEM workforce.
Technology is part of STEM so it is huge in attracting and maintaining a STEM workforce.

What role do technological resources (hardware and software) play in attracting and maintaining a STEM workforce?

Financial

Funding for these types resources
Money
More pay
Cost
Cost of STEM related hardware and software upgrades
Finances
Funds
Price
Salary

What role do technological resources (hardware and software) play in attracting and maintaining a STEM workforce?

Improved Quality/Efficiency of Work

Allow for greater innovation
At the same time, they must be state of the art - we are constantly updating - we must be a company that grows.
Availability
Businesses are looking at automation which requires employees to have to learn how to set up and operate machinery, robots, etc.
Competitive
Current businesses are looking at reducing employee numbers by automating, government thinks STEM will add jobs. Will not happen in current labor market. New businesses that start out fully automated would benefit all.
Dedicating time and effort
Efficiency
Enables some work to be done by well-designed programs
Encourages creativity
Functionality
Good programs make it easier for maybe non-stem workers to complete their work.
Improve productivity
Machinery converting to efficient technology requires PLC programmers.
Must be kept updated and current
Quickens the process
So important for clerical staff
Software and equipment is not always current.
Software MUST be compatible with other facilities.
Sustainability
Tech savvy
Technological advances
Ability to cooperate

What role do technological resources (hardware and software) play in attracting and maintaining a STEM workforce?
Improved Quality/Efficiency of Work (cont'd)

Accessibility
Adequate technological resources are required for day-to-day operations.
Being able to keep up with the demand needed
Better communication
Better performance and quality
By broadening an audience for the business
Collaboration
Competitiveness
Constant innovation
Customer service attention
Cutting edge tools
Data surveillance
Designing the structures
Development
Ease and portability of usage/Easy access
Efficiency of job tasks
Experimental tech
Focus on building functions
Having right equipment
If you do not have enough resources then the job cannot be carried out correctly.
Important for employees to be able to achieve goals.
In general, new tech makes all jobs more efficient and productive.
In our business (technological resources) matter a lot as we have to keep up with the hardware and software to do our CAD and CAM work.
Innovation
Interesting hardware boosts morale
Less expensive
Makes work easier
Making applications modern, attractive
Monitoring
More accessibility
More results to report to the customer
Must be working with the most up to date and innovative technology
Productivity
Quality
Significant need in communication
Social welfare and improvement should be brought through STEM
Software helps ease jobs
Sustainability

What role do technological resources (hardware and software) play in attracting and maintaining a STEM workforce?

Learning/Training

Advances students' interest
Allow for greater skills development
Encourages learning
Encourages new teachers by providing materials that have already been organized as a unit/lesson plan
Having beneficial software that teaches people the basics of these jobs is super important.
Important to education programs
Introduction to technology
It also helps by teaching people and getting them a foot in the door to kind of guide them into STEM jobs.
It helps by giving people a taste of what they could be accomplishing.
Makes program availability more possible
Provides data driven programs that build confidence in new(er) employees
Software can help people get the mental and visual knowledge in these fields of study.
Software lets people learn visually with these types of jobs.
Staying current
They help people learn the basics and some of the more advanced things to see if they actually like it before deciding about going full on in this field.
They teach people how to work in this field and help them get their feet in the door.
Training
Use of devices is an important basic skill to develop.
Advancing the idea that education never ends
Allows for students to research possible solutions and improvements
Awareness of STEM
Computers for ALL students, not just for the ones who can afford them
Continued training for STEM employees
Ensuring applicability of research (a neuroscientist who requires an FMRI, EEG, etc.) To work with patients
Expanding research options
Helping educate youth to get involved in STEM
Information
It speeds up the learning process.
Knowledge of the workforce
Low-income students may not have access to technology away from school.
Making workers aware of a rapidly changing and growing field.
Offering hands on
Provides answers to student questions
Research the topics
Spreading the benefits of STEM degrees
Vital that students have these tools at their disposal

What role do technological resources (hardware and software) play in attracting and maintaining a STEM workforce?
No Role

Not a huge encouragement
No
None
None
None

Should there be a role for the government to play in promoting STEM workforce dynamics? If so, what role?
None

Government should stop their role in standardized education.
Low to none
No
None, keep the government out of it.
Stay out of the way.
Fix the system before you promote anything.
No, each state should take control of it
No. Government is separate.
There should be minimal government involvement.

Should there be a role for the government to play in promoting STEM workforce dynamics? If so, what role?
Financial Role

Financial support
Business incentives to automate outdated facilities.
Certain incentives for students that are enrolled in certain careers
Give more grants
Help new technology businesses get started
Help states with funding
Helping people with scholarships so they don't have to possibly go bankrupt before entering the job force
Incentives and closer role between schools and businesses for internships and job shadowing
Incentives to companies to hire and train candidates in these types of jobs
Pay better
Promote new large business start-ups in the region. Incentives to locate here.
Sponsors
State funding for states that follow certain STEM programs
Supplement student loans for STEM students.
The government could offer incentives for companies to hire and train employees.

Should there be a role for the government to play in promoting STEM workforce dynamics? If so, what role?

Financial Role (cont'd)

The government should also promote some sort of benefit for getting into these programs either through reduced cost scholarships or some other way.
The government should help fund STEM programs in post-secondary schools and high schools.
The government should provide more scholarships to help people get into these stem studies.
They could also help by matching up to a certain percentage of money on whatever career path you choose in these STEM jobs.
They could also help by providing more funding to programs and other resources to help people learn more about these jobs.
They could also offer more financial assistance programs to help people pay for their schooling.
They could also offer more information in general about these fields of study outside of programs and or financial assistance. Maybe tech fairs or something for schools.
They should also offer STEM incentives to the military forces.
They should offer incentives for businesses to hire and train employees for future proofing their business.
Yes, offering scholarships to students interested in the studies.
Yes. The County, State and Federal governments should focus monetary efforts into promoting STEM.
Allocate money specifically for STEM studies.
Creating and funding educational programs
Creating tax incentives for STEM businesses
Ensuring funding for STEM related community programs
Ensuring funding for students pursing STEM degrees
Increased funding to NASA, NIH, CDC
Lower tax for extended education
Offer subsidiaries to employers who bring in STEM jobs
Provide incentives
Provide public education schools and universities with funding to encourage
Scholarship stimulant for these fields
Schools should get incentives for promoting and maintaining certain participation levels in STEM fields.
Should build Technology Labs across the state
Subsidizer
Tax breaks
Tax incentives
The government can establish new scholarships and financial incentives.
The government could provide additional funding to promote STEM work as it will be needed for technological advances.
The government should only provide funding and let the knowledgeable do the work.
There should be incentives such as a break in tuition for STEM related fields, especially for minorities.

Should there be a role for the government to play in promoting STEM workforce dynamics?
If so, what role?
Promote/Inform

A big role
By promoting and encouraging programs
Educating the educators on need
Education
General awareness
Higher education
Know everything about what to do
More research
Promote career development
Promoting programs to help people learn the ins and outs of these fields of study
Promoting US citizen interest
Putting more resources out there to public
Sustainability
They should also promote more programs to let people get hands on knowledge.
More promotion and public awareness
Motivator
Personal customer service
Planning
Programs for youth
Programs to further awareness and knowledge
Promoting the job to show the high demand and the amount of people needed to meet that demand
Promotion
Providing internship matching and subsidies for small firms
Providing resources
Some role with change in requirements
STEM programs
Stop H1-B visas
The economy drives the nation. If we want a strong nation, then the government should equip the educators to prepare the future workforce.
The government should encourage all types of workforce dynamics not just STEM.
The government should promote more STEM competitions both regionally and nationally.
To achieve as much promotion and activity as possible
Train the Trainers - teacher externships
Concentrate initially on elementary and secondary students to give them a good foundation.

Should there be a role for the government to play in promoting STEM workforce dynamics? If so, what role?
Should Regulate/Be Involved

Accreditation
Advocate
Attract business and industry
Be business friendly
Government should be engaged with local education.
Making sure products are safe
Mentoring by professionals
Monitoring
More programs to help people learn the ropes early on
Oversee
Teacher
The government should offer jobs.
Advocates
Alliances of STEM workers and educators
Assist and help facilitate people to the available opportunities
Availability
Better guidelines for educators
Collaborative efforts with stem professionals in other countries
Communication
Developing programs
Finding recruiters
Implementing
Increased responsibility for teachers
Leadership
Mandate it in schools for anyone above an 85% grade average
Monitor compliance
Monitoring quality and consistency
More involvement in the school system
More programs to encourage a desire to be involved in stem
More workers
No, government should provide regulations, not force procedures.
Oversee training
Standardized curricula aimed at various learning levels throughout the state educational system
Structured program
Student enforcement
Provide training
Tutoring

What are potential ways to engage business, industry, and other community partners to advance STEM?

Cooperation

Being flexible
By creating better programs for STEM in the workplace
By establishing a team of all community key players to begin discussions on how and with what resources can we increase/attract stem workforce
Communication for needs, engage these partners at our school.
Education system reaching out
Having good public relations
Link up with other business and sell the product together
Local government and community engagement programs
More communication with local business, industry and community partners
More technology advancement on a regular basis
People may not be aware of the impact of STEM in their daily lives. Community partners and business can help raise awareness.
All businesses could work together to take time to form a better project STEM.
Asking the business what their needs are
Being able to help others to open up opportunities
Better technology, be advanced, and spread the knowledge
Business partnerships with schools are needed.
Campus recruiting
College internships, job placement, sending reps to the schools
Company not only remains competitive and relevant to modern-day business but also becomes attract to a stem workforce.
Connecting students to mentors in fields of interest
Connectivity
Cooperate and share ideas with each other
Create cross training in different industries
Engage the local chamber of commerce, businesses, and schools to coordinate opportunities together
Make it open to more business, come up with a good structure plan
Making it a law
Meeting and discussing potential advances
More interaction with schools and sharing executives with the school system (on boards, in classrooms etc.)
More professional development and involvement with school systems to promote STEM
Networking
Partner with colleges with internships for these students.
Partnering with schools, business attending career fairs
Partnerships
School presentations, public forums, partnerships
The larger corporations can partner with education to get the hardware needed to teach with.

What are potential ways to engage business, industry, and other community partners to advance STEM?

Educate

Allow their employees to take classes at discounted tuition. This would also encourage Employer Funded Education Programs
Better workforce
By providing an apprenticeship program in businesses to prove worth of STEM areas for students who would see the value of employment with an additional benefit of a career (within a certain business).
Educate
Education & attractive incentives
Education, education, education
I think showing them that the future is now, should help persuade them. The world runs on computers, so people who know how to run and fix said computers are critical.
Internships - job fairs traditional methods
Knowledge
Provide equipment, courses, training to local residents
To keep up the colleges and to help them to learn more about the work background and when they are ready to go to work they will be ready to hit the work field.
Train/hire Americans.
Add more classes and jobs.
Be supportive and have the proper technology and training.
Bring them into universities and high schools to give presentations. Offer internships to underclassmen.
Community mentor programs for children/teens interested in STEM (i.e., job shadowing)
Education
Having students visit the jobs and show both students and employers how STEM will help both their respective careers and businesses
Help educate the masses on the benefits of this education and training and show how it translates into higher wages and lower cost products.
Improve the education quality.
Internship opportunities; school partnerships/sponsorships
Internships and externships at early ages, financial support to STEM prep organizations
Internships and programs to teach children about STEM occupations
Internships, entry level jobs, etc.
Knowledge
More internships for students. Let them get some real world experience for college credit.
Offer paid training.
Perhaps interning with the option to further one's education
Programs for middle and high school students to peak early interest in STEM fields provide larger pools of students to replenish for employee turnover.
Should be having some STEM education required for getting the job
STEM-related competitions, engineering examples
We wouldn’t have to if our school systems worked right.

What are potential ways to engage business, industry, and other community partner s to advance STEM?

Incentives

Add small incentives to attract more students
Adjust the pay structure to reward increased knowledge
By offering incentives to businesses, some tax breaks or some other intriguing way for business to benefit from advancing STEM
Funding and tax breaks for business, industry, and community partners to advance STEM programs in schools, both high school and post-secondary
Give businesses incentives to either incorporate these types of jobs or to help train/school employees for their already incorporated jobs
Incentives and other monetary ways to help companies offer on job training or off job education
Incentives to train and school people to help get them into the workforce with all the knowledge needed
Incentives, paid programs, additional tax benefits or other monetary benefits while hiring and or training these types of employees
Incentivize them and establish partnerships with them
Increase funding to those businesses
Offer incentives, also let them know that if they want to be future proof they should probably advance their STEM departments
Offer incentives or tax breaks to companies that promote and or train people for stem jobs
Scholarships
Tax benefits
There will have to be a financial incentive for the private sector to be interested.
Through incentives and education
Through programs and grants
Affordable options to the private sector
By showing companies how important STEM is to them, and offering them the opportunity to help with funding.
Creating tax incentives for STEM businesses. Creating and funding educational programs.
Encourage sponsorship
Free government funding
Offer subsidies to employers who bring in STEM jobs
Offer tax breaks to companies that hire and contribute to the STEM community
Offering incentives and providing training free or at discount to attract more people
Private funding and grants
Raise salaries and employment standards
Stop hiring foreigners for STEM jobs
Tax breaks for technology companies and create some space like Silicon Valley here
Tuition reimbursement. Scholarships.
Work benefits such as raises or paid STEM training
Workplaces can offer financial incentives to employees who are increasing their STEM abilities.

What are potential ways to engage business, industry, and other community partners to advance STEM?

Promote

Advertisement
By including it in seminars and presentations
By promotion and marketing
By showing them the advantages of these stem jobs. By showing them how important these jobs will be in the future.
Community forums, special recognitions
Give them more information on the project
Introduce a plan to them
It is focused on raising student interest and achievement in STEM subjects and improving STEM economic development
Make some t.v. and online ads
Organize events in communities to get young people interested in STEM
See the benefits and voice their opinions
To encourage
To make everything good about stem
Word of mouth.
Build more interest in STEM and contribute more to educating and enhancing those with an interest or skill in STEM
Businesses can engage more by helping stress the importance of the skills needed in STEM candidates. They can also help by showing that the future of business that will not waver in the future is in science and technology.
By letting the public know that they employ STEM workers and the types of jobs they do for the company.
Coming up with a good marketing plan that is both engaging and extremely thought-provoking.
Company growth and better performance
Display the potential benefits that STEM would have on the business and make them educated on the concepts of STEM and why it would be helpful for them to engage in it
Getting businesses to encourage students
Getting the word out as much as possible
Make the idea sound interesting and present statistics on the supply and demand for jobs in the STEM workforce to draw in business, industry, and other community partners to advance STEM
Market these opportunities and provide internships and exposure to young students about opportunities
Maybe some sort of programs to raise awareness
Promotion activities
Provide them with ideas on how they use STEM in their company and allow them the opportunity to showcase this and promote their business at the same time.
The careers need to be shown as interesting as law and business careers.

How does the advancement of technology affect your business?
Changes the Dynamics

Advancements help us more than hurt us as we are very serious about the future of this country and have taken many steps to ensure that this business is future proof.
Data analysis
Data collection
Demand for advanced equipment
Documentation
Employees need more
End up using contracted labor
I feel at the moment our business is future proof as we already have taken these stem jobs seriously
Intimidating
It brings in more people that want to work for the business
Many long term employees would no longer be needed.
More diversity
Mostly on the job training for machine operators with little knowledge of setting up or adjusting equipment. Increases down time.
Must be able to digitally communicate with other clinics
New focus on cybersecurity
Phone calls to place an order
Skilled workforce
The more technology with no training, the worse our operation. We need an IT department and IT trainer with regular, on-going training just like in corporate America...even if web based! Better than nothing!
Tracking prescriptions
We have some older people who don't embrace technology as fully as the younger people.
Could increase or decrease chances of survival
Employees have difficulty adapting to new changes.
Depleting job opportunities
Forces us to learn about the upgrades, new tools, etc.
Greatly affects how people consume product
More applicants than ever
More automation of internal functions
New chemicals
Privacy
Reduces radiation
Shows how smart the world is
Skilled workforce
Slow transitions
Software and hardware needs change daily

How does the advancement of technology affect your business?

Greatly Affects the Business Financially/Productively

Advanced technology will enable us to stay competitive.
Advanced training
Advancement of technology makes things easier overall for our business.
Automate processes
Better advertising
Better employees
Both above combined ensure we have the best workforce
Can't keep up
Certain technologies are making processes easier both for our agents and their clients.
Enhances our role
Faster computers
Faster technology
Helps
Helps improve service
Helps me be more efficient
Helps my business grow
Helps us to meet customer expectations
Increase in productivity
Increase in technology
Increases business
Innovative training
It makes most things easier overall since we are already well equipped for the future already.
It makes us more efficient.
It makes us stronger overall, we are prepared for the future.
Makes my work more enjoyable
Makes some a lot of current jobs easier for people to complete
Makes us more efficient with better quality work
Makes us stronger since we already have a well-staffed and educated group of employees
Money is needed
More complications
More customer satisfaction
More employees to choose from
Must have the latest equipment to run diagnostics to stay competitive
Patient care
Pleasant
Provides ease of maintaining records
Provides efficiency of business
Provides more skilled workers

How does the advancement of technology affect your business?
Greatly Affects the Business Financially/Productively (cont'd)

Provides opportunities for students
Reduces time
Reputation
Shut downs
Significant
Streamline workflows
They help our business tremendously as we are already using cutting edge technology and have lots of trained professionals for said jobs.
Threatening
We are near cutting edge with education and training and having the top employees in these fields so any advancements are a plus and an advantage for us.
We are now better prepared for new challenges.
We are on the cutting edge with our business and we train/school our employees.
We have to stay in step with the most current technology.
We hire and maintain a strong STEM team in our business so any advancements are beneficial to us in the long run since we already have a staff in place.
We see nothing but positives and a better future overall with STEM advancement.
Without proper education of new technologies many will be left behind affecting sales.

How does the advancement of technology affect your business?
Little to No Effect

It does not affect.
No
Not much actually.
We already use cutting edge technology so we are future proof at the moment
It does not affect.
20% of our workforce uses advanced technology.
In actuality, it does not affect
Little
No effect
None
None
Small to none

What are the major challenges your business faces in recruiting a STEM workforce?

Business challenges

A need for it
After hiring said people we need to keep them constantly updated on the latest information so they can be up to date on standards.
Applicants looking at the ads
Availability of jobs
Being able to put people that do work out in their proper most beneficially productive role
Clients
Cooperation and collaboration are a challenge currently.
Getting people into training is the first major hurdle.
Innovative technology
Keeping current employees on the cutting edge of knowledge and know how
Keeping employees up to date with the latest knowledge and training
Keeping people on the cutting edge of knowledge. It requires constant training and knowledge gain to be competitive.
Keeping people up to the cutting edge on training and knowledge
Lack of employee participation
No opportunities for advancement. If they come, they won't stay.
No one wants to put the time into the research.
Often contracted work
Our overall business practice
People sometimes don't agree
Positivity
The people we do get, keeping their knowledge up to the latest standards
Advancement
Advertising
Competition
Employees
Flexibility in production
Get new customers
Keep our tech up to date
Keeping said people motivated and with us for the duration of their career
Lack of training faculty
Not a traditional workplace
Old culture not wanting to change
Opportunities for training and growth
People liking their jobs
Proper management
Sexism
Shutting down
Time

What are the major challenges your business faces in recruiting a STEM workforce?
Financial

Being competitive in benefits and salary
Investments
Lack of competitive salaries
Low pay that won't attract STEM workers
Money
Pay
Proving to our owner that outside support would be necessary
Securing investment
Wants too much money
Adequate pay
Attractive salaries
Benefits
Competitive pay
Cost
Cost to train employees
Funding and available resources
High costs for technology
High employment salary costs
Highly paid
Incentives
Income potential
Increased pay requirements of skilled employees can make attaining suitable candidates cost prohibitive.
Lack of funds
Lack of incentive
Money
Non-competitive salaries
Not for profits can't pay the higher salary
Pay
Pricing
Salary
The cost
The cost of salaries.
The pay rate they expect
Tools
Wages
Willingness to pay the employees

What are the major challenges your business faces in recruiting a STEM workforce?
Labor Force

Availability of workers
Competition for too few STEM qualified applicants
Do they know what they're doing
Finding qualified workers
Getting and keeping employees and keeping the ones that do stay long term up to date with knowledge
Getting enough people is the major one.
Getting enough people overall, we are expanding quickly
Getting new employees in this competitive job market and also keeping the ones we have up to date with training and education so they remain cutting edge
Hard to find qualified candidates
Have the stem degree
Having candidates understand the high tech requirements of our industry
Hiring
Interns we hire from TCAT only stay a short time. They seek and obtain other employment with less pay, but where have weekends and holidays off.
Lack of certifications
Lack of needed skills
Less available people
Not enough applicants
Not enough STEM related jobs
Placements
Potential employee pool
Qualified people apply but overall don't work out for the company. This is a big challenge.
Quality workers
Recruiting and keeping key employees
Recruits' lack of understanding of workforce demands.
Slow transitions
Supply
Technology driven people
There can sometimes only be a trickle of people since not a ton go into these fields.
There may not be enough people that are knowledgeable in STEM area.
Trained people
Training of new hires
Unskilled workers
Work ethic
Technology related experience
The employees
The right skill sets needed
There is a lack of qualified applicants.

What are the major challenges your business faces in recruiting a STEM workforce?
Location

Rural/Distressed area without perks of metro area
There may not be enough STEM related jobs in this area.
Getting people to not leave the area
Location
Location preference
Look in other sources out of town
Not enough local talent
Reach and scope of searches.
Relocation requirements
Small town
Travel

What are the major challenges your business faces in recruiting a STEM workforce?
None

No issues with recruitment
There are no major problems with us at this time.
We don't have any major issues; we are at the top of the game so to speak at recruiting.
No issues whatsoever in recruiting people for our workforce

What are the major challenges your business faces in recruiting a STEM workforce?
STEM Awareness

No interest in our system
Not enough available from schools
Public perception
Interest
Lack of interest in science
Lack of awareness of the need of STEM jobs for our business
Lack of interest
Lack of ostensible prestige
Making people aware of the essential training
Marketing
Not enough programs to draw from
Not enough students participating
Not everyone knows what STEM is.
Qualified teachers
Some people just are not into it.
Spreading the STEM message
Uninterested