A Strategic Review of Technology Education

Preparing Students for Successful Transition to College and Careers

Virginia Department of Education, 2017
Office of Career, Technical, and Adult Education

A Strategic Review of Technology Education

Developed by the
Office of Career, Technical, and Adult Education
Virginia Department of Education
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Introduction

The Technology Education field plays a large role in the science, technology, engineering and mathematics (STEM) movement that currently receives a large amount of emphasis in education. Whether the acronym is STEM, or STEAM to include the arts, Technology Education is the primary delivery method for true inclusion of technology and engineering in the movement. Because technology is ever changing, topics within technology and engineering education change frequently. Laser engravers and 3-D printers are now common additions to any course. As virtual reality becomes more accessible, Modeling and Simulation must include this topic and teachers must use it to demonstrate concepts in other courses.

It has been a long time since the field was looked at in Virginia from a strategic viewpoint, and due to the critical nature of the material, it was decided to undertake a strategic review of Technology Education. The purpose of the review is to provide recommendations to drive change and improvement in courses and delivery that help prepare young people to succeed in careers and future education. It is not intended to imply that Technology Education courses have not made improvements and added new technologies as they become available. Rather, it is a quest to find areas for improvement for all courses, and review the relevancy of courses. Courses must be linked to high skill, high wage and high demand areas while providing the underlying framework of technological literacy that helps all students succeed.

With these thoughts in mind, the review was undertaken to gather input from business and industry representatives, education representatives, and research into how the field is viewed globally and nationally.

Table 1: Terms and Their Abbreviations/Acronyms

Advance CTE (formerly National Association of State Directors of Career and Technical Education Consortium)	NASDCTEc
Developing a Curriculum	DACUM
Engineering by Design	EbD
International Society for Technology in Education	ISTE
International Technology Education Association	ITEA
International Technology and Engineering Educators Association	ITEEA
National Science Foundation	NSF
National Academy of Engineering	NAE
National Aeronautics and Space Administration	NASA
National Assessment of Educational Progress	NAEP
Next Generation Science Standards	NGSS
Project Lead the Way	PLTW
Science, Technology, Engineering, Art, and Mathematics	STEAM
Science, Technology, Engineering, and Mathematics	STEM
Standards for Technological Literacy	STL
Technology and Engineering Literacy	TEL
Technology Student Association	TSA
Trade and Industrial	T&I
Virginia Technology and Engineering Education Association	VTEEA

Research Methodology

This comprehensive review of Technology Education in Virginia was conducted using a variety of sources and methods. The principal investigator used the following three steps to compile program data and make recommendations.

First, labor market data analysts from the University of Virginia's Weldon Cooper Center provided research and analysis on current and projected employment data regarding occupations in eight Career Clusters (Appendix A) covered in Virginia's Technology Education programs: Architecture and Construction; Arts, A/V Technology & Communications; Government & Public Administration; Information Technology; Law, Public Safety, Corrections & Security; Manufacturing; Science, Technology, Engineering & Mathematics; and Transportation, Distribution & Logistics. These Career Clusters encompass 31 of 79 Career Pathways. The principal investigator reviewed and compiled data from this source.

Second, the principal investigator reviewed and compiled historical and contemporary literature to provide insight into trends and issues nationally, internationally, and within the commonwealth. These trends and issues focused on Technology Education teaching, learning, and assessment. Also reviewed were Virginia program data and Technology Education program offerings in other states.

Third, feedback and recommendations from key stakeholders was desired. Two focus groups were held to gather Information from business and industry leaders, then Technology Education leaders. The CTE Resource Center was the scribe for these meetings and compiled answers from both groups. Virginia Department of Education (VDOE) staff was on hand to address policy and technical questions. Recommendations from the focus groups were compared to help develop report recommendations that will serve as a framework to prepare Virginia students for rapidly changing careers associated with Technology Education.

Historical Context

The foundation of Technology Education in the United States is attributed to two educational leaders from the 1870s. Calvin Woodward, dean of the polytechnic school at Washington University in Missouri, created the Manual Training School in St. Louis. Simultaneously, John Runkle, president of the Massachusetts Institute of Technology (MIT), introduced manual training into the curriculum for instructional purposes. Manual training was established to be a general education subject for all students, not vocational training, because Woodward and Runkle believed in actively engaging students in the learning process.

In 1904, the field changed its name to industrial arts to better represent the broader content and practices of industry. In practice, the field maintained the active learning environment advocated by Woodward and Runkle as well as notable educational reformers such as John Dewey. Throughout the 20th century, however, many technology educators believed the field's content should be broadened even further to encompass all technology, not just industrial practice. As a result, in 1985 the field changed its name to Technology Education to reflect this paradigm shift but it continued to be misunderstood on two fronts. First, many still viewed

Technology Education as vocational preparation, not general education for all, due to the laboratory-based learning environment. Second, the ambiguity of the word "technology" has caused confusion with related disciplines. Table 2 provides clarification on fields closely related to Technology Education.

Technology Education has changed immensely from 1980s industrial arts. Instead of content based on industrial practice (industrial arts) or the natural world (science), Technology Education studies the human designed world, which is inclusive of technological systems, processes, and artifacts (not just computers) (ITEA/ITEEA, 2000/2007). In 2010, the International Technology Education Association (ITEA) changed its name to reflect this shift and is now called the International Technology and Engineering Educators Association (ITEEA). In response to this name change, many states, teacher preparation programs, and organizations now refer to this K-12 discipline as technology and engineering education (Missouri Department of Elementary and Secondary Education, 2015; Rouch, 2015). Virginia's official program is still called Technology Education, but the state's primary professional education association changed its name to the Virginia Technology and Engineering Education Association (VTEEA) in 2011 to align with the national association.

Table 2: Clarification of Related Disciplines

	Technology Education	Science Education	Instructional Technology	Technical Education
Focus	Study of the human-designed world.	Study of the natural world.	The use of technology to facilitate teaching and learning.	Preparation for a specific occupation.
Attributes	Based on Standards for Technological Literacy (ITEA/ITEEA, 2000/2007). Virginia's program has a dual purpose of focusing on technological literacy and providing a foundation for technical education. Referred to as Design and Technology in countries using the British educational model.	Based on Next Generation Science Standards (NGSS Lead States, 2013).	Content neutral. All disciplines utilize technology to enhance the learning process. Also known as Educational Technology. Uses ISTE standards.	Based on industry standards. Commonly associated with community colleges, trade schools, and apprenticeship programs. Virginia's secondary program is Trade and Industry (T&I). A significant factor in STEM education and employment (see Rothwell, 2013; Symonds, Schwartz, & Ferguson, 2011).

Contemporary Trends and Issues

Nationally, throughout the past two decades there has been an increased focus on science, technology, engineering, and mathematics (STEM) education. Science and mathematics are core disciplines in secondary education, but there is less consensus on the implementation of technology and engineering at the secondary level. National surveys indicate many Americans narrowly view of technology as computers or cellphones, but when provided a broader definition of technology, they agree Technology Education should be a priority for K-12 schools (Rose & Dugger, 2002; Rose, Gallup, Dugger, & Starkweather, 2004).

Virginia's Technology Education program is based on Standards for Technological Literacy: Content for the Study of Technology (STL; ITEA/ITEEA 2000/2007), which was developed at Virginia Tech from National Science Foundation (NSF) and National Aeronautics and Space Administration (NASA) funding and endorsed by the National Academy of Engineering (NAE). The STL is used in 41 states and translated into five languages although only seven states (excluding Virginia) require K-12 coursework in technology and engineering education (Moye, Dugger, & Starkweather, 2012).

The Next Generation Science Standards (NGSS; NGSS Lead States, 2013) has greatly increased the focus on K-12 engineering design. However, the NGSS makes no claim to responsibility for teaching technology or engineering content. Specifically, NGSS states that the technology, engineering, and mathematics focus within NGSS serves only to aid the study of science.

Additionally, the issue of dedicated engineering courses is also addressed in NGSS:

> *The decision to integrate engineering design into the science disciplines is not intended either to encourage or discourage development of engineering courses…*
> *…The engineering design standards included in the NGSS could certainly be a component of such courses but most likely do not represent the full scope of such courses or an engineering pathway. Rather, the purpose of the NGSS is to emphasize the key knowledge and skills that all students need in order to engage fully as workers, consumers, and citizens in 21st century society (NGSS Lead States, 2013, p. 107).*

Virginia has a long history of dedicated pre-engineering courses, having introduced them at the secondary level in 1988 (G. Willcox, personal communication, September 17, 2015). Since that time, the National Academies have released numerous reports to support the study of technology and engineering in K-12 education (see National Research Council, 2002, 2006; Katehi, Pearson, & Feder, 2009; National Academy of Engineering, 2010).

In 2013, the National Assessment of Educational Progress (i.e., The Nation's Report Card) Technology and Engineering Literacy (NAEP TEL) Assessment was piloted in eighth grade and will eventually assess the technology and engineering literacy of fourth-, eighth-, and 12th-grade students. The three technology and engineering literacy areas in the center of Figure 1 and the three practices circling the edge are based heavily on Standards for Technological Literacy (ITEA/ITEEA 2000/2007) and mirror content taught in Virginia's Technology Education programs.

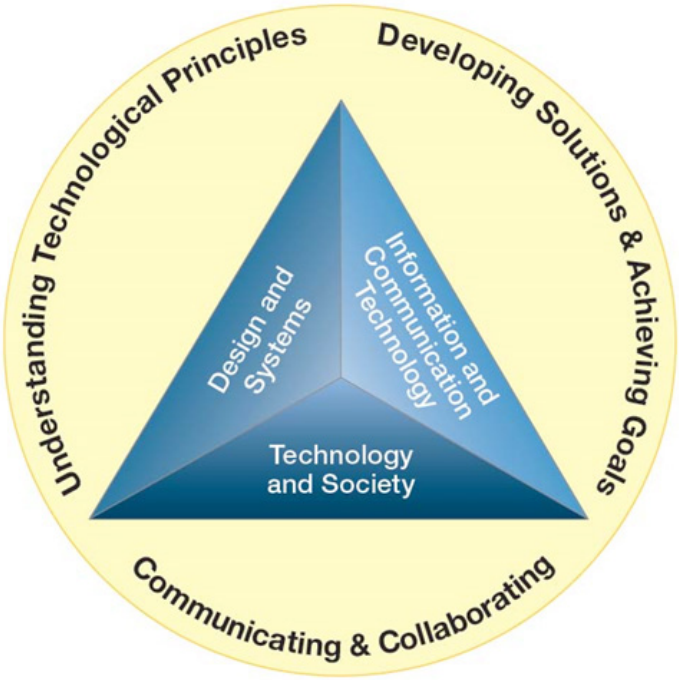


Figure 1: NAEP TEL Assessment Areas and Practices (National Assessment Governing Board, 2014, p. 3-2).

The NAEP TEL practices are applied across all three major assessment areas. For example, communicating effectively and collaborating with others are necessary skills for comprehending the relationships between technology and society, designing and systems thinking, and achieving a goal using information and communication technology.

There have been compelling studies over the past two decades calling for all students to study technology (ITEA/ITEEA, 1996, 2005, 2000/2007), as well as for all U.S. citizens to become more technologically literate (National Research Council, 2002, 2006). *Standards for Technological Literacy: Content for the Study of Technology* (ITEA/ITEEA, 2000/2007) is the primary document that has shaped Virginia's Technology Education program during this period. At the same time, the study of technology has been incorporated into the standards for science, social studies, and mathematics (Foster, 2005; NGSS Lead States, 2013) and will become a regular part of NAEP through the TEL assessment (National Assessment Governing Board, 2014).

Career Projections

All workers use some form of technology in their work, whether it is products, systems, or processes. Virginia's Technology Education program exposes students to broad technological literacy concepts as assessed by the NAEP TEL (National Assessment Governing Board, 2014), ways of thinking such as the engineering design process, and specific competencies needed for employment. The Technology Education program in Virginia addresses eight of the sixteen Career Clusters and 31 of their related Career Pathways. To summarize the employment data presented in this section:

1. Almost 124,000 students were enrolled in Virginia's secondary Technology Education courses during the 2015-2016 school year.

2. In Virginia alone, there are projected to be more than 1.2 million job openings by 2022 in Career Pathways associated with Technology Education.
3. Most of the Career Clusters covered by Virginia's Technology Education program (67 percent) have projected employment increases of 11 percent or higher by 2022.
4. All of the careers associated with Technology Education require a high school diploma and most require higher levels of education.

Careers in Technology Fields

Standards for Technological Literacy defines technological literacy as "the ability to use, manage, assess, and understand technology" (ITEA/ITEEA, 2000/2007, p. 7). In this context, it is clear that all 16 Career Clusters and their 79 related Career Pathways (NASDCTEc, 2015) each require a level of technological literacy because all occupations require varying uses of technological products, systems, and processes. An annotated listing of Career Clusters can be found in Appendix A and their related Career Pathways can be found in Appendix B. Virginia's Technology Education program focuses on eight Career Clusters and 31 related Career Pathways. Table 3 provides occupational estimates and projections for these areas as compiled by the Weldon Cooper Demographics Research Group from data supplied by the Virginia Employment Commission (VEC) and the U.S. Bureau of Labor Statistics (BLS).

Table 3: Virginia Occupational Estimates and Projections for Career Clusters and Pathways Addressed by Technology Education

Career Cluster	Career Pathway	Estimated 2014	Projected 2024	Percent Change	Annual Openings
Architecture and Construction	Construction	185,188	203,047	10%	4,542
	Design/Pre-Construction	29,609	31,412	6%	932
	Maintenance/Operations	66,309	72,015	9%	1,909
Arts, Audio/Video Technology & Communications	Audio and Video Technology and Film	No data – occupations assigned to other career pathways for projection purposes			
	Journalism and Broadcasting	17,140	18,289	7%	540
	Performing Arts	5,144	5,528	7%	201
	Printing Technology	7,268	6,564	-10%	116
	Telecommunications	11,462	11,100	-3%	180
	Visual Arts	13,733	14,587	6%	398

Note: The Trailblazers methodology for assigning occupations to career clusters and pathways changed this year. For projection purposes, each occupation is now matched with only one pathway instead of multiple pathways. For this reason, Trailblazers 2014-24 occupational employment projection data should not be compared to projection data from prior years.

Table 3: Virginia Occupational Estimates and Projections for Career Clusters and Pathways Addressed by Technology Education (Continued)

Career Cluster	Career Pathway	Estimated 2014	Projected 2024	Percent Change	Annual Openings
Government & Public Administration	National Security	1,805	1,730	-4%	25
	Planning	1,288	1,458	13%	41
	Public Management and Administration	6,402	7,098	11%	130
	Regulation	7,796	8,498	9%	260
	Revenue and Taxation	3,377	3,672	9%	123
Information Technology	Information Support and Services	32,087	35,367	10%	747
	Network Systems	51,654	59,903	16%	1,537
	Programming and Software Development	101,442	120,797	19%	3,557
	Web and Digital Communications	5,166	6,638	28%	213
Law, Public Safety, Corrections & Security	Emergency and Fire Management Services	18,866	21,902	16%	808
	Law Enforcement Services	26,328	29,111	11%	1,123
Manufacturing	Health, Safety and Environmental Assurance	No data – occupations assigned to other career pathways for projection purposes			
	Logistics and Inventory Control	No data – occupations assigned to other career pathways for projection purposes			
	Manufacturing Production Process Development	28,343	28,306	0%	728
	Production	145,779	141,815	-3%	3,558
	Quality Assurance	19,443	20,089	3%	579
Science, Technology, Engineering & Mathematics	Engineering and Technology	44,135	46,060	4%	1,368
	Science and Mathematics	23,188	25,235	9%	744
Transportation, Distribution & Logistics	Facility and Mobile Equipment Maintenance	54,717	59,680	9%	1,961
	Health, Safety and Environmental Management	No data – occupations assigned to other career pathways for projection purposes			
	Logistics Planning and Management Services	12,805	13,520	6%	316
	Transportation Systems/ Infrastructure Planning, Management and Regulation	No data – occupations assigned to other career pathways for projection purposes			
Total Employment		**920,474**	**993,421**	**8%**	**26,636**

Note: The Trailblazers methodology for assigning occupations to career clusters and pathways changed this year. For projection purposes, each occupation is now matched with only one pathway instead of multiple pathways. For this reason, Trailblazers 2014-24 occupational employment projection data should not be compared to projection data from prior years.

Occupations in the 31 Career Pathways represented approximately 1.1 million Virginia jobs in 2012 providing about 28 percent employment in the commonwealth. Employment projections for 2024 in these pathways show an overall 8 percent growth, with the highest growth in Web and Digital Communications (28 percent), Programming and Software Development (19 percent), Emergency and Fire Management Services (16 percent), and Network Systems (16 percent).

Appendix C contains a listing of Virginia's current Technology Education courses, enrollment for the 2015-2016 school year, and the associated Career Clusters for each course. There are 93 courses listed, but some courses may be offered for varying lengths of time. Virginia's Technology Education program contains 71 different courses that served almost 115,000 students during the 2015-2016 school year. As Appendix C illustrates, the broad focus on technology allows most of these students to experience multiple Career Clusters within their Technology Education coursework. This is particularly important for science, technology, engineering, and mathematics careers. The Virginia Technology Education program also offers Principles of Technology, which may be taken for a verified science credit, a design and technology course as part of the International Baccalaureate (IB) program, and the national pre-engineering program Project Lead the Way (PLTW).

Detailed statistics for each of the eight Career Clusters represented by Virginia's Technology Education program are in Appendix D. Seven of the eight Career Clusters have seen a steady increase in the number of credentials earned by students in the past four years. The one exception, Architecture and Construction, has remained consistent with approximately 2,500 students annually earning a credential.

Program completers in seven of these eight Career Clusters have earned standard and advanced studies diplomas at consistent or increasing rates over the past four years. Only Information Technology has seen a slight decrease in the number of program completers.

The data for in Appendix D is from the Virginia Employment Commission and include median wage, projected employment, and typical education needed for entry into a variety of occupations. It is important to note that all of the careers associated with Technology Education require a high school diploma and most require higher levels of education. Table 4 provides national data on high job openings (more than 10,000) related to six of the eight Technology Education Career Clusters and 12 of their related Career Pathways. The overlap with the state data reported in Appendices D-K indicate the Technology Education program is helping to prepare students for high-demand jobs in the commonwealth and the nation.

Table 4: High Employment Opportunities Nationwide

Cluster	Pathway	Occupation Title	Annual job openings, average
Architecture & Construction	Construction	Construction Laborers	48,910
		Carpenters	32,920
		Electricians	22,460
		First-Line Supervisors of Construction Trades and Extraction	18,710
		Construction Managers	15,460
		Operating Engineers and Other Construction Equipment Operators	14,440
		Plumbers, Pipefitters, and Steamfitters	13,050
		Painters, Construction and Maintenance	11,050
	Design/Pre-Construction	Civil Engineers	12,010
		Cost Estimators	11,800
	Maintenance/ Operations	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	12,370
Government & Public Administration	Public Management and Administration	Postal Service Mail Carriers	10,270
Information Technology	Information Support and Services	Computer User Support Specialists	19,690
	Network Systems	Network and Computer Systems Administrators	10,050
	Programming and Software Development	Software Developers, Applications	21,850
		Computer Systems Analysts	20,960
		Software Developers, Systems Software	13,470
		Computer Programmers	11,810
Manufacturing	Logistics and Inventory Control	Laborers and Freight, Stock, and Material Movers, Hand	92,250
		Shipping, Receiving, and Traffic Clerks	18,960
	Production	Team Assemblers	21,260
		Machinists	12,590
		Welders, Cutters, Solderers, and Brazers	10,850
		Helpers--Production Workers	10,220
	Quality Assurance	Inspectors, Testers, Sorters, Samplers, and Weighers	12,770
Science, Technology, Engineering & Mathematics	Engineering and Technology	Civil Engineers	12,010
Transportation, Distribution & Logistics	Facility and Mobile Equipment Maintenance	Automotive Service Technicians and Mechanics	23,760
		Cleaners of Vehicles and Equipment	12,630

Overview of Focus Group Discussions

In the fall of 2015, two focus group meetings were held with key stakeholders. The first group was composed of business and industry professionals who were engineers, managers, economic development specialists, and workforce specialists from postsecondary education. The second group was composed of educators from all levels, including the national president of the Technology Student Association (TSA) as well as technology teachers, CTE administrators, members of Virginia's Children's Engineering Council, university faculty, and members of the Virginia Technology and Engineering Education Association (VTEEA).

Both groups spent the first part of the day learning about Virginia's Technology Education program offerings and course enrollments, as well as the key historical and contemporary trends and issues discussed above. The majority of the day, however, was used to gather stakeholder comments on the following questions:

Big Picture Questions

- What do you believe are the most important technology and engineering career pathways for Virginia's economy now and in the future?
  - » What knowledge and skills will be needed in these careers?
  - » How do we prepare our students for these careers?
- What will the major challenges be in ensuring our students are ready for the jobs of the future?
  - » What educational mechanisms are currently in place to prepare students with the knowledge and skills needed for the top 10 technology/engineering career areas?
  - » What trends indicate which technology/engineering career pathways warrant the greatest attention over the next five or 10 years?

Specific Programmatic Questions

- After hearing about the curriculum overviews, to what extent does this curriculum address the content of the current/future careers and the level of rigor necessary to develop individuals prepared to enter those careers?
  - » Are there specific components that should be added now or in the future?
  - » What options might help to ensure that students in technology and engineering programs have equal opportunities and good choices to transition into college and careers?
- What industry-based certifications are valued in technology and engineering jobs?
  - » What other high-stakes, valid, nationally recognized credentials could be used to reinforce/confirm successful completion of Technology and Engineering Education programs?
  - » What are we currently doing to effectively prepare our students for these credentials?

    - How would you define technology and engineering literacy?
    - What knowledge and skills are needed to help students become technology and engineering literate?
    - What activities and experiences should students encounter to build their technology and engineering literacy?
- Discussion of industry-school partnerships—
    - What are some characteristics that define a successful industry-school partnership in technology and engineering?
    - Can you provide some examples you consider successful?
    - What does industry/do educators expect from these partnerships?
- Discussion of pre-service and in-service experiences for teachers—
    - What pre-service experiences would help prepare technology and engineering teachers?
    - What in-service experiences would help prepare technology and engineering teachers?
    - What should teachers zero in on in terms of design?
    - What should elementary school teachers be thinking about in terms of technology?

Technology Education in Transition

A significant amount of time for both focus groups centered on content for Virginia's Technology Education program. Participants felt strongly there should be continued focus on technological literacy, engineering, and the engineering design process as shown in Figure 2. There was significant discussion on keeping program content relevant in the face of rapid technological change and the ever-progressing needs in the workplace. Participants felt the curriculum revision schedule and DACUM process used by the Virginia Department of Education could help keep program content relevant. Additionally, some specific content areas were recommended by both focus groups. A continued focus on manufacturing was addressed, but participants claimed program content should be more reflective of advanced manufacturing techniques (e.g., quality control) and additive manufacturing (e.g., 3-D printing). Other specific content areas that were emphasized included computer science/programming, cybersecurity, robotics, and mechatronics.

As many of these programmatic strengths were discussed, it quickly became apparent that a sustained marketing effort could benefit students as well as other constituents. Key groups that were mentioned included principals, school counselors, parents, superintendents, school boards, legislators, business, industry, and Technology Education teachers, as well as teachers from other disciplines.

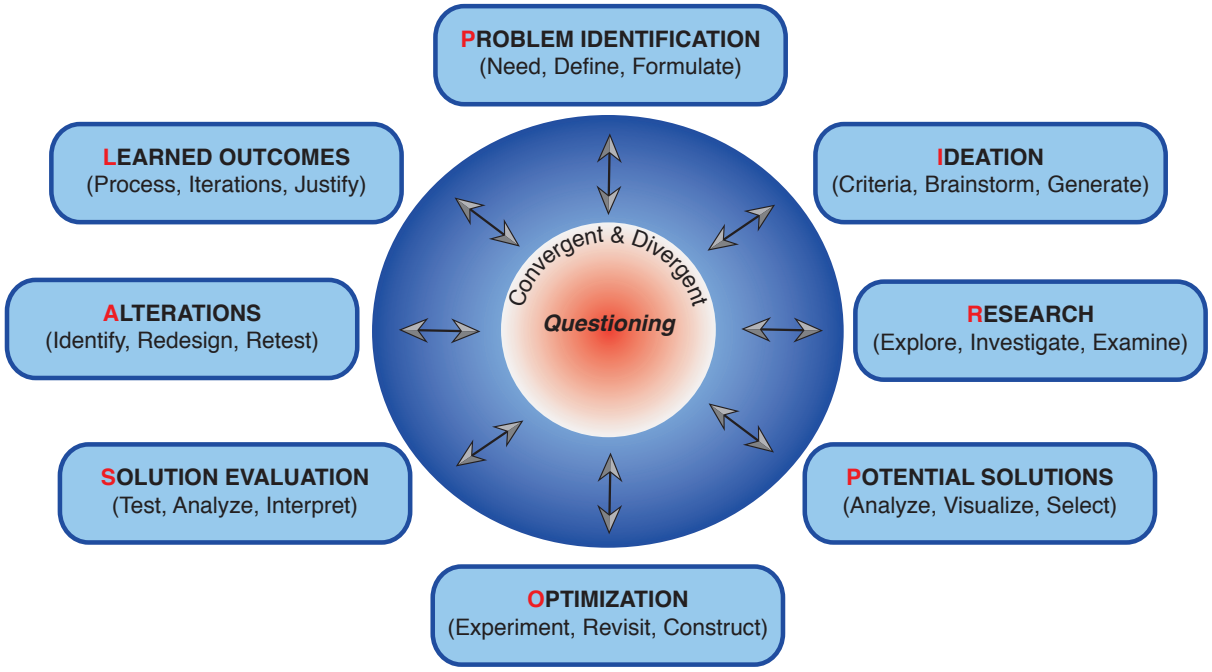


Figure 2. PIRPOSAL Model of Integrative STEM Education (Source: John G. Wells, 2015)

Teacher Preparation

The issue of teacher recruitment was stressed in both focus groups and even the industry partners were keenly aware of Virginia's critical shortage of Technology Education teachers.

Participants strongly encouraged new efforts to recruit and retain qualified teachers. Some focus group members, however, were cautious about career switchers and advocated for strong teacher professional development for all teachers. A great number of comments centered on training for current teachers to update their skills and program content. Specific examples included standardized training on the engineering design process as well as modeling integrative STEM lessons.

Collaboration with business, industry, and teachers from other disciplines (particularly mathematics and science) were encouraged as a way to keep content relevant and several participants recommended teacher externships with industry.

Student Preparation

Many participants stressed the importance of teaching students ways of thinking and acting in order to face emerging realities in the human designed world. For example, strong emphasis was placed on teaching problem solving, critical thinking, systems thinking, and the ability to break down and analyze complex systems and problems.

Career awareness and a continuation of the hands-on, active learning strategies used in Technology Education were seen as valuable across the program. Certifications and training, such as Lean Six Sigma, were seen as important, but many employers believe 21st century

skills such as communications are more valuable. For example, several business and industry representatives stressed the need for new employees to have a solid technological foundation, preparation in Virginia's Workplace Readiness Skills, and a willingness to work toward certifications and credentials once employed.

Both focus groups felt there should be a focus on integrative STEM with particular attention to the appropriate levels of mathematics and science in a given technological situation. Additionally, competitions and participation in the Technology Student Association (TSA) were seen as valuable to help students practice teamwork, communicate, and develop leadership skills.

Promoting Technology Careers

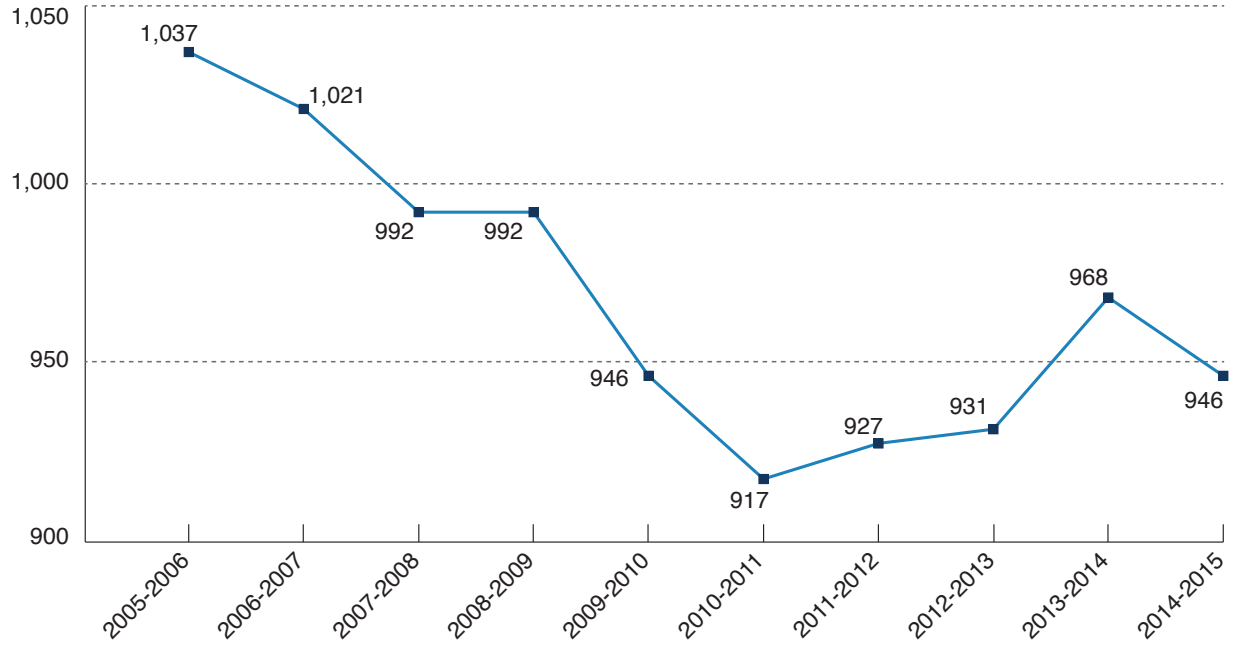
Focus group participants spent a considerable amount of time discussing the advantages of Virginia's Technology Education program. Examples included the use of laboratories, equipment, and materials to engage students in project-based learning. The lack of pacing guides was also seen as an advantage because it allows teachers to adjust instructional time as needed. Finally, participants believe technology teachers are in a key position when it comes to integrative STEM and skills that are not typically obtained in other disciplines (i.e., technological literacy, engineering design, and Workplace Readiness Skills). Integrative STEM is defined as "the application of technological/engineering-design-based pedagogical approaches to intentionally teach content and practices of science and mathematics education through the content and practices of technology/engineering education (adapted from Sanders and Wells.)"

Conclusions

This report provides essential data on the overall state of Virginia's Technology Education program. Several broad conclusions can be drawn to help maintain and advance this field in order to better aid students in their future education and career endeavors:

1. There is unprecedented support for technology and engineering education from prominent organizations such as the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the National Academies, and the National Assessment Governing Board.
2. The employment outlook for careers associated with technology and engineering education is very strong, both in the commonwealth and nationally.
3. Technology Education teachers are consistently listed on the critical shortage list in Virginia. Additionally, Figure 3 on page 14 shows a decline of Technology Education teachers in the past decade. This trend needs immediate attention, especially since it runs counter to conclusion 1.
4. Develop a comprehensive marketing plan for the Technology and Engineering Education program. The plan should identify key stakeholders, have multiple strategies, and have a clear timeline.
5. Outline a professional development plan for current teachers, teachers entering from industry, and career switchers. The plan should identify research-based practices, be grounded in the program offerings, and have a clear timeline.

Figure 3: Ten-year trend of technology teachers in Virginia



Source: Weldon Cooper Center, University of Virginia

Recommendations

The findings from this strategic review provide strong evidence to guide the long-term success of technology and engineering education in Virginia. Priority attention will be given to the following recommendations:

1. Change the official program name to Technology and Engineering Education. This is a more accurate reflection of the program's heritage as well as the program's contemporary focus on integrative STEM education and engineering design.

2. Update Virginia's Technology Education Program around five levels: grades PK-5, grades 6-8, grades 9-12, adult education, and professional development for teachers and other school personnel. Specifically:

    a. Develop formal support for elementary technology and engineering education. The Virginia Children's Engineering Council is nationally renowned, but curriculum, assessment, professional development, and other support should be developed through the Office of Career, Technical, and Adult Education.

    b. Continue to align nationally recognized curricula such as IB, PLTW, and Principles of Technology with Virginia's program of study. Expand the support of additional nationally recognized curriculum programs to aid with content consistency, student assessment, and the professional development of teachers. Consider joining the Engineering by Design (EbD) consortium. EbD provides all participating states with curriculum from the STEM Center for Teaching and Learning for all elementary grades, technology teachers, and

teacher professional development, as well as student assessment, and provides membership into a network of states, teachers, and students nationally.

c. Investigate the efficacy of low-enrolled courses (i.e., Biotechnology Foundations, Bioengineering, Global Logistics, and Enterprise Systems).

d. Broaden from narrow technical content at the upper level (i.e., Electronics II and III) toward broader technological courses that use a systems approach (i.e., robotics, mechatronics).

e. Focus on authentic approaches of design-based learning. Problems such as the NAE Grand Challenges for Engineering (National Academy of Engineering, 2015) should be used to provide real-world contexts for students.

f. Strengthen work-based learning experiences for students in grades 9-12.

g. Develop adult education for career switcher teachers and adults needing retraining in technology fields.

3. Increase teacher recruitment, preparation, and retention efforts. Provide scholarships for new teachers and grants for continuing professional development. Develop a pathway for school divisions to "grow-their-own" through division/community college/university partnerships that use Teachers for Tomorrow and distance learning. Finally, strengthen the recruitment and training of career switchers, targeting those with degrees in architecture, engineering, engineering technology, industrial design, industrial technology, and physics.

4. Maintain a cadre of Technology and Engineering Education leaders, which would work with the state Advisory Committee to provide continuous program guidance. Members should come from business and industry, the VTEEA, the Children's Engineering Council, CTE directors, the TSA, and teacher educators.

5. Promote the importance of careers and opportunities available through Technology and Engineering Education to ensure all Virginians are technologically literate.

6. Increase program completion rates through the use of Virtual Virginia. For example, Technology Foundations is one of the highest-enrolled high school courses, and Technology Assessment and/or Technology Transfer both have appropriate content that should be developed for online delivery.

7. Ensure all K-12 students develop a degree of technological literacy.

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Appendix A
National Career Clusters Framework

One of the keys to improving student achievement is providing students with relevant contexts for studying and learning. Career Clusters do exactly this by linking school-based learning with the knowledge and skills required for success in the workplace. The National Career Clusters Framework is comprised of 16 Career Clusters and related Career Pathways to help students of all ages explore different career options and better prepare for college and a career.

Each Career Cluster represents a distinct grouping of occupations and industries based on the knowledge and skills they require. The 16 Career Clusters and related Career Pathways provide an important organizing tool for schools to develop more effective programs of study and curriculum.

Agriculture, Food & Natural Resources

The production, processing, marketing, distribution, financing, and development of agricultural commodities and resources including food, fiber, wood products, natural resources, horticulture, and other plant and animal products/resources.

Architecture & Construction

Careers in designing, planning, managing, building, and maintaining the built environment.

Arts, A/V Technology & Communications

Designing, producing, exhibiting, performing, writing, and publishing multimedia content including visual and performing arts and design, journalism, and entertainment services.

Business Management & Administration

Careers in planning, organizing, directing, and evaluating business functions essential to efficient and productive business operations.

Education & Training

Planning, managing, and providing education and training services, and related learning support services such as administration, teaching/training, administrative support, and professional support services.

Finance

Planning and related services for financial and investment planning, banking, insurance, and business financial management.

Government & Public Administration

Planning and executing government functions at the local, state, and federal levels, including governance, national security, foreign service, planning, revenue and taxation, and regulations.

Health Science

Planning, managing, and providing therapeutic services, diagnostic services, health informatics, support services, and biotechnology research and development.

Hospitality & Tourism

Preparing individuals for employment in career pathways that relate to families and human needs such as restaurant and food/beverage services, lodging, travel and tourism, recreation, amusement, and attractions.

Human Services

Preparing individuals for employment in career pathways that relate to families and human needs such as counseling and mental health services, family and community services, personal care, and consumer services.

Information Technology

Building linkages in IT occupations for entry level, technical, and professional careers related to the design, development, support, and management of hardware, software, multimedia, and systems integration services.

Law, Public Safety, Corrections & Security

Planning, managing, and providing legal, public safety, protective services and homeland security, including professional and technical support services.

Manufacturing

Planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.

Marketing

Planning, managing, and performing marketing activities to reach organizational objectives such as brand management, professional sales, merchandising, marketing communications, and market research.

Science, Technology, Engineering & Mathematics

Planning, managing, and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.

Transportation, Distribution & Logistics

The planning, management, and movement of people, materials, and goods by road, pipeline, air, rail, and water and related professional and technical support services such as transportation infrastructure planning and management, logistics services, mobile equipment, and facility maintenance.

Appendix B
Science, Technology, Engineering, and Mathematics Career Cluster

Virginia Career, Technical and Adult Education is organized into the nationally recognized 16 Career Clusters. The Science, Technology, Engineering, and Mathematics Career Cluster is composed of two Career Pathways, described here.

Planning, managing, and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services.

Career Pathway

1. Engineering and Technology

For a future in the Engineering and Technology pathway, students should study and apply principles from advanced mathematics, life sciences, physical science, earth and space science, and technology. In addition, future engineers and technologists should learn certain processes in mathematics, science and technology. In Grades 9-12, all future engineers and technologists should study mathematics each year, learning important mathematical concepts and processes defined by the National Council of Teachers of Mathematics in Principles and Standards for School Mathematics. With such knowledge and skills, students will be able to demonstrate the following competencies: 1.) Apply mathematics, science, and technology concepts to solve problems quantitatively in engineering projects involving design, development, or production in various technologies; and 2.) Recognize the core concepts of technology and their relationships with engineering, science, math, and other subjects. All future engineers and technologists should learn important science concepts and processes with an understanding of physics, chemistry, and biology as a minimal set. These concepts and processes are defined by the National Research Council in the National Science Education Standards and by the American Association for the Advancement of Science in Benchmarks for Science Literacy. Additionally, learners should become proficient in the areas of technology defined by the Standards for Technological Literacy.

2. Science and Mathematics

Those who choose careers in the Science and Mathematics pathway apply essential mathematics and science content and skills in a real world context science and mathematics occupations include those in physical, environmental, and human endeavors. Career possibilities range from teachers of science and mathematics to lab technicians to NASA astronauts. Preparation for such occupations require the following: 1) Understanding the process and applying the skills necessary to engage in discovery; 2) Recognizing the need to obtain a broad education in science and mathematics and share (communicate) this knowledge with the world; and 3) Understanding the role of gathering, creating, processing, and sharing data in science and mathematics.

Appendix C
Technology Education Courses Offered in Virginia Schools

Course Code	**Current Technology Education Courses** offered by the Virginia Department of Education's Office of Career, Technical and Adult Education. Courses have been aligned to the Career Clusters associated with the Technology Education Program.	2015-16	2014-15	Architecture and Construction	Arts, Audio/Video Technology & Communications	Government & Public Administration	Information Technology	Law, Public Safety, Corrections & Security	Manufacturing	Science, Technology, Engineering & Mathematics	Transportation, Distribution & Logistics
Middle School Courses											
8484	Introduction to Technology – 12 Weeks	1,527	2,685	●	●		●		●	●	●
8482	Introduction to Technology – 18 Weeks	5,578	5,406	●	●		●		●	●	●
8483	Introduction to Technology – 36 Weeks	277	179	●	●		●		●	●	●
8480	Introduction to Technology – 6 Weeks	11,464	11,427	●	●		●		●	●	●
8481	Introduction to Technology – 9 Weeks	15,670	13,012	●	●		●		●	●	●
8485	Inventions and Innovations – 12 Weeks	857	1,097			●		●	●	●	
8464	Inventions and Innovations – 18 Weeks	17,109	16,170			●		●	●	●	
8461	Inventions and Innovations – 36 Weeks	137	404			●		●	●	●	
8456	Inventions and Innovations – 6 Weeks	4,319	4,825			●		●	●	●	
8454	Inventions and Innovations – 9 Weeks	3,967	4,028			●		●	●	●	
8486	Technological Systems – 12 Weeks	598	1,654	●	●	●	●		●	●	●
8463	Technological Systems – 18 Weeks	7,822	7,448	●	●	●	●		●	●	●
8462	Technological Systems – 36 Weeks	1,480	1,903	●	●	●	●		●	●	●
8477	Technological Systems – 6 Weeks	1,936	3,480	●	●	●	●		●	●	●
8457	Technological Systems – 9 Weeks	2,128	786	●	●	●	●		●	●	●
High School Courses											
8438	Advanced Drawing and Design	576	858	●	●	●			●	●	
8427	Advanced Manufacturing Systems II	365	170						●	●	
8428	Aerospace Engineering (PLTW)	72	65							●	●
8487	Aerospace Technology I	419	375							●	●
8488	Aerospace Technology II	142	31							●	●
8492	Architectural Drawing and Design – 18 Weeks	191	146	●		●				●	

Course Code	**Current Technology Education Courses** offered by the Virginia Department of Education's Office of Career, Technical and Adult Education. Courses have been aligned to the Career Clusters associated with the Technology Education Program.	2015-16	2014-15	Architecture and Construction	Arts, Audio/Video Technology & Communications	Government & Public Administration	Information Technology	Law, Public Safety, Corrections & Security	Manufacturing	Science, Technology, Engineering & Mathematics	Transportation, Distribution & Logistics
8437	Architectural Drawing and Design – 36 Weeks	1,618	1,513	●		●				●	
8467	Bioengineering	16	15							●	
8468	Biotechnology Foundations	0	0							●	
8430	Civil Engineering and Architecture (PLTW)	219	137			●				●	
8418	Communication Systems – 18 Weeks	2,295	2,114		●					●	
8415	Communication Systems – 36 Weeks	972	1,052		●					●	
8442	Computer Integrated Manufacturing (PLTW)	49	135						●	●	
8431	Construction Technology – 36 Weeks	2,764	2,047	●		●				●	
8432	Construction Technology – 18 Weeks	169	234	●		●				●	
8440	Digital Electronics – PLTW	313	334							●	
8459	Digital Visualization	1,060	807		●						
8417	Electronics Systems I – 18 Weeks	172	218						●	●	
8416	Electronics Systems I – 36 Weeks	1,005	939						●	●	
8412	Electronics Systems II	352	365						●	●	
8413	Electronics Systems III	122	81						●	●	
8448	Energy and Power – 36 Weeks	53	12						●	●	●
8495	Energy and Power – 18 Weeks	7	261						●	●	●
8436	Engineering Drawing and Design – 36 Weeks	1,704	1,207	●	●	●			●	●	
8493	Engineering Drawing and Design – 18 Weeks	291	628	●	●	●			●	●	
8451	Engineering Analysis and Applications II	592	436	●		●	●		●	●	●
8452	Engineering Concepts and Processes III	89	31	●		●	●		●	●	
8443	Engineering Design and Development (PLTW)	248	199	●		●	●		●	●	●
8450	Engineering Explorations I	3,559	3,360	●	●	●	●		●	●	●
8453	Engineering Practicum IV	554	461							●	
8491	Engineering Studies	482	494	●	●	●	●		●	●	●
8409	Forensic Technology	39	20					●		●	
8423	Geospatial Technology I	234	284				●			●	●

Course Code	**Current Technology Education Courses** offered by the Virginia Department of Education's Office of Career, Technical and Adult Education. Courses have been aligned to the Career Clusters associated with the Technology Education Program.	2015-16	2014-15	Architecture and Construction	Arts, Audio/Video Technology & Communications	Government & Public Administration	Information Technology	Law, Public Safety, Corrections & Security	Manufacturing	Science, Technology, Engineering & Mathematics	Transportation, Distribution & Logistics
8424	Geospatial Technology II	70	36				●			●	●
8419	Global Logistics and Enterprise Systems I	9	7				●			●	●
8458	Graphic Communication Systems	948	880		●					●	
8494	Graphic Communication Systems – 18 Weeks	615	638		●					●	
IB4585	International Baccalaureate (IB) Design Technology I	122	128	●	●		●		●	●	●
IB4585	International Baccalaureate (IB) Design Technology I	16	0	●	●		●		●	●	●
8455	Imaging Technology – 36 weeks	1,364	1,241		●		●			●	
8474	Imaging Technology – 18 weeks	597	836		●		●			●	
8439	Introduction to Engineering Design – PLTW	2,459	1,956	●	●		●		●	●	●
8426	Manufacturing Systems I – 18 Weeks	191	264						●	●	
8425	Manufacturing Systems I – 36 Weeks	1,198	1,080						●	●	
8478	Materials and Processes Technology – 18 Weeks	683	840						●	●	
8433	Materials and Processes Technology – 36 Weeks	1,713	1,147						●	●	
8460	Modeling and Simulation Technology	277	219		●		●		●	●	
8444	Power and Transportation – 18 Weeks	29	394							●	●
8445	Power and Transportation – 36 Weeks	320	26							●	●
8441	Principles of Engineering (PLTW)	929	1,038							●	
9811	Principles of Technology I	723	546							●	
9812	Principles of Technology II	522	398							●	
8446	Production Systems – 18 Weeks	196	144						●	●	
8447	Production Systems – 36 Weeks	471	1,094						●	●	
8408	Renewable Energy	0	4	●						●	
8414	Sustainability and Renewable Technologies	283	179	●						●	
8434	Technical Drawing and Design – 18 Weeks	566	627	●	●	●			●	●	
8435	Technical Drawing and Design – 36 Weeks	6,452	6,144	●	●	●			●	●	

Course Code	**Current Technology Education Courses** offered by the Virginia Department of Education's Office of Career, Technical and Adult Education. Courses have been aligned to the Career Clusters associated with the Technology Education Program.	2015-16	2014-15	Architecture and Construction	Arts, Audio/Video Technology & Communications	Government & Public Administration	Information Technology	Law, Public Safety, Corrections & Security	Manufacturing	Science, Technology, Engineering & Mathematics	Transportation, Distribution & Logistics
8407	Technology Assessment – 36 Weeks	75	70	●	●	●	●	●	●	●	●
8406	Technology Assessment – 18 Weeks	0	0	●	●	●	●	●	●	●	●
8471	Technology Education – Development	1	37							●	
8469	Technology Education – Preparation	0	15							●	
8402	Technology Foundations – 18 Weeks	875	921	●	●	●	●	●	●	●	●
8403	Technology Foundations – 36 Weeks	3,371	3,410	●	●	●	●	●	●	●	●
8420	Technology of Robotic Design – 18 Weeks	232	58						●	●	●
8421	Technology of Robotic Design – 36 Weeks	1,032	703						●	●	●
8404	Technology Transfer – 18 Weeks	36	49	●	●	●	●	●	●	●	●
8405	Technology Transfer – 36 Weeks	754	653	●	●	●	●	●	●	●	●
8497	Video and Media Technology	717	705		●					●	
	Totals	**123,770**	**120,147**								

Appendix D: Career Cluster Data Snapshots

Appendix D: Career Cluster Data Snapshot
Agriculture, Food & Natural Resources

The ***Agriculture, Food, and Natural Resources Career Cluster*** prepares you for careers that involve the science and mechanics of improving the quality and safety of food, cultivating and preserving our natural resources and caring for livestock and other animals.

Careers in conservation, including reducing the use of chemical fertilizers and pesticides, soil and water conservation, sustainable forestry and wildlife are some options in this diverse cluster. Additionally, you can learn about the business aspects involved in this broad field.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Landscaping and Groundskeeping Workers	$24,010	36,600	High school	26,060
Farmworkers and Laborers, Crops	$22,590	20,130	High school	830
Landscaping Supervisors	$40,790	7,368	High school and work experience	2,810
Veterinary Assistants	$25,760	4,611	Some college/associate degree	3,080
Environmental Scientists and Specialists	$74,230	3,899	Bachelor's or more	3,110
Farmworkers, Animals	$25,800	3,662	High school	810
Water Treatment Plant Operators	$39,040	3,615	High school and training/certification	3,200
Veterinarians	$91,980	3,254	Bachelor's or more	2,190
Environmental Engineers	$98,620	2,926	Bachelor's or more	2,030
Veterinary Technologists and Technicians	$36,420	2,230	Some college/associate degree	1,710
Farming, Fishing, and Forestry Supervisors	$46,140	1,849	High school and work experience	470
Biological Technicians	$40,220	1,329	Bachelor's or more	2,090
Natural Sciences Managers	$126,970	1,305	Bachelor's or more and work experience	1,310
Environmental Science Technicians	$44,050	807	Bachelor's or more and training/ certification	540
Geoscientists	$91,220	616	Bachelor's or more	460
Environmental Engineering Technicians	$43,020	537	Some college/associate degree	460
Conservation Scientists	$59,100	491	Bachelor's or more	430
Forest and Conservation Technicians	$36,370	379	Bachelor's or more	270
Agricultural and Food Science Technicians	$35,270	226	Bachelor's or more	160
Soil and Plant Scientists	$58,480	192	Bachelor's or more	100

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Architecture and Construction

The ***Architecture and Construction Career Cluster*** prepares you for careers that allow you to design, plan, manage, build, and maintain structures such as buildings, homes, and bridges or machinery. People employed in this cluster work on new structures, restorations, additions, alterations, and repairs.

In the next few years, many new jobs will be added and employment opportunities will rise as experienced workers retire. Highly-skilled workers who earn specializations and certification of accreditation are in great demand as this field continues to advance and become more competitive.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Carpenters	$38,070	30,671	High school and training/certification	17,420
Construction Supervisors	$58,110	26,162	High school and work experience	17,650
Electricians	$46,380	21,583	High school and training/certification	16,750
Plumbers, Pipefitters, and Steamfitters	$43,740	15,122	High school and training/certification	11,060
Construction Managers	$93,330	13,929	High school and work experience	5,360
Construction Equipment Operators	$37,210	11,386	High school and training/certification	9,960
Heating, Air Conditioning, and Refrigeration Mechanics	$45,720	10,809	High school and training/certification	9,610
Civil Engineers	$79,760	10,495	Bachelor's or more	8,060
Cost Estimators	$60,390	9,798	Some college/associate degree	8,470
Sheet Metal Workers	$41,310	6,198	High school and training/certification	4,230
Cement Masons and Concrete Finishers	$39,940	5,650	High school and training/certification	4,600
Architects	$76,640	3,984	Bachelor's or more and training/ certification	2,650
Brickmasons and Blockmasons	$43,180	3,882	High school and training/certification	2,340
Electrical Power-Line Installers/ Repairers	$59,440	3,209	High school and training/certification	2,300
Civil Engineering Technicians	$41,460	2,959	Some college/associate degree	2,320
Strucutral Iron and Steel Workers	$42,770	2,287	High school and training/certification	1,420
Interior Designers	$51,890	1,605	Bachelor's or more and training/ certification	990
Surveyors	$51,340	1,538	Bachelor's or more	1,410
Architectural and Civil Drafters	$48,400	1,452	Some college/associate degree	1,760
Landscape Architects	$69,360	913	Bachelor's or more and training/ certification	750

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Arts, Audio/Video Technology and Communications

The ***Arts, Audio/Video Technology and Communications Career Cluster*** allows you to apply your creativity in a variety of different areas.

People in this field will need excellent communication skills that will allow them to work both in the spotlight and behind the scenes. This industry allows you to learn about advanced technologies used in venues ranging from corporate boardrooms, hotels, and convention centers, to classrooms, theme parks, stadiums, and museums.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Graphic Designers	$50,320	7,744	Bachelor's or more	5,820
Telecommunications Line Installers	$63,760	6,290	Some college/associate degree and training/certification	7,360
Printing Press Operators	$34,250	6,189	High school and training/certification	4,660
Telecommunications Equipment Installers	$61,190	5,284	Some college/associate degree and training/certification	3,990
Writers and Authors	$63,090	4,210	Bachelor's or more and training/ certification	1,240
Editors	$58,930	4,063	Bachelor's or more and work experience	3,280
Technical Writers	$72,620	3,832	Bachelor's or more and work experience	2,740
Photographers	$34,800	3,485	Bachelor's or more and training/ certification	970
Print Binding and Finishing Workers	$28,370	1,948	High school	1,000
Audio and Video Equipment Technicians	$36,360	1,754	Some college/associate degree and training/certification	1,140
Art Directors	$84,130	1,603	Bachelor's or more and work experience	740
Broadcast Technicians	$33,970	1,430	Some college/associate degree	670
Multimedia Artists and Animators	$58,380	1,331	Bachelor's or more and training/ certification	410
Prepress Technicians and Workers	$38,300	904	High school	870
Reporters and Correspondents	$42,860	604	Bachelor's or more	**
Commercial and Industrial Designers	$46,410	604	Bachelor's or more	490
Desktop Publishers	$40,540	531	Some college/associate degree	360
Film and Video Editors	$52,200	400	Bachelor's or more and work experience	250
Proofreaders and Copy Markers	$38,790	388	Bachelor's or more and training/ certification	290

**2014 employment data unavailable from the Bureau of Labor Statistics

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Business Management and Administration

The ***Business Management and Administration Career Cluster*** prepares you for careers in which you plan, organize, direct, and evaluate operations in order to run a successful business.

There are a variety of career opportunities available that require skills in organization, time management, customer service and communication. As technology becomes more advanced and businesses begin to expand globally, international expertise will be a valuable skill for individuals in this field.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Office Clerks	$29,600	96,004	Some college/associate degree	86,540
Management Analysts	$93,340	65,224	Bachelor's or more and work experience	45,220
General and Operations Managers	$116,350	63,704	Bachelor's or more and work experience	50,070
Customer Service Representatives	$31,230	57,853	Some college/associate degree	57,100
Bookkeeping Clerks	$36,860	57,349	Some college/associate degree and training/certifcation	41,600
Supervisors of Office Workers	$51,170	46,207	Some college/associate degree and work experience	41,470
Secretaries and Administrative Assistants	$53,060	42,901	Some college/associate degree	40,660
Receptionists	$26,910	36,486	High school	30,160
Executive Secretaries and Assistants	$53,060	21,573	Some college/associate degree and work experience	17,200
Shipping, Receiving and Traffic Clerks	$30,190	14,782	High school	11,870
Training and Development Specialists	$63,400	12,548	Bachelor's or more	9,920
Operations Research Analysts	$101,930	6,546	Bachelor's or more	5,500
Administrative Services Managers	$87,930	5,472	Some college/associate degree and work experience	4,320
Human Resources Assistants	$37,750	4,319	Some college/associate degree	4,130
Payroll and Timekeeping Clerks	$41,330	4,276	Some college/associate degree and training/certification	3,540
File Clerks	$26,500	3,446	Some college/associate degree	2,850
Human Resources Managers	$119,390	3,405	Bachelor's or more and work experience	3,130
Compensation and Job Analysis Specialists	$60,610	2,725	Bachelor's or more	2,300
Procurement Clerks	$42,190	2,292	Some college/associate degree and training/certification	1,930
Training and Development Managers	$190,570	1,342	Bachelor's or more and work experience	1,110

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Education and Training

The ***Education and Training Career Cluster*** prepares you for careers to provide education and training services that serve individuals across a range of industries. With a greater need to reach children with learning differences, obtaining specialization in Special Education will help distinguish students in the marketplace.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Elementary Teachers, except Special Education	$56,690	41,569	Bachelor's or more and training/ certification	36,040
Teacher Assistants	$23,680	33,286	Some college/associate degree	31,000
Secondary Teachers, except Special Education, CTE	$57,780	25,476	Bachelor's or more and training/ certification	23,920
Middle School Teachers, except Special Education, CTE	$55,800	19,066	Bachelor's or more and training/ certification	16,860
Preschool Teachers, except Special Education	$31,780	10,396	Bachelor's or more	9,760
Coaches and Scouts	$30,630	8,283	Bachelor's or more and training/ certification	7,840
School Counselors	$54,920	7,656	Bachelor's or more	6,720
Education Administrators, Elementary/ Secondary	$86,300	7,208	Bachelor's or more and work experience	6,490
Self-Enrichment Education Teachers	$38,280	7,042	Bachelor's or more and training/ certification	4,400
Librarians	$58,620	5,237	Bachelor's or more	4,310
Kindergarten Teachers, except Special Education	$55,640	4,853	Bachelor's or more and training/ certification	4,570
Instructional Coordinators	$66,960	4,726	Bachelor's or more and work experience	3,640
Special Education Teachers, Secondary	$55,780	4,159	Bachelor's or more and training/ certification	3,480
CTE Teachers, Secondary	$56,810	3,884	Bachelor's or more and training/ certification	2,360
Adult Basic Education Teachers	$54,400	3,376	Bachelor's or more and training/ certification	1,650
Special Education Teachers, Middle	$57,050	3,292	Bachelor's or more and training/ certification	2,660
Education Administrators, Postsecondary	$87,370	3,056	Bachelor's or more and work experience	2,640
Library Technicians	$31,090	2,861	High school	2,690
Education Administrators, Preschool/ Childcare	$49,190	1,187	Bachelor's or more and work experience	940

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Finance

The ***Finance Career Cluster*** prepares you for careers in financial and investment planning, banking, insurance, and business financial management. Every sector of the economy offers a job in this career. Many career opportunities require specialized skills in organization, time management, customer service, and communication. An increase in the number of retired baby boomers will continue to open employment opportunities in the banking industry.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Accountants and Auditors	$72,280	48,788	Bachelor's or more	39,290
Financial Managers	$128,830	16,141	Bachelor's or more and work experience	12,630
Tellers	$27,950	13,258	Some college/associate degree	12,650
Financial Analysts	$85,830	11,354	Bachelor's or more	8,340
Insurance Sales Agents	$43,350	11,099	Bachelor's or more and training/ certification	9,590
Bill and Account Collectors	$33,630	10,414	Some college/associate degree and training/certification	8,940
Loan Officers	$64,640	7,740	Bachelor's or more and training/ certification	7,730
Personal Financial Advisors	$81,960	6,910	Bachelor's or more	4,360
Financial Services Sales Agents	$65,650	6,247	Bachelor's or more and training/ certification	4,530
Loan Interviewers and Clerks	$37,750	5,615	Some college/associate degree	6,660
Insurance Clerks	$33,340	5,314	Some college/associate degree and training/certification	6,570
Claims Adjusters and Investigators	$61,340	4,362	Bachelor's or more and training/ certification	4,760
Budget Analysts	$82,340	3,524	Bachelor's or more	3,480
Tax Preparers	$34,120	3,097	Bachelor's or more and training/ certification	1,950
Credit Analysts	$70,990	1,791	Bachelor's or more	2,010
Brokerage Clerks	$42,340	1,526	Some college/associate degree and training/certification	820
Credit Authorizers	$28,950	925	Some college/associate degree	2,230
Insurance Appraisers, Auto Damage	$61,820	210	Bachelor's or more and training/ certification	550
Actuaries	*	**	Bachelor's or more and training/ certification	200

* 2014 wage data unavailable from the Bureau of Labor Statistics

**2022 projections suppressed by the Virginia Employment Commission

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Government and Public Administration

The ***Government and Public Administration Career Cluster*** prepares you for the diverse jobs within our government. Virtually every occupation can be found within this field. You may help our nation defend against foreign aggression, represent our interests abroad, or pass and enforce local laws.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Interpreters and Translators	$64,440	8,134	Bachelor's or more and training/ certification	1,990
Compliance Officers	$65,170	7,616	Bachelor's or more and training/ certification	7,150
Postal Service Mail Carriers	$55,510	5,674	Some college/associate degree	7,620
Eligibility Interviewers	$38,020	4,263	Some college/associate degree and training/certification	3,570
Construction and Building Inspectors	$55,130	3,808	Some college/associate degree, training/ certification, and work experience	3,360
Tax Preparers	$34,120	3,097	Bachelor's or more and training/ certification	1,950
Court, Municipal, and License Clerks	$32,930	2,448	Some college/associate degree and training/certification	2,030
Occupational Health and Safety Specialists	$62,310	2,445	Bachelor's or more and training/ certification	2,490
Transportation Security Screeners	$37,680	2,254	High school and training/certification	1,700
Tax Examiners and Collectors	$46,300	1,866	Bachelor's or more and training/ certification	1,480
Appraisers and Assessors of Real Estate	$55,020	1,864	Bachelor's or more and training/ certification	1,370
Financial Examiners	$80,210	1,667	Bachelor's or more and training/ certification	1,390
Urban and Regional Planners	$66,900	1,599	Bachelor's or more	1,270
Postal Service Clerks	$55,590	1,378	Some college/associate degree	2,050
Legislators	$18,650	861	Bachelor's or more and work experience	700
Postmasters and Mail Superintendents	$64,950	518	Some college/associate degree, training/ certification, and work experience	510
Transportation Inspectors	$71,240	436	Some college/associate degree	710
Occupational Health and Safety Technicians	$47,930	391	Bachelor's or more and training/ certification	350

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Health Science

The ***Health Science Career Cluster*** prepares you to help keep people healthy and treat those who are not. Individuals work with people by conducting research on diseases and other important health information. As the medical and health science fields continue to advance with technology, new job opportunities will emerge. Many careers will require high-skilled applicants with experience in healthcare and business management. Also, an aging population and increased competition will increase demand for new and improved medications and will create more jobs.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Registered Nurses	$62,610	66,990	Bachelor's or more	62,700
Licenses Practical Nurses	$39,490	27,715	Some college/associate degree	21,300
Home Health Aides	$21,090	15,248	High school	9,710
Medical Assistants	$30,300	14,625	Some college/associate degree and training/certificate	10,680
Dental Assistants	$35,700	11,612	Some college/associate degree	8,530
Pharmacy Technicians	$27,620	10,629	Some college/associate degree and training/certificate	8,610
Pharmacists	$123,170	8,242	Bachelor's or more and training/ certification	7,020
Medical and Health Services Managers	$92,520	8,187	Bachelor's or more	6,570
Physical Therapists	$83,720	7,593	Bachelor's or more	4,730
EMTs and Paramedics	$30,640	6,564	Some college/associate degree	5,080
Dental Hygienists	$80,780	6,356	Some college/associate degree	4,290
Medical Laboratory Technicians	$36,990	5,260	Bachelor's or more	3,850
Medical Laboratory Technologists	$55,420	4,952	Bachelor's or more	4,220
Medical Records Technicians	$35,720	4,488	Some college/associate degree	3,810
Dentists	$139,580	4,433	Bachelor's or more and training/ certification	2,910
Psychiatric Technicians	$26,200	4,318	Some college/associate degree	4,370
Speech-Language Pathologists	$74,220	3,594	Bachelor's or more	2,920
Occupational Therapists	$85,200	3,292	Bachelor's or more	2,400
Physician Assistants	$87,920	3,097	Bachelor's or more and training/ certification	2,404
Physical Therapist Assistants	$54,530	2,945	Some college/associate degree	2,060
Respiratory Therapists	$57,500	2,538	Bachelor's or more	2,420

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Hospitality and Tourism

The ***Hospitality and Tourism Career Cluster*** prepares you for careers that allow you to travel and work with a variety of people. Careers can be found all over the world and range anywhere from hotel and restaurant operations to working in amusement parks and other tourist destinations. Excellent customer service skills are essential for everyone in this field.

Due to fluctuations within the economy, the need and desire for travel, recreation, and leisure activities shift. Higher degrees and excellent customer service skills with food service plus experience within upscale luxury hotels will provide the best job opportunities.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Cooks, Restaurant	$22,650	33,803	High school and training/certification and work experience	29,740
Supervisors of Food Service Workers	$32,030	28,210	High school and work experience	24,720
Recreation Workers	$23,670	14,830	Bachelor's or more	10,030
Hosts and Hostesses, Restaurant/ Related	$18,440	11,242	High school	11,180
Supervisors of Housekeeping Workers	$34,650	10,068	High school and work experience	5,920
Bartenders	$28,140	9,786	Some college/associate degree	9,430
Cooks, Institution and Cafeteria	$24,280	9,618	High school	7,010
Cooks, Fast Food	$17,940	8,094	High school	9,500
Hotel, Motel, and Resort Desk Clerks	$20,230	7,077	High school	7,350
Amusement and Recreation Attendants	$18,330	6,779	High school	6,010
Meeting, Convention, and Event Planners	$54,510	6,058	Bachelor's or more and work experience	3,560
Food Service Managers	$57,380	5,269	High school and work experience	4,210
Bakers	$25,090	3,203	High school and training/certification	2,570
Chefs and Head Cooks	$37,960	3,083	High school and work experience	2,930
Tour Guides and Escorts	$22,920	1,917	Bachelor's or more and training/ certification	1,460
Travel Agents	$42,530	1,648	Some college/associate degree and training/certification	1,730
Lodging Managers	$72,320	1,462	Bachelor's or more and work experience	**
Concierges	$29,840	1,595	High school and training/certification	1,870

**2014 employment data unavailable from the Bureau of Labor Statistics

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Human Services

The ***Human Services Career Cluster*** prepares you for jobs in which you help families and individuals with life services. This diverse career cluster requires individuals to have superior communication and problem-solving skills to provide various levels of support. Jobs will be easier to find within urban as opposed to rural environments.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Personal Care Aides	$18,530	51,224	High school	36,260
Childcare Workers	$19,030	33,981	High school	14,920
Hairstylists	$29,230	24,212	High school	11,400
Fitness Trainers and Aerobics Instructors	$41,230	10,343	Bachelor's or more	9,190
Mental Health Counselors	$43,150	9,832	Bachelor's or more and training/ certification	8,060
Child, Family, and School Social Workers	$43,640	9,373	Bachelor's or more	8,050
Supervisors of Personal Service Workers	$34,870	8,120	Some college/assoc. degree and work exp.	4,870
Human Service Assistants	$29,300	7,574	Bachelor's or more	6,090
Rehabilitation Counselors	$38,800	4,946	Bachelor's or more	3,360
Massage Therapists	$37,200	4,731	Some college/associate degree	2,240
Mental Health and Substance Abuse Social Workers	$44,830	3,868	Bachelor's or more	3,400
Healthcare Social Workers	$52,180	3,381	Bachelor's or more	2,370
Substance Abuse and Behavioral Disorder Counselors	$41,260	2,979	Bachelor's or more and training/ certification	2.070
Residential Advisors	$27,450	2,807	Some college/assoc. degree and work exp.	2,370
Marriage and Familiy Therapists	$45,330	2,421	Bachelor's or more and training/ certification	1,410
Skincare Specialists	$38,640	1,813	High school	840
Tailors, Dressmakers, and Custom Sewers	$24,590	1,786	High school and training/certification	670
Health Educators	$51,980	1,333	Bachelor's or more	1,080
Clergy	$42,070	1,189	Bachelor's or more and training/ certification	890
Directors, Religious Activities & Education	$45,840	*	Bachelor's or more and work experience	380

*2022 projections suppressed by the Virginia Employment Commission

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Information Technology

The ***Information Technology Career Cluster*** gives you the opportunity to design, develop, and manage different types of software programs and hardware. This field requires a solid foundation in mathematics and science as well as high technical skills. Information technology workers can be found in every sector of the economy, providing assistance at a multitude of levels. As technology advances across the globe, it is important to have individuals who understand and can support the new technological demands.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Software Developers, Applications	$102,550	43,914	Bachelor's or more	36,840
Software Developers, Systems Software	$107,000	41,871	Bachelor's or more	26,310
Computer Systems Analysis	$94,080	40,198	Bachelor's or more	27,130
Network and Computer Systems Admin.	$87,280	24,272	Bachelor's or more	19,760
Computer Support Specialists	$51,460	23,o48	Bachelor's or more	20,540
Computer Programmers	$86,800	11,531	Bachelor's or more	8,850
Computer Occupations, All Other	$98,920	9,930	Bachelor's or more	10,750
Database Administrators	$91,410	7,764	Bachelor's or more and work experience	5,450
Technical Writers	$72,620	3,832	Bachelor's or more and work experience	2,740
Computer/Informatin Research Scientists	$116,440	2,219	Bachelor's or more	1,750
Computer Hardware Engineers	$116,130	2,320	Bachelor's or more	1,210
Multimedia Artists and Animators	$58,380	1,331	Bachelor's or more and training/ certification	410

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Law, Public Safety, Corrections and Security

The ***Law, Public Safety, Corrections and Security Career Cluster*** prepares you for service in public safety and security. Responsibilities include prevention of and protection from harm such as crime or natural disasters. Positions in state and federal agencies will be more competitive, requiring some type of college degree or gain military experience.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Security Guards	$27,230	40,712	High school	32,240
Lawyers	$117,800	23,029	Bachelor's or more	17,090
Police and Sheriff's Patrol Officers	$48,490	20,636	Some college/associate degree and training/certification	18,270
Correctional Officers and Jailers	$35,870	20,587	Some college/associate degree and training/certification	15,500
Paralegals and Legal Assistants	$49,070	10,708	Some college/associate degree	8,580
Firefighters	$44,700	9,856	Some college/associate degree and training/certification	8,910
EMTs and Paramedics	$30,640	6,564	Some college/associate degree	5,080
Detectives and Criminal Investigators	$83,550	3,943	Bachelor's or more and training/ certification and work experience	3,580
Police, Fire, and Ambulance Dispatchers	$35,670	3,548	Some college/associate degree and training/certification	2,960
Legal Secretaries	$40,130	3,474	Some college/associate degree and training/certification	3,080
Probation Officers	$43,080	3,160	Bachelor's or more	2,820
Supervisors of Correctional Officers	$46,000	2,835	Some college/associate degree, training/ certification and work experience	2,300
Supervisors of Police and Detectives	$80,070	2,753	Some college/associate degree, training/ certification and work experience	2,550
Supervisors of Fire Fighting Workers	$68,620	1,866	Some college/associate degree and work experience	1,720
Private Detectives and Investigators	$46,630	992	Bachelor's or more and training/ certification and work experience	*
Animal Control Workers	$34,600	520	High school and training/certification	430
Judicial Law Clerks	$45,500	176	Some college/associate degree	130
Forensic Science Technicians	$65,920	405	Bachelor's or more and training/ certification	620
Fish and Game Wardens	$43,910	282	Bachelor's or more	230
Court Reporters	$42,880	275	Some college/associate degree	*

* 2014 employment data unavailable from the Bureau of Labor Statistics

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot Manufacturing

The ***Manufacturing Career Cluster*** prepares you for careers in planning, managing, and performing the processing of materials into intermediate or final products. Careers also include related professional and technical support activities such as production planning and control, maintenance and manufacturing/process engineering. Careers related to quality, logistics and safety, and environmental assurance will continue to grow as these issues gain importance to the public.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Maintenance and Repair Workers	$36,770	36,047	High school and training/certification	31,950
Production Supervisors	$59,430	14,003	High school and work experience	13,320
Purchasing Agents	$71,740	12,858	Bachelor's or more and training/ certification	12,040
Team Assemblers	$25,640	10,736	High school and training/certification	13,800
Welders, Cutters, Solderers, and Brazers	$41,080	9,901	High school and training/certification and work experience	8,100
Industrial Machinery Mechanics	$46,520	9,685	High school and training/certification	8,050
Inspectors, Testers, and Weighers	$35,420	8,757	High school and training/certification	8,660
Production, Planning, and Expediting Clerks	$49,470	8,516	Some college/associate degree and training/certification	9,180
Machinists	$43,000	8,284	High school and training/certification	6,670
Electrical/Electronics Engineering Tech.	$63,640	5,458	Some college/associate degree	4,700
Electrical/Electronic Equipment Assemblers	$31,240	3,584	High school	3,250
Industrial Production Managers	$102,010	2,645	Bachelor's or more and work experience	2,250
Mechanical Drafters	$52,460	2,594	Some college/associate degree	2,420
Maintenance Workers, Machinery	$41,780	2,529	High school and training/certification	1,770
Cabinetmakers and Bench Carpenters	$30,060	2,375	High school and training/certification	2,090
Industrial Engineering Technicians	$53,300	1,292	Some college/associate degree	1,050
Chemical Technicians	$43,360	1,290	Bachelor's or more	1,490
Tool and Die Makers	$47,510	1,052	Some college/associate degree and training/certification	880
Electromechanical Equipment Assemblers	$33,220	1,025	High school	1,550
Power Plant Operators	$48,010	520	Some college/associate degree and training/certification	470

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Marketing

The ***Marketing Career Cluster*** prepares you for careers in advertising, public relations, sales, and planning. This career cluster allows you to demonstrate your creativity through promotional campaigns, event planning, and new sales techniques. There will be a great deal of competition within the industry, especially for higher-level positions. College graduates with relevant experience, strong creativity, and solid communication skills have the best job opportunities.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Retail Salespersons	$20,860	138,054	High school	127,740
Cashiers	$18,790	96,511	High school	97,670
Retail Sales Supervisors	$39,280	45,853	High school and work experience	32,180
Sales Representatives, Except Techical/Scientific	$56,990	33,338	Bachelor's or more and training/ certification	30,320
Real Estate Sales Agents	$46,080	22,960	Bachelor's or more and training/ certification	7,290
Market Research Analysts & Specialists	$63,370	19,893	Bachelor's or more	16,410
Driver/Sales Workers	$22,610	15,078	High school	11,490
Supervisors of Non-Retail Sales Workers	$82,060	10,510	Bachelor's or more and work experience	6,600
Courter and Rental Clerks	$27,410	10,383	High school	12,270
Sales Representatives, Technical/ Scientific	$90,370	9,549	Bachelor's or more and training/ certification	8,520
Public Relations Specialists	$62,700	8,848	Bachelor's or more and training/ certification	7,430
Sales Managers	$133,890	6,866	Bachelor's or more and work experience	6,080
Telemarketers	$22,480	5,964	High school	5,150
Marketing Managers	$146,010	5,431	Bachelor's or more and work experience	3,910
Advertising Sales Agents	$51,280	3,245	Bachelor's or more and training/ certification	2,500
Real Estate Brokers	$67,280	3,041	Bachelor's or more and work experience	1,290
Wholesale and Retail Buyers	$50,330	2,975	Some college/assoc. degree & training/ cert.	2,250
Merchandise Displayers	$29,740	2,676	Some college/assoc. degree & training/ cert.	2,000
Public Relations and Fundraising Managers	$131,440	1,795	Bachelor's or more and work experience	1,390
Advertising and Promotions Managers	$96,640	430	Bachelor's or more and work experience	280

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

Appendix D: Career Cluster Data Snapshot
Science, Technology, Engineering, and Mathematics

The ***Science, Technology, Engineering and Mathematics (STEM) Career Cluster*** prepares you for careers using science, technology, engineering, and mathematics skills. Jobs within this career cluster conduct in-depth research to provide solutions to a variety of technical problems within many different fields.

Over the next decade, jobs aligned with advancing technology are predicted to boom as new career opportunities open. Individuals with college degrees and experience working with high-tech laboratory equipment have the most potential for success within this industry.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Civil Engineers	$79,760	10,495	Bachelor's or more	8,060
Mechanical Engineers	$90,450	8,504	Bachelor's or more	8,210
Electrical Engineers	$89,670	6,865	Bachelor's or more	6,770
Architectural and Engineering Managers	$138,150	6,660	Bachelor's or more and work experience	4,530
Electronics Engineers	$105,470	5,636	Bachelor's or more	4,480
Aerospace Engineers	$120,450	5,222	Bachelor's or more	2,980
Industrial Engineers	$82,860	4,243	Bachelor's or more	4,020
Nuclear Engineers	$86,180	2,434	Bachelor's or more	2,630
Computer Hardware Engineers	$116,130	2,320	Bachelor's or more	1,210
Computer Scientists	$116,440	2,219	Bachelor's or more	1,750
Biological Technicians	$40,220	1,329	Bachelor's or more	2,090
Chemical Engineers	$104,620	1,275	Bachelor's or more	1,220
Petroleum Engineers	$135,050	1,101	Bachelor's or more	940
Marine Engineers	$88,420	1,096	Bachelor's or more	1,260
Biochemists and Biophysicists	$82,460	737	Bachelor's or more	600
Geoscientists	$91,220	616	Bachelor's or more	460
Health and Safety Engineers	$87,900	580	Bachelor's or more	680
Environmental Engineering Technicians	$43,020	537	Some college/associate degree	460
Materials Engineers	$90,920	448	Bachelor's or more	410
Microbiologists	$62,590	417	Bachelor's or more	560

Sources for Median Wages and Employment by Occupation in Virginia

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Appendix D: Career Cluster Data Snapshot
Transportation, Distribution, and Logistics

The ***Transportation, Distribution, and Logistics Career Cluster*** prepares you for careers in which you plan, manage, and move everything from people to company products through a range of transportation services. Individuals in this field are involved in the logistics of all types of transportation from road to rail and air to water.

Median Wages and Projected Employment by Occupation in Virginia

Occupation	2014 Median Wage	2022 Proj. Emp.	Predominant Level of Education	2014 BLS Est. Emp.
Heavy and Tractor-Trailer Truck Drivers	$37,630	43,398	High school and work experience	36,510
Automotive Service Technicians	$39,480	25,170	High school and training/certification	19,220
Light Truck or Delivery Service Drivers	$29,820	20,202	High school	18,590
Bus Drivers, School or Special Client	$27,550	18,121	High school and training/certification	*
Billing and Posting Clerks	$35,540	15,553	Some college/associate degree	11,230
Logisticians	$81,000	8,543	Bachelor's or more and work experience	6,080
Diesel Engine Specialists	$42,480	7,952	High school and training/certification	6,280
Supervisors of Transportation Operators	$55,990	6,149	High school and work experience	5,410
Dispatchers	$35,430	4,650	Some college/associate degree and training/certification	4,140
Bus Drivers	$35,260	4,205	High school and training/certification	*
Mobile Heavy Equipment Mechanics	$45,720	3,541	High school and training/certification	3,200
Airline Pilots, Copilots, and Flight Engineers	$111,260	2,841	Bachelor's or more, training/ certification, work experience	3,150
Transportation and Distribution Managers	$95,910	2,438	Bachelor's or more and work experience	2,070
Tire Repairers and Changers	$27,300	2,273	High school and training/certification	1,810
Captains, Mates, Pilots of Water Vessels	$67,830	2,098	High school	1,670
Cargo and Freight Agents	$35,530	1,943	Some college/associate degree	1,720
Aircraft Mechanics and Service Technicians	$59,110	1,879	Some college/associate degree	2,300
Couriers and Messengers	$29,200	1,742	High school	1,480
Ship Engineers	$57,120	1,718	Some college/associate degree	1,390
Air Traffic Controllers	$136,490	1,325	Some college/associate degree and training/certification	*

**2014 employment data unavailable from the Bureau of Labor Statistics

Sources for Median Wages and Employment by Occupation in Virginia

Wage data comes from the U.S. Bureau of Labor Statistics' May 2014 State Occupational Employment and Wage Estimates: Virginia. **Employment projections** data is sourced from the Virginia Employment Commission's Virginia Occupational Employment Projections 2012-2022 **Predominant education level** was developed by Trailblazers, based on U.S. Bureau of Labor Statistics occupational education and training data.

For more information about CTE programs, visit the CTE Resource Center's website.