Defining Engineering as a Career: the States Career Clusters Initiative

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Abstract

Communicating to high school teachers, students and parents about engineering as a career is a complex task that has not necessarily been well defined or standardized. The States Career Clusters Initiative was an effort to define the knowledge and skills necessary to pursue a given career pathway. A panel of experts drawn from interested industry, government and academia nationwide compiled the lists with strong reference to national education standards in science, math and technology. The state of North Carolina took on the task of defining engineering and science careers. This paper describes the results of the North Carolina panel on engineering. The knowledge and skills identified form a strong basis for learner success whether the learner is a student in high school, college, technical training, an apprenticeship program or in the workplace.

Introduction

Technological advances and a changing global market have transformed the nature of work. Jobs in the future will require students to have better skills, more knowledge, and the ability to be flexible in any occupational area. Students must also be prepared to work in ever changing environments with abilities to continually update their knowledge and skills. The above statement is one that is heard today throughout occupational education in every state. Public institutions, especially secondary education, have a mission to meet both current and future needs of employers with the graduates they produce. Not only do students need to have current skills, but have the ability to grow these skills in new and exciting areas. Knowledge about a given occupational area in no longer the norm when starting a career but more is needed in areas of technology, technical literacy, and computing. Given these statements about the future of education, the National Association of State Directors for Career and Technical Education Consortium (NASDCTEc) and the Department of Education Office of Vocational and Adult Education (OVAE) set forth an agenda to meet these demands for the future of our workforce in America.

In January of 2001, the Department of Education (OVAE), under the direction of State Supervisors (NASDCTEc), developed a strategy to update current curricula to meet future needs of employers. This movement was funded by the US government and called the "Career Clusters Project." This joint effort by states throughout the US was to develop curricula guidelines that could be used in future curricula development to ensure that the products will meet future needs of employers. The project was designed for both secondary and post-secondary education, but emphasis was placed on secondary education, as high schools work to

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educate students for initial employment upon graduation, or to continue on into higher education. The project was led by the State Department of Education in Oklahoma with 13 other states and the District of Columbia helping in this initiative. These project participants broke all occupations into 16 different clusters to be studied. The mission of the project was to identify the universal knowledge and skills needed for a given occupational area and plan for future knowledge and skills needed for that area. The idea was to group occupational areas and broad industries based on commonalities. By doing so, the information developed by the career clusters project could be used as an organizational tool for schools to offer a broader and more durable preparation for the world of work.

The goals for the Career Cluster Project were all student centered. The project was designed to help offer students the "big picture" in terms of options and understanding of a broad industry. Also, the project provided schools with the necessary resources to enhance academic achievement and make sure no child is left behind. The common theme for communication from state to state was curricula development. This way, curriculum development would have a template that all states could use to produce common curricula for each occupational area, and, if a student moved, the curricula would be similar from state to state. Overall, the project when finished would provide high schools an organizational tool for curricula. Educators would have a curriculum framework with assessment, certifications, and professional development areas identified. Guidance counselors would have information to help students better explore career options for the future. Employers would have well trained quality workers who can learn new skills and adjust to change. Parents would be reassured that their student was better prepared for college and the workplace, and students could make better career choices.

Career Clusters

The project received funding in 2001, and, after an initial planning stage, states were given a chance to volunteer to develop one of the 16 career clusters. Oklahoma was chosen to oversee the process due to their previous experience in developing materials similar to this project. The following career clusters were developed.

1. Agriculture, Food and Natural Resources- This cluster developed guidelines for the development of agricultural commodities from the production process through the distribution and financing occupations related to this cluster. Resources included in this cluster were food, fiber, wood products, natural resources, horticulture, and other animal products.
2. Architecture and Construction- The cluster developed curricula guidelines for careers in designing, planning, managing, and building structures.
3. Arts, A/V Technology and Communications- From designing to performing and publishing multimedia, this cluster developed guidelines for career development in the entertainment services.
4. Business, Management and Administration- Planning, organizing, directing, and evaluating business functions and careers related to such areas of business management and administration were developed in this cluster.
5. Education and Training- This cluster developed curricula guidelines for planning and delivering services related to education and training.
6. Finance- This cluster included areas related to planning, services, and investment

planning, as well as banking, insurance and business finance management.

7. Government and Public Administration- The cluster focuses on governmental functions from national security to revenue and regulation to management of administration at local, state, and federal levels.
8. Health Science- From planning and managing therapeutic and diagnostic services, to health and support services, this cluster also dealt with careers in biotechnology and research.
9. Hospitality and Tourism- Looking at management functions and operations in careers related to recreation and travel was the purview of this cluster.
10. Human Services- This cluster developed curricula guidelines for preparing professionals in family and human services.
11. Information Technology- IT is a growing area in the US, and this cluster identified basic knowledge for all IT occupations from technical to multimedia.
12. Law, Public Safety and Security- This cluster looked at protective services and homeland security, including professional and technical support services.
13. Manufacturing- The cluster identified knowledge and skills need for all levels of manufacturing from planning to final products and related support activities.
14. Marketing, Sales, and Service- Guidelines were developed for the planning and managing of marketing activities to reach organizational objectives.
15. Science, Technology, Engineering, and Mathematics- The cluster developed guidelines to be used for curricula development in the four areas including laboratory research and development services.
16. Transportation, Distribution, and Logistics- This cluster defined careers from the planning and management of movement of people and goods, to support and logistic services related to occupations in transportation.

Once the career clusters were assigned to the different states for development, each cluster had to identify professionals from entry level positions to senior levels to be on the committee for that particular cluster and work together to develop the general skills and knowledge areas for all positions within the career pathway. Each state had a template or format from which to work so that each cluster would be uniform in presentation.

Science, Technology, Engineering, and Mathematics

The North Carolina State Department of Public Instruction (NC-DPI) managed the Science, Technology, Engineering, and Mathematics (STEM) career cluster. The process of organizing such a task began with the formation of an advisory committee of professionals in occupational fields related to STEM areas. These professionals consisted of scientists, mathematicians, engineers, technologists, and educators from secondary and post-secondary education. Advisory members came from a variety of areas and occupations from around the country with representatives from high schools, community colleges, universities, and companies like IBM, SAS, DuPont, Underwriters Laboratory, GlaxoSmithKline, as well as national project leaders in education like CORD, High Schools that Work, Project Lead the Way, and Standards for Technological Literacy. Overall, these partners to development the STEM cluster were made up of eleven representatives from postsecondary education, seven from secondary education, fourteen from business and industry, one from labor, three from associations, and four from government agencies. These advisory members were given the mission to develop guidelines that integrate academic and technical subject areas together with particular emphasis on problem solving, teaming skills, and critical thinking.

The original name for the cluster was Scientific Research and Engineering, but the committee of professionals formed to develop these knowledge and skills decided that the original name was too focused and that technology and mathematics both need to be established and considered as separate disciplines of study. The group met four times during the 2001-2002 year with elected chairpersons to represent the group at both state and national meetings. The group started its first meeting by identifying certifications needed by the various occupations that were associated with the cluster, and by June of 2002, the group had identified those common knowledge and skills needed from any occupation associated with the cluster area. The engineering and technology representatives worked together and developed a framework from national standards for technology called Standards for Technological Literacy (STL). The mathematics and science professionals developed four common core scientific principles for all math and science occupational areas, with the SCANS report being the underlining theme for the entire cluster. Although both groups used the same template for headings and format, each area had its own particular listing of knowledge, skills, and assessment measures for its area. The cluster hired a technical writer during the final stages and merged both areas together into one document.

The knowledge and skills common to all careers in this cluster were categorized into nine areas: academic foundations, information technology applications, technical skills, design, communications, safety-health-environmental, leadership-teamwork, employability-career development and ethics-legal responsibilities. The full listing of the statements chosen to define these knowledge and skill categories is available on the web site: www.careerclusters.com. This website also contains a list of examples of careers that fit into the definition of this pathway.

In addition to statements that further define the categories, performance elements (i.e. specific skill requirements) and measurement criteria (i.e. how these skills would be demonstrated) are listed. Taken together, these elements should describe the knowledge and skills that would be necessary to anyone seeking a career in this cluster area. Some of these categories were judged to be common across the engineering and technology and science and mathematics sub clusters, and some were identified as belonging only to engineering and technology.

Engineering and Technology

The knowledge and skill statements were brainstormed and carefully defined by the group of consultants that formed the cluster advisory committee. The following table lists some examples of knowledge and skill statements, performance elements, and measurement criteria. In each topic area, multiple knowledge statements have been identified, and in each knowledge area, multiple performance elements are listed. Under each performance element may be multiple measurement criteria, e.g.,

Topic area 1
  Knowledge statement 1
    Performance element 1
      Measurement criteria 1
      Measurement criteria 2
      Etc.
    Performance element 2
    Etc.
  Knowledge statement 2
  Etc.
Topic area 2
Etc.

The table lists only a few examples. The total document is available on the web site for duplication and use by teachers, administrators, curriculum planners, etc.

Topic: Academic Foundations	
Knowledge statement: Apply concepts and processes as defined by the National council of Teachers of Mathematics in Principles and Standards for School Mathematics	
	Performance Element: Choose and/or create models that can be used to solve problems
	Measurement Criteria: Recognize appropriate models, concepts and processes for the situation, and apply them in solving the problem
	Measurement Criteria: Explain the impact of assumptions, initial conditions, boundary conditions, and other constraints on problem solutions
	Performance Element: Select and use appropriate statistical methods to analyze data to help make decisions
	Measurement Criteria: Apply concepts of probability to help make decisions
	Measurement Criteria: Apply appropriate data collection and analysis methods and means of displaying data

Knowledge statement: Apply concepts and processes as 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	
	Performance Element: Use systems of measurement
	Measurement criteria: Convert units of measurement from one system to another
	ETC.
Topic: Communications	
Knowledge statement: Demonstrate effective oral, written, and visual communications	
	Performance element: Effectively communicate scientific, technological, engineering and/or mathematical information to the intended audience ETC.

Assessment

During the summer of 2002, Oklahoma developed a website that professionals in these fields could use to review the document and rate each knowledge and skill and provide feedback. The website used a Likert Scale of one to five to rate each knowledge and skill for both areas on the question of, "Is the knowledge or skill common to all occupations within this pathway?" With one (1) indicating not knowing to five (5) being appropriate for 76% or more, the average for the engineering and technology area was 3.35, with 399 people responding.

A second question asked, "Is the knowledge and skill statement important to workplace success and or/further education?" With 399 participants responding to the engineering and technology pathway, the average score for all knowledge and skills associated with this area was a 3.45 on a Likert scale with one representing do not know to five representing critical for success. Once the survey was completed, the final document was published and sent to each state for distribution.

Conclusion

Although the original funding was for three years, after the first year, funding was dropped and no detailed assessment strategies, pilot testing, or implementation plans were developed for this cluster area. Currently, the framework developed by this cluster is being used by North Carolina to develop and enhance curricula in technology education courses and engineering graphics courses throughout the state. The State Supervisors are looking for a professional agency or group to continue the funding and process of developing this STEM cluster.

Resources

http://www.careerclusters.org/
http://www.iteawww.org/TAA/STLstds.htm

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