A pilot study identifying recruitment and pathway development for high school manufacturing

Kris Frady
Clemson University

Claretha Hughes
University of Arkansas

Kapil Chalil Madathil
Clemson University

ABSTRACT

In today's globally-competitive, knowledge-based economy Career and Technical Education (CTE) programs face the challenge of providing rigorous career pathways. Identifying effective recruitment strategies aligned with local labor market needs is critical to supporting regional economic development initiatives thus strengthening communities and providing substantive employment and career opportunities. This paper presents a pilot study of a descriptive research study being conducted with students statewide, in a southeastern state, who are enrolled in CTE manufacturing courses. Importance is placed on sharing literature emphasizing the importance of pathway development in CTE and construction and pilot testing of an empirically-based survey designed to describe the motivations, attitudes, opinions, experiences and characteristics of high school students currently enrolled in manufacturing courses. The study is focused on supporting regional CTE and technological education initiatives to better understand student motivations to enter advanced manufacturing educational and career pathways and strategies for recruitment into these pathways.

Keywords: career and technical education, economic development, high school, manufacturing, online learning, pathways; pilot study

INTRODUCTION

In today's globally-competitive, knowledge-based economy Career and Technical Education (CTE) programs face the challenge of providing viable and rigorous pathways to postsecondary education and careers. The state Department of Education CTE division in a southeastern state, with a burgeoning manufacturing economy, has taken an innovative approach to meeting this challenge. This team is using digital learning tool to build 21st Century classrooms with interactive, media-rich digital curriculum which are preparing students for high-wage, high-demand advanced manufacturing opportunities throughout the region.

The program features a blended learning approach which integrates the Manufacturing Skill Standards Council (MSSC) aligned digital, online Educate Workforce curriculum which can be found at www.EducateWorkforce.com. The Educate Workforce virtual learning environment was developed by a team of researchers from a research-based land grant university in the region. Teacher engaged in this pilot program integrate the virtual Educate Workforce materails with textbooks (MSSC, 2006) and teacher generated classroom resources. Over 400 students, 24 CTE teachers, and 44 classes have been exposed to knowledge and workplace skills preparing them for the industry-recognized MSSC certification. This technology rich curriculum represents an innovative approach to CTE while linking it with regional demand where the average manufacturing wage in the state is $67,889, over 10 percent of the state is employed in manufacturing jobs and manufacturing represents 20.9 percent of the gross state product (GSP) making this state one of the top five grossing states in the nation (National Association of Manufacturers, 2016). Through this statewide high school program, this state Department of Education CTE initiative is presenting rich career opportunities for students exploring advanced manufacturing.

This paper presents a pilot study for a descriptive research study to be conducted with students statewide, in a southeastern state, who are enrolled in CTE manufacturing courses. The study is focused on supporting regional CTE and technological education initiatives to better understand strategies for recruitment into advanced manufacturing educational and career pathways and how using virtual learning environments can enhance and support the curriculum. This study aims to answer key primary research questions:

> RQ1: What are the motivations, of high school students, to enroll in and pursue advanced manufacturing educational and career pathways?
> RQ2: How can career and technology education and technological education programs develop recruitment strategies to encourage students to pursue pathways in fields supporting local labor markets and regional economic development?
> RQ3: What are the fundamental components, supported by virtual learning environments that support student learning and CTE career development?

Through engaging in the research to answer this question, this CTE division is also taking another important step in pushing practice forward by engaging in significant research with this team of researchers to learn more about the development of pathways in a regional approach to career and workforce preparation.

LITERATURE REVIEW

Discoveries and utilization of pathway techniques can foster discrete program change or more broad scale, systematic transformation. The theories and emerging research related to pathway development are relatively new (Fein, 2012) and additional research is needed to more fully develop the theoretical framework for CTE career pathways. While federal funding from organizations such as the National Science Foundation and the National Institutes of Health have spurred interest and emerging research in the development of STEM pathway and recruitment programs, less is known specifically about advanced manufacturing. Given the prominence of the manufacturing industry in the United States economy, more needs to be learned to support the labor market needs of this growing industry.

The manufacturing sector has a large footprint in the United States economy representing 8.8% of total U.S. employment (The Manufacturing Institute, 2015) yet 67% of manufacturers report a shortage in available, qualified workers (Colby & Ortman, 2014). Further, only 39% of American's hold a postsecondary credential yet it is predicted that 63% of all jobs will require a postsecondary degree by 2018 (Carnevale, Smith, & Strohl, 2010). To combat these troubling trends the technological education and higher education communities are implementing new and innovative programs aimed at improving attainment of postsecondary credentials and creating, sustaining, and retaining a well-trained and highly qualified workforce to support the labor demands of current and future industry. New, state-of-the-art digital learning tools are poised to be game changers in this field affording greater accessibility and flexibility to all students, empowering 21st Century digital learners, and increasing enrollment capacity of higher education programs (Willis, Kestell, Grainger, & Missingham, 2013). However; the success and impact of these programs is strongly correlated with development of innovative educational and career pathways and the ability of secondary and post-secondary institutions to recruit students into pathways aligned with local labor market needs and regional economic development initiatives.

Importance of STEM and Advanced Manufacturing in Pathway Development

Raising the skill level and public perception of American craftswomen and craftsmen, who are technicians and engineers working directly with manufacturing personnel, is critical in manufacturing a high-quality, state-of-art finished product. Increasing skills and competencies for the manufacturing labor force is directly related to improvement of Science, Technology, Engineering and Math (STEM) educational programs and pathways. Building a strong bridge between advanced manufacturing and STEM strengthens recruitment opportunities and allows multiple disciplines and industries to benefit from opportunities for growth. STEM occupations are expected to grow about 13% between 2012 and 2022, faster than the 11% growth projected for all other jobs during that same period of time (BLS Occupational Outlook Handbook, 2014). Further, STEM degree holders enjoy higher earnings and employability than non-STEM degree holders (US Department of Commerce, Economics and Statistics Administration, 2011).

In order to enter into the STEM workforce via advanced manufacturing, post-secondary educational attainment provides significant advantages in areas of increased employability and enhanced earning potential (Carnevale, Smith, & Strohl, 2010). In fact, more than 40% of jobs in manufacturing will require postsecondary education by 2018 (Carnevale, Smith, & Strohl, 2010). As education, has become a lifelong pursuit and establishment of stackable certificates have begun to develop more symbiotic relationships between employers and educational institutions,

building innovative career pathways and research opportunities to support STEM careers helps to provide greater economic growth and development in STEM industries throughout the region.

Research suggests that recruitment and pathway initiatives and the workforce overall can be enhanced through an emphasis on increased diversity (Hoffman et al, 2010). Within the manufacturing field there is a lack of gender diversity where women currently make up 47% of the labor force but only 27% of the manufacturing workforce (The Manufacturing Institute and Deloitte, 2015). In STEM fields, which have been characterized as masculinized fields of study, students and workers experience additional pressure based on gender and ethnic interactions (Jackson & Laanan, 2015; Jackson, Starobin & Laanan, 2013; Kenny & Goe, 2004; Martin, Simmons, & Yu, 2013; Reyes, 2011). Multiple programs have been implemented in technician and STEM fields to promote greater diversity within this specialized workforce (Hoffman et al, 2010). In order to successfully recruit a more diverse workforce, it is essential to understand the motivations of students to enter (or do not enter) educational pathways (Bjurulf, 2010). Understanding these motivations will aid future efforts in tailoring the development of digital learning curriculum and recruitment tools being disseminated to high schools and two-year colleges.

Based on regional economic development data, advanced manufacturing technician career pathways have become a focus (Brett, 2011). Yet, there is a prevailing view that K-12 school systems do not encourage students to pursue careers in manufacturing (The Manufacturing Institute and Deloitte, 2015). Similarly, students are not receiving the message of the strength in the manufacturing field at home from their parents where only 33 percent of parents state that they would encourage their children to enter into a career in manufacturing (The Manufacturing Institute and Deloitte, 2015). There is a need, within technical careers, for information about future career possibilities to be used in messaging to encourage students to make technical career-related decisions (Bjurulf, 2010).

Integration of Virtual Learning Environments

As products being manufactured integrate technology at rapidly increasing rates, programs with the ability to implement high-technology approaches to prepare the workforce to be more highly-skilled and equipped for the advanced manufacturing environment are progressively becoming more significant. Virtual learning environments and online learning continue to grow in prevalence and popularity and have been used in a variety of ways including: information space for teacher to student learning and communication, social space, virtual and 3D immersive space, enrichment for classroom activities, integration of multiple heterogeneous technologies and pedagogical approaches and as a way to overlap and support physical teaching space (Dillenbourg, Schneider, & Synteta, 2002). Online modules have been found to be effective in supplementing and enhancing face-to-face learning support (Thomson, 2010) and through integration of virtual reality simulations of actual manufacturing environments, equipment and scenarios; students have exposure to and authentic experiences in the field. Additionally, online and virtual modules provide opportunities for students to experience real-world scenarios where safety or cost might otherwise be prohibitive (Merchant, Goetz, & Cifuentes, 2014). Effective use of technology has been shown to improve student engagement (Young, 2003) and it has even been suggested in a meta-analysis of online education that the online model can be as or even more effective than traditional face-to-face instruction (U.S. Department of Education, 2009). In many cases, high school students have limited access to

manufacturing information, experts and environments. Virtual learning environments and services can help to bridge this gap by providing educational opportunities and career information that would not otherwise be available and also help prepare students for industry recognized certification.

Virtual learning environments and services have also been found to have multiple components which support holistic educational attainment and career development and have been used in a variety of ways including recruitment, outreach, advising, building communities and creating new avenues for communication (Hornak, Akwek, & Jeffs, 2010). As students engage in online courses, technology can assist in creating a virtual community to improve sense of belonging to the institution which may in turn increase retention and graduation rates (Crawley, 2004).

Interestingly, as enrollment in online programs is increasing and as there is greater emphasis at a national level on CTE as an approach to strengthen the economy, little is understood about the scope and impact of online CTE in technological education (D'Amico, Morgan, Katsinas, & Friedel, 2014; Mitchell, 2017). Moreover, even less is known about how the characteristics of virtual learning environments may support the development of online career skills and it is important to engage in research which has the potential to elucidate ways in which educational and career pathway development may be supported by these tools and resources (Rutten, Ros, Kuijpers, & Kreijns, 2016).

Career Pathways

Despite numerous studies which demonstrate the future need and career earning potential of technological career pathways, CTE and related two-year college programs are facing frequent barriers to developing, recruiting to and sustaining programs aligned with regional economic and workforce development needs. Many CTE programs lead to postsecondary programs of study which prepare students for high skill, high wage career opportunities. Students in meaningful CTE programs may begin preparing for a career while in high school and innovative programs are successfully linking regional demand and bourgeoning industries with state-of-the-art learning opportunities (Bjurulf, 2012).

Career pathways are series of latticed educational programs and activities, connecting learning with real-world applications, which enable students to advance to higher levels educational and career opportunities. Pathways provide a wide range of experiences for students which may range from career exploration, to certification, to postsecondary credentials and are typically stackable, portable and designed to enable students to seamlessly transfer from stage to stage while providing many employable points of entry and exit. Pathways are demonstrating the potential to reduce dropout rates, increase achievement and learning, and increase future earning potential (ConnectEd, 2008). Pathway development also supports K-12 STEM education ecosystems engaging businesses, industries and stakeholders to establish a pipeline of future innovators. Career guidance and support can include support in development of career awareness and employment readiness skills and identification of career goals and application of skills to achieve those goals but the most fundamental component is identification of career pathways and development of career goals (Stipanovic & Stringfield, 2013).

Well-designed pathways offer an effective approach to meeting skill shortage challenges in the labor market and support data-driven decision making in selection of educational options to improve transitions between high school, certificate programs, 2-year colleges and beyond.

Recent trends have increased focus on stackable certificates to build core skills and gain industry-recognized credentials, such as the MSSC, as the first step in a pathway leading to an associate of science, an applied science certificate, a bachelor of engineering, or even a master of engineering for those seeking an advanced degree. Programs such as these which are experiencing success in reaching a broad group of students can offer invaluable insight to other programs aiding in development of a data driven approach to support creation of effective recruitment programs.

Importance of Recruitment

Education continues to be one of the strongest predictors of employment rate and income and is the most effective path to sustained employment (Wong, McNamara, Shulkin, Lettieri, & Carerio, 2008). Increasing educational attainment among citizens within the United States is an issue of national importance where current predictions indicate that the United States has not only dropped in international ranking in college degree attainment has fallen from first in 1990 to eleventh in 2013 but also must produce more post-secondary credential holders in order to meet projected workforce demands (The Organization for Economic Cooperation and Development, 2013). In 2015, The White House issued an ambitious goal that in 2020 the United States would regain the ranking as the country with the highest proportion of college graduates in the world (The White House, 2015). Because of their access to more diverse populations and wide enrollment CTE and technician education programs, such as those taught in two-year colleges, are uniquely positioned to be strategic allies in recruiting new types of students and in boosting post-secondary attainment (The College Board, 2012).

Exploration of recruitment practices which not only expand the size of the workforce but also broaden diversity and inclusion are of significant interest to manufacturing and STEM industries, secondary and post-secondary educational programs and federal initiatives (National Academy of Engineering, 2002). There are many evidence-based recruitment practices, used in other STEM fields such as Information Technology, that have been tested and proven by a number of organizations including Carnegie Mellon University, the University of California Irvine, the University of Virginia, Georgia Institute of Technology, the National Center for Women and Information Technology, high schools nationwide and many more (Agosto, Gasson & Atwood, 2008; Cohoon & Barker, 2008) yet little is known regarding best practices for recruitment into high-technology manufacturing career pathways.

Recruitment is of vital important for many reasons. The skill and availability of a highly trained workforce is a strong inducement for industrial recruitment initiatives which are spearheaded by economic development organizations (Lowe, 2012). Importantly, there is also great potential to benefit the individual in areas of increased employability and earning potential by connecting them to job in an industry which have experienced steady growth since 2009 and current estimates suggest that over 12 million Americans or nine percent of the workforce is directly employed in manufacturing (Bureau of Economic Analysis, 2013). With current labor shortages reported of approximately 600,000 manufacturing jobs unfilled due to a skills gap and anticipated future labor shortages stemming from an aging workforce with retirement number projected to outpace current pipeline and recruitment forecasts; advanced manufacturing represents a strong and viable field for secure employment and career advancement (Colby & Ortman, 2014). If this workforce and recruitment issue goes unresolved,

industry leaders have reported that this will compromise their ability to stay competitive which would have implications of national competitiveness and importance (Peralta, 2014).

METHODS

The design for the study is a nonexperimental, descriptive research design. To date, the survey has been developed through rigorous research on online learning assessment, career guidance and development and manufacturing career exploration; participants for the study have been selected and are currently providing feedback and pilot tests have been conducted on significant items in the survey. This intentional development, selection and testing of these components provides a strong foundation for this study.

Instrumentation

The student survey is being utilized to help the researchers better describe the students enrolled in the manufacturing courses who are engaging with digital learning tools on www.EducateWorkforce.com (Fraenkel et al, 2012). The survey is intended to describe attitudes, opinions, experiences and characteristics (Creswell, 2005). The survey utilizes constructs designed and implemented in previous studies which include satisfaction and perception (Ai-Lim Lee et al., 2010; Davis, 1989) and manufacturing career interests (Kier, Blanchard, Osborne, & Alber, 2014; Educational Research Center of America, 2015; The Manufacturing Institute, 2014). Table 1 (Appendix) identifies each survey construct, a listing of the general topics included and source.

Of specific interest in this study are the questions which focus on manufacturing and career interests. These questions ask students to identify their motivations for registering for the course, influencers on their career pathways, motivations to pursue manufacturing as a career and programs which would be beneficial in increasing interest in manufacturing. These questions were identified through research and review of recent manufacturing reports being produced by leading manufacturing organizations across the country (Kier, Blanchard, Osborne, & Alber, 2014; Educational Research Center of America, 2015; The Manufacturing Institute, 2014). Focusing in on the specific questions selected for the survey in this study will allow researchers to not only gain an understanding of statewide student motivations but will also allow a comparison point against national data sets which have been previously collected using the same or similar questions.

Participants and Procedure

All students, statewide, enrolled in manufacturing courses are given an opportunity to provide feedback on their experiences and motivations regarding the manufacturing course. There are over 400 students in approximately 50 different classrooms who are participating in this study. Students are asked to complete a survey containing 28 items near the end of the semester thus, this study is a work in progress and the research team is currently collecting student survey responses.

Procedurally, to distribute surveys across all schools participating in the state the team worked through multiple levels of administration. First, through contacts provided by the state CTE representative, researchers contacted each individual school district to ensure that data

collection from minors followed specific district guidelines. Next, teachers were asked to distribute parent consent and student assent letters. Finally, all teachers were instructed to direct their students to the survey link which was embedded in the online course website. The student responses to the survey questions are being collected using Qualtrics.

Once students across all classrooms have had an opportunity to participate, the team will begin to analyze the data, using SPSS, looking for trends overall and within subgroups which may be divided based on demographic feedback such as gender, race, location or grade to name a few.

Pilot Trials and Previous Use

In addition to selecting survey items that have been previously used in peer reviewed research studies, key items in this survey have also been previously piloted with student audiences. Questions 13 – 20, focusing on student satisfaction and perception with the online learning platform, have been utilized in a previous study conducted by this research group with 171 students utilizing similar material across four two-year college campuses. Questions 13 – 20 help to answer the research question related to efficacy of the virtual learning environments and are important for the research team to evaluate in terms of overall student experience with the advanced manufacturing course, specifically in the area of the digital learning tools.

Various questions from the 21 – 28 range have been pilot tested with approximately 190 high school students. The purpose of the pilot twofold. The first purpose was to test the data collection platform (embedding the survey link in the online course and using Qualtrics to collect the data) from a variety of school district sites. The second purpose was to ensure that high school students were able to understand and answer the survey questions being asked.

After analyzing the prior research study and the pilot results, the research team decided to reduce the overall number of questions to ensure that students more fully complete the survey and to restructure some of the format to make it easier for students to progress through the survey.

DISCUSSION

Understanding student motivations to support development of pathways aligned with regional career opportunities is a key aspect of strengthening local economic development efforts and linking students to sustainable career opportunities. Previous career development and counseling models have included key factors such as developing career awareness and employment readiness skills, identifying career goals, and acquiring career information to achieve career goals (Stipanovic & Stringfield, 2013). However, this model does not take into account student motivations and desires to pair with these previously successful career development models. Understanding why students are enrolled in non-traditional career and technical education programs is a key insight which may be utilized in recruitment of additional students. Further, since these programs do reflect a lack of diversity it is critical to explore the perceptions of underrepresented students to further understand their motivations to participate in these programs.

Additionally, connecting learning experiences with perceptions and preconceptions of occupational activities can support career decision making of all students, not just those in manufacturing pathways (Buschor et al, 2014). Focus on expectations and motivations of female

students in this study may help to either build on or disprove previous studies have found that females place high importance on their professional career (Hannover & Kessels, 2004) and factors such as providing career options and applied courses of study related to a secure career are key in selection of an academic program (Bargel et al, 2008). Additionally, prior studies have reported that females choose to enter STEM fields do so due to strong motivations to make the world a better place (Lupart, Cannon, & Telfer, 2004). The importance of analyzing the survey based on subgroups is expected to help the researchers to form a comparison between different types of students (McMillian, 2012).

Analysis of this data is expected yield insights into the motivations of the students to enroll and engage in advanced manufacturing courses and new and better ways to integrate digital tools into CTE classrooms. Being able to link the insights and motives of these students to identification of recruitment strategies will be important in the continued recruitment of new students into pathways that are connected with strong regional workforce demand. It is through these types of research partnerships that evidence-based digital learning tools with the potential to improve the workforce pipeline, increase educational attainment, improve wage earning potential and employability and accelerate business growth are being developed in ways that strengthen and modernize workforce and career education.

REFERENCES

Agosto, D., Gasson, S. & Atwood, M. (2008). Changing mental models of the IT professions: A theoretical framework. *Journal of Information Technology Education, 7,* 205-211.

Atchley, P., Hooker, E., Kroska, E., & Gilmore, A. (2012). Validation of an online orientation seminar to improve career and major preparedness. *Teaching Psychology*, 39(2), 146-151.

Bargel, T., Multrus, F., & Schreiber, N. (2008). The quality and attractiveness of majors in engineering sciences. Bonn, Germany: BMBF.

Bureau of Economic Analysis. (2013). Industry Input-Output Tables.

Bjurulf, V. (2012). Reasons for choosing a technically oriented education: an interview study within the fields of pipefitting and industry. *International Journal of Technology & Design Education*, 22, 377-397.

Brett, J.T. (2011). Give manufacturers the right tools: transforming manufacturing as a career choice and an economic driver. *New Hampshire Business Review*, 33(11), 16.

Buschor, C.B., Berweger, S., Frei, A.K., & Kappler, C. (2014). Majoring in STEM – What accounts for women's career decision making? A mixed methods study. *The Journal of Educational Research*, 107(3), 167-176.

Carnevale, A.P., Smith, N., & Strohl, J. (2010). Help wanted: projections of jobs and education requirements through 2018. Washington, DC: The Georgetown Center on Education and the Workforce.

Colby, S.L. & Ortman, J.M. (2014). The Baby Boom Cohort in the United States: 2012 to 2060. Washington, DC: US Department of Commerce Economics and Statics Administration, US Census Bureau. Retrieved from http://www.census.gov/prod/2014pubs/p25-1141.pdf?eml=gd&utm_medium=email&utm_source=govdelivery.

ConnectEd, The California Center for College and Career. (2008). Expanding pathways: Transforming high school education in California. Berkeley, CA.

Cohoon, J. P., Cohoon, J. M., & Soffa, M. L. (2013). Educating diverse computing science students at the university of Virginia. *IEEE Computer Society, March 2013.*

Crawley, A. (2004). Online student services benefit all students. *Student Affairs Online*, *5*(1). Retrieved from http://studentaffairs.com/ejournal/Winter_2004/index.html.

Creswell, J.W. (2005). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (2nd ed.). Upper Saddle River, NJ: Merrill/Prentice Hall.

D'Amico, M. M., Morgan, G. B., Katsinas, S. G., & Friedel, J. N. (2014). State director views on community college workforce development. *Career and Technical Education Research*, *39*(3), 191–211.

Dillenbourg, P., Schneider, D., & Synteta, P. (2002). Virtual learning environments. 3rd Hellenic Conference "Information & Communication Technologies in Education", Rhodes, Greece. Kastaniotis Editions, Greece, 3-18.

Fain, P., Assembly Line (2012). Inside Higher Ed, July. Retrieved from https://www.insidehighered.com/news/2012/07/18/manufacturing-industry-taps-colleges-help-alternative-credential

Fraenkel, J.R., & Wallen, N.E. (2003). Action research. In *How to design and evaluate research in education* (5th ed., pp. 571-597). Boston, MA: McGraw-Hill.

Hannover, B., & Kessels, U. (2004). Self-to-prototype matching as a strategy for making academic choices. Why high school students do not like math and science. *Learning and Instruction*, 14, 51-67.

Hoffman, E., Starobin, S.S., Lannan, F.S., Rivera, M. (2010). Role of community colleges in STEM education: Thoughts on implications for policy, practice, and future research. *Journal of Women and Minorities in Science and Engineering*, 16(1), 85-96.

Hornak, A.M., Akweks, K., Jeffs, M. (2010). Online student services at the community college. New Directions for Community Colleges, No. 150, Summer 2010.

Huck, S.W. (2008). *Reading statistics and research* (5th ed.). Boston, MA: Allyn & Bacon.

Jackson, D. L., & Laanan, F. S. (2015). Desiring to fit: Fostering the success of community college transfer students in STEM. Community College Journal of Research and Practice, 39(2), 132-149.

Jackson, D. L., Starobin, S. S., & Laanan, F. S. (2013). The shared experiences: Facilitating successful transfer of women and underrepresented minorities in STEM fields. New Directions for Higher Education, 2013(162), 69-76.

Kenney, M., & Goe, W. R. (2004). The role of social embeddedness in professorial entrepreneurship: A comparison of electrical engineering and computer science at UC Berkeley and Stanford. Research Policy, 33(5), 691-707.

Lowe, N.J. (2012). Using industrial recruitment as a strategic tool for manufacturing development. *Economic Development Quarterly*, *28*(4), 287-299.

Lupart, J.L., Cannon, E., & Telfer, J.A. (2004). Gender differences in adolescent achievement, interests, values and life-role expectation. *High Ability Studies*, 15, 25-42.

Martin, J. P., Simmons, D. R., & Yu, S. L. (2013). The role of social capital in the experiences of Hispanic women engineering majors. Journal of Engineering Education, 102(2), 227-243.

McMillan, J.H. (2012). *Educational research: Fundamentals for the consumer* (6th ed.). Boston, MA: Allyn & Bacon.

Merchant, Z., Goetz, E. T., & Cifuentes, L. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: A meta-analysis. *Computers & Education*. Retrieved from http://www.sciencedirect.com/science/article/pii/S0360131513002108.

Mitchell, R.L. (2017). Online career and technical education in the community college.

Community College Journal of Research and Practice 41(6), 336-340.
Manufacturing Skill Standards Council (MSSC). (2006). High-performance manufacturing: Portable production skills. Textbook Contributor and Reviewer 2002- 2006. Chicago, IL: Glencoe/McGraw-Hill.
National Academy of Engineering. (2002). *Diversity in Engineering: Managing the Workforce of the Future*. Washington, DC: National Academies Press.
Peralta, K. (2014). US Manufacturers Say Skills Gap Could Compromise Competitiveness. US News and World Report. Retrieved from http://www.usnews.com/news/articles/2014/05/07/us-manufacturers-say-skills-gap-couldcompromise-competitiveness.
Reyes, M. E. (2011). Unique challenges for women of color in STEM transferring from community colleges to universities. Harvard Educational Review, 81(2), 241-263.
Rutten, M., Ros, A., Kuijpers, M., & Kreijns, K. (2016). Usefulness of Social Network Sites for Adolescents' Development of Online Career Skills. *Educational Technology & Society*, 19 (4), 140–150.
Stipanovic, N., & Stringfield, S. (2013). A qualitative inquiry of career exploration in highly implemented career and technical education programs of study. *International Journal of Educational Reform*, 22(4), 334-354.
The College Board (2012). Improving student transfer from community colleges to four-year institutions – the perspectives of leaders from Baccalaureate-granting institutions.
The Manufacturing Institute and Deloitte, Overwhelming Support: U.S. public opinions on the manufacturing industry, 2015.
The Manufacturing Institute and Deloitte, Women in manufacturing study: Exploring the gender gap, 2015.
The National Association of Manufacturers. (2016). State manufacturing data.
The National Bureau of Economic Research. (n.d.) *ESA calculations using Current Population Survey public-use Merged Outgoing Rotation Groupfiles.* Cambridge, MA.
The Organization for Economic Cooperation and Development (2013). Education at a Glance, Retrieved May 20, 2014 from http://www.luminafoundation.org/goal_2025#goal-issue.
The White House. (2015). Higher Education. Retrieved June 25, 2015 from https://www.whitehouse.gov/issues/education/higher-education.
Thomson, A. (2010). Embedding an online career development program into student learning. *Australian Journal of Career Development*, *19*(3), 6-14.
US Department of Commerce, Economics and Statistics Administration (2011). STEM: Good jobs now and for the future. Langdon, D. McKittrick, G., Khan, B., & Doms, M. ESA Issue Brief #03-11, July 2011. Retrieved from http://files.eric.ed.gov/fulltext/ED522129.pdf on June 25, 2015.
U.S. Department of Education, Office of Planning, Evaluation, and Policy Development. (2009). Evaluation of evidence-based practices in online learning: A meta-analysis and review of online learning studies. Washington, DC.
U.S. Department of Labor, Bureau of Labor Statistics. (2014). Occupational Outlook Handbook. http://www.bls.gov/ooh/About/Projections-Overview.htm#employment.
Willis, C., Kestell, C., Grainger, S., & Missingham, D. (2013). Encouraging the adoption of educational technology for improved student outcomes. *Australasian Journal for Engineering Education*, *19*(2), 109-117.

Wong, M., McNamara, T., Shulkin S., Lettieri, C., Carerio, V. (2008). South Carolina indicators: aging and work. The Center on Aging and Work State Perspectives at Boston College. Retrieved from http://dlib.bc.edu/islandora/object/bc-ir:100395/datastream/PDF/view on June 14, 2015.

Young, J. R. (2003). Student engagement in learning varies significantly by major, survey finds. *Chronicle of Higher Education*, Nov. 14, 2003, A37.

APPENDIX

Table 1

Analysis of survey items

Survey Item	Construct	Definition	Author(s)
1 – 12	Demographics	General participant information including gender, age, ethnicity, race, GPA, expected grade in course, grade, and experience with Internet-based courses.	General
13 – 20	Satisfaction and perception	Satisfaction with the program and perceived ability of the program to increase, enhance and support learning and allow self-paced learning. Also, an evaluation of the learning value of individual components in the system and overall satisfaction with the program.	Ai-Lim Lee et al., 2010; Davis, 1989
21 – 28	Manufacturing career interests	Motivations to register for the course, influences on career pathway, interest in manufacturing (as a field, career and class topic), importance of recruitment tools for manufacturing and overall value of the manufacturing course.	Kier, Blanchard, Osborne, & Alber, 2014; Educational Research Center of America, 2015; The Manufacturing Institute, 2014