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CREATING A STATE-WIDE TRANSFER PROGRAM FOR ENGINEERING TECHNOLOGY AND TECHNOLOGY MANAGEMENT STUDENTS

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Abstract

The primary purpose of the Western Kentucky Pipeline for 2+2+2 Engineering Technology and Technology Management (ET/TM) students program is to significantly increase degree production and workforce preparation in central and western Kentucky through the construction of a long-term sustainable, reproducible model bridging program of cooperation between Western Kentucky University (WKU), Murray State University (MSU) and the Kentucky Community and Technical College System (KCTCS). The program will significantly increase industrial and technology education opportunities, technology enrollment and two- and four-year degree completion. Additionally, this project supports the Kentucky Council on Postsecondary Education's (CPE) goal to double the overall number of undergraduate degrees granted. Kentucky's "2020 Goals" represents a united P-16 effort to improve student achievement, compared with national norms. This program will establish and demonstrate a model that may be replicated throughout the Commonwealth. Other states may find elements of the model useful.

Introduction

Technology revolutionizes and advances all aspects of modern life. While the strategic importance of attracting and retaining more students to STEM disciplines cannot be overstated, it must be stressed that engineering technology (ET) and technology management (TM) are critical fields in the overall endeavor—fields in which new innovations are applied to real-world problems in order to improve the quality of life for our citizenry. Our recruitment and retention approach is centered on conveying this exciting impact of technology. Despite this crucial role in our standard of living, technology is frequently misunderstood by society—it is primarily perceived to be related to computers, electronics and the Internet [1]. Popular media generally promote the engineer and scientist over the knowledge and applied skills of the technologist, and advanced technology programs are often an afterthought for students interested in science and engineering. Early exposure to advanced technology for students ultimately prepares them to obtain a position of leadership in business, industry or workforce development in support of innovation and global competitiveness.

In order to increase the number of talented students entering ET and TM, three broad themes need to be addressed. First, students need to see the excitement of this field, recreating the charisma of science and technology that was so evident during the twentieth-century "Space Race." Second, once attracted to the field, student motivation should be maximized by underscoring personal buy-in and ownership of projects by students. Finally, streamline inter-institutional transfers in order to ensure that students remain committed to achieving a baccalaureate or higher credential in this field.

This paper outlines an approach to create just such an environment for the fields of Engineering Technology and Technology Management. The approach is novel, exciting, engaging and straightforward. The purpose is to outline a statewide or regional ideological plan to increase degree production and workforce preparation. The example provided will highlight the development of a long-term sustainable and reproducible program of cooperation in central and western Kentucky between two comprehensive universities and state community and technical college systems. It will show how such an approach would improve the preparation of the workforce by transforming and opening industrial technology education opportunities to students in regions of Kentucky where the talent pool remains largely untapped. The goal is to significantly increase the industrial and technology education opportunities, technology enrollment and two- and four-year degree completion. This paper proposes a model that could be implemented in Kentucky. Other states may find elements of the model useful.

According to Maurizio [2], the integration of secondary and post-secondary technical education increases the visibility and desirability of technology programs and promotes first-generation college success in this area. The pipeline approach has been demonstrated to increase student retention, decrease overall program costs while increasing services, improve overall program delivery and provide significant economic benefits [3].

The Kentucky Example

The targeted service region is comprised of thirty-eight counties of western Kentucky with very low rates of post-secondary education; only five counties have 15% of the population with a baccalaureate degree or higher [4]. This would particularly target first-generation college students, students in rural or underserved areas, and non-traditional students with potential and talent but with financial challenges. All seven of the community college partners are within one hundred miles of either the partnering universities, where students can continue to pursue coordinated four -year degree programs in ET and TM. Additionally, this supports the statewide goal enunciated by the Kentucky Council on Postsecondary Education (CPE) to double the overall number of undergraduate degrees granted. Kentucky's "2020 Goals" represents a united P-16 effort to improve student achievement, as compared to national norms [5].

The community and technical college system in Kentucky is the largest provider of postsecondary education and workforce training in the state, and the proximity of many of its campuses supports reasonable expectations for students to seamlessly commute or relocate to the receiving universities to continue their studies. Current enrollment in the community and technical college system is 98,000 students, with approximately 600 technology students transferring to the partnering universities each year. The number of STEM degrees conferred by these universities combined has increased every year and now exceeds 600 per year. Current university ET and TM degree production represents approximately 23% of the total STEM degree production, an increase of 7% since 2005.

Program Goals

The overarching goal is to create a vibrant, seamless pipeline in ET/TM disciplines from secondary school to baccalaureate success. The specific goals would be to:

1. Increase ET/TM involvement of secondary and post-secondary teachers and school counselors.
2. Increase the number of associate degrees awarded by partnering community colleges.
3. Increase the number of community college transfers into ET/TM disciplines at the partner universities.
4. Double the number of baccalaureate degrees awarded in ET/TM over a five-year period.

Recruitment efforts should be directed to middle school, high school and community college students, as well as existing university undergraduates. Once students are enrolled at the community college level, efforts should be focused on fostering the transition to the baccalaureate level and beyond. In Kentucky, although a transfer structure exists, the success rate for transfers to the universities is poor, ranging from 16 to 28 percent [6]. However, STEM disciplines are one of the highest areas of interest for transfer students [7]. There is ample opportunity for considerable improvement in the transfer rate if students are engaged early and successfully sustained through the pipeline.

The Approach: Institutions Operating as One

No single institution is simply a provider or a user. Rather, all participating institutions are intimately involved in the development, implementation and success of the program. This program allows the partnering institutions to function as one large educational institution (unprecedented in many educational environments) to provide the best possible career opportunities. The barriers in educational administration and control will become less critical as the needs of the students in Kentucky and the region are placed as a priority. The logistics and operations of this are challenging.

In addition to further developing the existing 2+2 programs, the approach requires the participating institutions to provide a seamless transition from the community college to the university. The faculty work closely with regional industry to develop "relevant and interactive" courses fully developed for online delivery to students and industry professionals. The following describes how each institution contributes to the goals and objectives.

University Level

Two institutions are represented at the university level. One institutional program focuses primarily on technology management while the other focuses on engineering technology. The technology management programs consist of advanced manufacturing, architectural science, construction management and industrial education. These programs maintain an enrollment of approximately 400 students and graduate 60-70 high-quality majors each year. The institution has had a 2+2 agreement with the community college system for the last five years. This program has grown from 33 students in 2007 to over 70 majors using online course delivery to students in Kentucky and across the U.S. Faculty and administration consistently support the online program and are particularly interested in further development as it relates to retention of transfer students, as this is an institutional strategic goal.

The engineering technology programs consist of architectural engineering technology, civil engineering technology, construction engineering technology, environmental engineering technology and electromechanical engineering technology. It also includes three industrial technology programs of engineering graphics and design, interior design, manufacturing technology, as well as a telecommunications systems management program. With over 500 students, this unit produces 80-90 highly technical and industry-focused graduates annually. The institution has had a 2+2 agreement with the community college system for over 12 years and also uses an online delivery method for courses.

Duplication of the 2+2 model allows students to transfer from the community and technical colleges into the universities without duplication of coursework. The current state of industry across Kentucky and the U.S. is the reconditioning of industry to cutting-edge, state-of-the-art high-tech production and integration. TM and ET programs are positioned to have a great deal of interaction and support for the direction of industry throughout this region as there is almost 100% placement in the manufacturing industries.

Using new and cutting-edge technology, students in years three and four of the programs have hands-on experience in lab-based courses using VMware and Internet capabilities to operate equipment remotely from wherever they live in the world. The live, hands-on labs set these programs apart from other on-line programs around the world. Faculty and administration have fully embraced the direction of the programs and anticipate future program development, especially through the exploration and delivery of an interactive remote online program.

Community and Technical College Level

In Kentucky, the community and technical college system consists of campuses strategically located to provide accessible education and workforce training that is relevant and responsive to the needs of students, business and industry leaders, and the communities they serve. They offer certificates (some as short as 6 weeks) and diplomas as well as two-year associate degrees in over 600 credit program offerings. The most popular area of study is the baccalaureate transfer program, which allows a student to earn an associate degree and then transfer to a four-year institution within the state.

While emphasizing its historical mission to provide general education, the community college system has expanded its focus on occupational/technical education. In the past 10 years, the Kentucky Community and Technical College System (KCTCS) has become the largest provider of post-secondary education and workforce training in the state. In 2007, KCTCS provided workforce services to 4,850 businesses and industries and approximately 48,000 employees [8]. More recently, KCTCS and the state of Kentucky invested millions of dollars in the development of state-of-the-art emerging technology centers at many of the community colleges. These institutions are perfectly positioned to articulate with four-year institutions with innovative, industry-relevant engineering technology and technology management programs.

All of the KCTCS institutions work very closely with the universities. Students throughout Kentucky (and on-line around the world) have the ability to either physically attend one of the participating community colleges or work completely *on-line* to progress through an Associate of Applied Science (AAS) degree and then move forward to a Bachelor of Science degree. What is different from most on-line programs is that these students would have the potential to work with hands-on lab equipment in one of the institutions or work on lab equipment from any remote location (e.g., home, work). Students would also have the choice of graduating from an AAS degree into a technology-management-based curriculum or articulate to an engineering technology program. This would provide the best alternative for a student wanting to go beyond the AAS degree.

Secondary Level

Kentucky has over 200 high schools in the state [9]. Transition-to-college programs for high-school students typically cater to those deemed either gifted or at-risk with very little attention paid to the middle majority. One of the more successful transition programs has been Tech-Prep, a vocational and technology education curriculum that promotes articulation agreements between secondary schools and community colleges. Cellini [10] found that Tech-Prep participants were more likely to complete high school and attend a two-year college. While encouraging, the results of the study also found that the same participants were less likely to attend a four-year university. This has led to some concern that programs like Tech-Prep may be diluting the college-prep track. Conversely, the findings may be an indicator that more articulation and cooperation is needed between community colleges and four-year institutions in the ET and TM areas.

A number of other states such as Oregon, Illinois, Maryland, Georgia, New York and Washington have implemented statewide programs that prepare students both vocationally and for college. The programs develop and measure both aptitudes and skills critical for work or post-secondary success. In some cases, the measures are used instead of

placement exams [11]. Statewide articulation helps reduce confusion between different high schools and post-secondary institutions. Articulation should be more than local agreements between schools. Articulation should be comprehensive, involving all levels of education [12-14]. Kentucky could easily do some of the same coordination.

Middle School Level

At the middle school level, transition to secondary school programs is virtually non-existent, but some degree of coordination between educators at the middle and secondary level is desirable. Particularly, there should be common agreements about grading, promotion, educational objectives and guidance counseling. If articulation is to take place, it should be based upon what knowledge and skills are needed at the next level. From a vocational perspective, educators need to ask employers what skills are necessary to obtain and hold a job. This could then lead to courses or programs such as business writing or applied math that reinforce these skills and encourage interest [15]. National studies have indicated that it is in the middle grades where most students begin to formulate their career goals and where many students lose interest in math and science [16-17]. Exposing middle schools to some form of technology is a critical component for establishing a sustainable pipeline.

The Program Plan

Each educational institution brings unique and valuable experience and expertise to the program. The plan seeks to build on proven capabilities to produce a powerful mechanism for ET/TM degree production, workforce development and economic growth in Kentucky. The approach has four strong activities to support and expand efforts to recruit, prepare and retain highly qualified ET/TM majors. The activities are targeted recruitment, student engagement, articulation and capability development. Each of these attracts potential students and builds capacity for the knowledge/ skills needed at the university level.

Targeted Recruitment

The establishment of a secondary education pipeline:

a) In an effort of this breadth and scope, it is critical that target markets, such as students, parents, counselors and faculty, be fully informed of the unique opportunities that it provides [18]. According to Lipton [19], "thoughtful consideration must be given to strategies for marketing the program on several levels." Therefore, a full-time professional advisor assigned to the 38-county service area of WKU and MSU as a service area circuit rider is critical to overall success. The circuit rider has direct and frequent interactions with the target middle and high schools. This person is responsible for promotion of ET/TM careers and pre-technology curricula, publicizing the various opportunities and features of the collaboration, scholarships, summer opportunities and workshops and conferences. Through direct interaction with students and teachers, the circuit rider enhances positive perceptions about technology careers and provides consistent information about the technology programs with the high schools, two-year community colleges and four-year universities. The circuit rider position will be funded and shared between MSU and WKU.

b) Scholarships, identified by all partner schools and administered by the community college system, are awarded to students who take math and science courses in high school and plan to enroll in any of the participating schools. The service region consists of 38 counties with a population of more than 900,000. In this region, 28 of the counties have low socioeconomic status compared to the U.S. average poverty rate of 13.2% [20-21]. The scholarships are reserved for students who successfully complete mathematics at the algebra II level, have a minimum of five science credits, an overall 2.5 grade point average, and meet the federal criteria for financial aid.

c) ET/TM career encounter programs and early career counseling for young students plays a critical role in providing students a chance to explore careers outside of their social norms. One day each summer, one of the participating post-secondary schools would host a "Super Saturday" for high school students to introduce them to applied engineering and industrial technologies using hands-on instruction in one of the campus laboratories. This could be done in conjunction with career-planning fairs held at the postsecondary schools for students, teachers, and guidance counselors to inform them about educational and career choices available for students interested in technology.

Student Engagement

Sustain students through the pipeline and across institutions:

a) The circuit rider would nurture student awareness, enthusiasm and capabilities that end with transfer and completion of programs at one of the university programs. The aim is to provide motivation and seamless continuity for a student even when this crosses institutional boundaries.

b) ET/TM distance students would be automatically enrolled in the on-campus national professional student chapter organizations such as the Association of Technology, Management, and Applied Engineering (ATMAE), The Society of Manufacturing Engineers (SME) or the International Society of Automation (ISA). This would promote communication, friendships and collaboration with traditional on-campus students for senior projects, design competitions and student chapter activities.

c) The community college technology students would be invited to participate in national competitions, design teams and chapter student activities at the four -year institutions and vice versa.

Integrated Articulation

Provide for a seamless transition between institutions:

a) Permanently establish 2+2 programs through Memoranda of Agreements (MOA) for ET/TM disciplines for a seamless transition with little or no lost credit hours between institutions. Make long-term agreements by providing or expanding block or program articulation through which the completion of coursework at one institution results in advanced placement at another. This strategy is much more effective than course-to-course articulation [2], [19]. Annual meetings among the principles at the participating institutions would facilitate this.

b) There should be transition, advising and support services for transfer students to establish connections with the university and their departments of interest. In particular, offer campus tours, create student cohorts and provide access to the well-established transition programs at the universities.

c) Offer programs at the community college that are focused on community needs and career opportunities for ET/TM-targeted enrollment, while using the pre-existing, degree-granting capability and teacher base of the universities using both distance and face-to-face formats.

d) A scholarship program for students who graduate from the community college with a GPA of 3.5 or higher would cover the difference in tuition costs between the university and the community college for their remaining two years of study.

e) Expand non-traditional student opportunities for ET and TM degrees via industrial cohorts in agreements with commercial partners that have industrial and technology employment needs.

f) Hold annual conferences for faculty that include facility and capability reviews of the participating institutions. The purpose of these reviews would be to reduce redundancy of equipment and services and identify gaps in curricula or resources.

Capability Development

Support teacher and counselor development:

a) In-service and pre-service workshops and conferences should be held for industrial technology secondary/post-secondary education teachers and school counselors. This would promote sharing of best classroom practices and recruitment strategies between a team of likeminded individuals “in the trenches”.

b) Critically lowly enrolled courses should be evaluated for funding streams so they can be offered with adequate frequency at the participating institutions. The growth plan of the program is to increase the total number of students in the program at all levels to a self-supporting level.

c) Provide initial front-end funding for needed laboratory classroom and equipment development in ET/TM-related classes and labs such as the ones that will be identified in the following paragraphs.

Facilities for ET/TM majors are critical to establishing a high-quality curriculum. While the universities have infrastructure for science labs and other crucial parts of the curricula, all partner schools would need to review and assess existing facilities for quality and equipment. In particular, the following areas have high potential.

- Multi-skilled technician programs. One such example is the Advanced Industrial Integrated Technology (AIIT) program at KCTCS-Madisonville campus. Students have three options within this program: multi-skilled technician, medical instrumentation and management, or power plant technician. The last option, established in 2010, meets the needs of coal-fired power plants to help replace their aging workforce. It is the only degree in the state that directly prepares graduates to work as skilled technicians in coal-fired power plants.

- Food automation programs. An example is the Automated Food Processing program in Advanced Manufacturing at Western Kentucky University (WKU). In

partnership with KCTCS-Owensboro, Perdue Farms and the Owensboro Economic Development Authority, WKU is developing a scale-up laboratory with major unit operations in food manufacturing, biotechnology and agro-technology. Due to the geographic location and a readily available workforce, this region of Kentucky is fast becoming attractive to food processing facilities. However, industry is unable to recruit enough technically competent managers for the growth envisioned. The program provides students with the unique opportunity to do applied research with food processing companies such as Smuckers, Marzetti, Sara Lee, Unilever, Specialty Foods, Tyson, Barton Brands and Swedish Match.

- Early college-start programs. The OnTrack program at KCTCS-Bowling Green is a partnership between three of the region's largest county high schools. It provides opportunities for college success, affordability and a head start in college achievement while in high school. In its first cohort, 93% of high school participants matriculated into a college or university. Students graduate "college ready" with no requirement that they take developmental courses. The project raises funds to alleviate any financial hardships for high school students who cannot afford to pay for college tuition or books. Students enroll in the technical school while still in high school in order to gain a head start to finishing college. This allows students to graduate high school with workplace skills. Students have the potential to earn college credentials while enrolled in high school. The joint admissions agreement gives students access to more resources and creates a smooth and seamless transfer pathway to a four-year degree. It ensures a successful transfer process for students in engineering technology, nursing and related health occupations, and an associate degree in science.

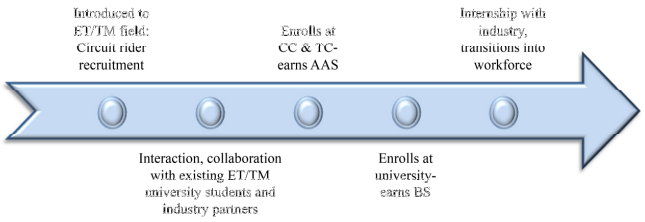

Figure 1. Transitioning Through the Pipeline – An Example of How a Student Might Transition Through the Program

Conclusion

Among the STEM disciplines, technology programs are often an afterthought for students interested in science and engineering. A well-designed program such as the one described here would help dispel the myths associated with the technologist and their applied skill sets and could redefine the value of the technologist as a viable career path for young men and women to advance in science and engineering for practical use.

Strategies include development of a secondary education pipeline, transition and transfer support for post-secondary institutions, instructional and course support at all levels, and capability development. Well-designed cooperative agreements between secondary and post-secondary technical education programs increase visibility, promote first-generation college success and dispel media-perpetuated myths [2]. The strength of collaborative relationships can transform the technology education pipeline and improve the economic prospects of the future workforce. Coupled with the innovative use of the multi-institutional partnerships and the circuit rider position, this plan could double the annual production of baccalaureate ET/TM degrees over a five-year period. However, institutional commitment is important for sustaining subsequent gains.

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