Building a STEM Pathway with Engineering by Design and

Ms. Laura E. LeMire, The Community College of Baltimore County

Upon graduation from the University of Maryland at College Park with her masters in geotechnical engineering, Laura went to work for Baltimore Gas and Electric where during her career there she was responsible for substation and transmission line construction projects, relocation and installation of BGE facilities for Oriole Park at Camden Yards and for the Light Rail, and for improving service reliability. After obtaining her MBA, Laura became the Director of Corporate Purchasing and was a financial analyst in Investor Relations. Laura left the utility to become the Director of Women’s Sports at STX, Inc., a sporting goods manufacturer where she became the holder of four patents. Returning to the classroom once again, Laura obtained a Masters in environmental engineering from UMBC and became an Affiliate Professor for Project Lead The Way. Laura is the Acting Engineering Department Chair at the Community College of Baltimore County (CCBC) where she has built an engineering technology program and doubled the size of the engineering transfer program by stimulating interest in high school students, training PLTW teachers, and obtaining scholarships to help students cope with the expense of college. In addition, she is the PI on three NSF grants and a Northrop Grumman grant. In her spare time, Laura continues her pursuit of athletics, toils in her garden, and travels the world.
Building a STEM Pathway with Engineering by Design™ and

Early Counselor Intervention
Building a STEM Pathway with Engineering by Design and Early Counselor Intervention

Laura E. LeMire

Abstract

The Community College of Baltimore County (CCBC) is aligning high school advanced technology education curriculum with college-level engineering technology programs to increase the number and diversity of high school students pursuing two or four-year degrees in engineering technology. Skilled engineering technicians are a critical part of the nation’s high-tech workforce and frequently require an associate’s degree. To help meet that demand, CCBC, with funding from the National Science Foundation, created an articulated pathway with Baltimore Public Schools in Maryland utilizing Engineering by Design™ (EbD) courses developed by the International Technology and Engineering Education Association (ITEEA) and used by many secondary schools throughout the United States. After taking a fundamental technology course, high school students may elect to enroll in the EbD advanced technology education courses called Advanced Design Applications (ADA) and Engineering Design (EngD). Upon successful completion of these two courses, high school students can earn articulated credit for CCBC’s Introduction to Engineering Technology course. Receipt of college credit opens the door of higher education to many students who may not have considered college an option.

The model developed by CCBC is being replicated by other colleges. As each college has a unique introductory course for its engineering technology program, supplemental materials will be developed for ADA and EngD to meet the college’s specific course requirements. A library of supplemental materials will gradually be created that will enable colleges to create an articulated pathway with their Local Education Agency (LEA) by pulling from existing materials rather than having to create their own. Since the ITEEA EbD curriculum is widely used throughout the state of Maryland and across the country, the potential exists to expand this approach nationwide.

In addition to creating an articulated pathway from high school to a college-level engineering technology program, CCBC developed a training program for school counselors. The training makes counselors better able to encourage students, especially those from underrepresented groups, to pursue a career in Science, Technology, Engineering or Math (STEM) and to enroll in the EbD series of advanced technology education courses with the goal of continuing education beyond high school. Topics covered with the counselors include local STEM job opportunities and needed skill sets, micromessaging, neuroscience, and the EbD articulation initiative. The development of the articulated pathway and the training of counselors are helping to broaden participation in engineering technology careers by creating a more seamless and efficient pathway from high school into technician jobs requiring an associate’s degree.
Introduction

Employment projections for engineering technicians are good and must continue to grow if the United States is to keep up with technological development in other countries. Jobs in architecture and engineering in Maryland are expected to grow by 35% between 2010 and 2020, with engineering technician positions in particular growing by 30%.\(^1\) Nationally, job growth predictions for fields within engineering technology range from 2% to 24%.\(^2\) These industry and employment trends will be intensified by national policy. A continued focus on vocational and technical careers has been identified as one of the top 10 state policy issues for 2014 by the American Association of State Colleges and Universities (AASCU). In 2013, governors and state lawmakers changed state financial aid programs and provided scholarships to students enrolling in career and technical programs to increase awareness of well-paying, available jobs requiring vocational and technical training.\(^3\) Research indicates that, in order for the United States to retain its preeminence in science and technology, a million more STEM professionals will be needed over the next decade.

Key to reaching this goal is an increase in the retention of current STEM students. This can be accomplished by training STEM faculty in an evidenced-based teaching method that keeps the students actively engaged in the STEM field.\(^4\) In addition, the results of a study that evaluated a number of engineering curriculum projects, from small to large, determined that when done well, engineering projects are meaningful to a student’s personal experience. It is easier for them to relate to how a city or a bridge is constructed than an abstract geometry problem or even a science experiment. Engineering is a problem-solving discipline that through iteration, experimentation, inquiry and research can capture the interest of a student.\(^5\) The International Technology and Engineering Education Association (ITEEA), a nonprofit professional organization of educators, addresses both the training of STEM teachers and the provision of a problem-solving, project based technology curriculum.

As skilled engineering technicians are a critical part of the nation’s high-tech workforce and frequently require an associate’s degree, in 2013, The Community College of Baltimore County (CCBC) began working with ITEEA, the Maryland State Department of Education (MSDE) and Baltimore County Public Schools (BCPS) to align the county’s high school advanced technology education curriculum with CCBC’s college-level engineering technology program. In order to increase the number and diversity of high school students pursuing two or four-year degrees in engineering technology, CCBC, with the support of ITEEA, MSDE and BCPS, sought and received funding from the National Science Foundation (NSF) to create an articulated pathway between BCPS and CCBC utilizing Engineering by Design™ (EbD) courses developed by ITEEA and used by many secondary schools throughout the United States. To encourage more students to pursue the articulated engineering technology pathway as well as other STEM careers, CCBC included professional development for school counselors in the program. The training is designed to enable counselors to better identify, encourage, and provide appropriate advisement for secondary school students who are interested in STEM.

CCBC subsequently sought a new Advanced Technology Education (ATE) grant from NSF in order to replicate its model for aligning engineering technology curriculum between a high school system and a local community college in other regions within the state of Maryland and in
Illinois where the curriculum was originally developed. NSF awarded CCBC grant DUE 1400583, Generating Excitement and Training for Engineering Technology (GET ET), to fund the expansion, addressing the need for a broader and more diverse technical workforce through curriculum alignment and professional development for teachers and counselors.

**Background**

*The Community College of Baltimore County*

As the largest provider of higher education and work force development training in the Baltimore metropolitan area with 23,136 students enrolled in credit courses and total enrollment exceeding 67,000 in 2014, CCBC is well positioned to meet the growing need for engineering technicians. Significantly, ninety-one percent of the college’s graduates continue to live and work in the Greater Baltimore region.

*The International Technology and Engineering Education Association*

ITEEA’s STEM Center for Teaching and Learning™ (STEM-CTL) was established in 1998 to strengthen professional development and advance technological literacy. STEM-CTL initiatives are directed toward four goals: development of standards-based curricula, teacher enhancement, research concerning teaching and learning, and curriculum implementation and diffusion. STEM-CTL develops and disseminates quality educational products and services specific to local and professional development needs. EbD is a national STEM-CTL program developed collaboratively by a consortium of states, ITEEA’s Technology Education Advisory Council, ITEEA institutional members, and the science, mathematics and engineering communities. The program is built on the Standards for Technological Literacy (ITEEA); Principles and Standards for School Mathematics (National Council of Teachers of Mathematics); and Project 2061, Benchmarks for Science Literacy (American Association for the Advancement of Science).

*Engineering by Design*

EbD is designed to make K-12 students more technologically literate. Students participating in the program learn concepts and principles in a problem-based environment that includes individual and group hands-on projects. The goals of the EbD Program include: providing a standards-based K-12 program that ensures technological literacy for all students; providing opportunities for all students without regard to gender or ethnic origin; setting clear standards and expectations for increasing student achievement in math, science and technology; and providing leadership and support that will produce continuous improvement and innovation in the program.

The EbD curriculum is directed toward students interested in careers as engineering technicians, engineers, or technology educators and is aligned to Common Core objectives and Next Generation Science Standards. The high school courses are taught in 36-week modules and include: Foundations of Technology (FOT), Technology and Society, Technological Design, Advanced Design Applications (ADA), Advanced Technological Applications, and Engineering
Design (EngD). A consortium of states works collaboratively to help teachers of EbD courses improve student achievement and technological literacy.

**Curriculum Alignment**

In the State of Maryland, high school students are required to take a technology education credit that includes “the application of knowledge, tools, and skills to solve practical problems and extend human capabilities.” In addition, one of the three options available to Maryland public school students to meet graduation requirements is the completion of two advanced technology education classes. As a part of Maryland’s Race to The Top efforts, MSDE contracted with ITEEA to provide its FOT course to all ninth grade students in the state. Because aligning curriculum between high school and college technology programs makes the engineering technology career pathway a more viable option for students and increases the number pursuing post-secondary education, CCBC worked with BCPS and MSDE to identify which EbD advanced technology education courses best met the learning outcomes included in CCBC’s Introduction to Engineering Technology course (EGNT 101). It was determined that the material covered in ADA and EngD was the closest match, and with the addition of certain topics to the course curriculum, high school students who successfully complete the two EbD advanced technology education courses could earn articulated credit for EGNT 101 in addition to meeting the graduation requirements for their high school diploma.

**School Counselor Training**

Professional development is of particular importance for school counselors because they can strongly influence a student’s decision to pursue engineering technology or inadvertently reinforce social stereotypes that discourage members of underrepresented groups (especially women) from pursuing a STEM education, especially in technology. The low rate of on-time high school graduation in the United States (76% in 2009), particularly among blacks, Hispanics, and native groups (about 20% below the combined rate for whites and Asians) represents the loss to our economy of large numbers of potential talented engineers and engineering technicians. This differential is compounded by the fact that a smaller percentage of graduates from the underserved groups immediately enroll in college, as compared to their white and Asian counterparts. Moreover, those who graduate from high school late, or earn a GED, have more trouble returning to school, especially for technical training. Providing STEM focused professional development for school counselors will result in a broader and more diverse pool of students completing secondary school career technology programs and enrolling in post-secondary engineering technology programs.

**Methodology**

**Curriculum Alignment**

After ADA and EngD were selected as the most closely aligned EbD advanced technology education courses, a crosswalk was conducted between the EGNT 101 curriculum and the EbD curriculum to determine what topics were missing and what supplemental resources needed to be developed for ADA and EngD. CCBC faculty worked with BCPS, MSDE and ITEEA to
identify the optimal units in the existing courses in which to add the supplemental resources and to incorporate spatial skills enhancement—a critical component for success in STEM, especially for women and minorities.

With the overall structure in place, a team of EbD high school teachers and administrators were assembled to write the new material with input from CCBC. With NSF permission, a portion of the funds available in the first and second one-year extensions of CCBC’s Project Lead The Way professional development train-the-trainer grant (DUE-1003317) were allocated to pay for the curriculum development as well as the subsequent training for the BCPS instructors teaching the EbD courses and for BCPS elementary, middle and high school counselors. Writers began with the ADA curriculum as it is the first course in the EbD advanced technology education sequence. ADA is comprised of four major units: transportation, energy and power, manufacturing, and construction. Under the direction of a lead writer, writers were assigned to the four different topic areas for the creation of new material. New materials developed were reviewed by ITEEA for formatting and compliance with Common Core objectives and Next Generation Science Standards. The edited materials were intended to be uploaded to ITEEA’s website to create a library of supplemental instruction accessible to all schools teaching ADA nationwide. However, the enhancements and additions made to the existing curriculum were determined to be of such quality and merit that they were incorporated into the core ADA curriculum.

Under the direction of a lead writer, writers were next assembled to create missing content identified by the crosswalk for inclusion in EngD and to enhance the existing curriculum. Like ADA, EngD is comprised of four units: Principles of Design; Engineering Resources; Engineering Design Process; and Project Management/NASA Project Management. Some of the topics included in these units include: engineering disciplines, factors affecting design, the engineering design process, project management, scientific calculations, and testing. The new materials developed will be reviewed by ITEEA for formatting and compliance with standards, and then incorporated into the core EngD curriculum.

As the process is replicated by other community and four-year colleges, new materials developed for ADA and EngD will be uploaded to ITEEA’s website after formatting and compliance review, to create an open-access library of supplemental instruction materials.

**Professional Development for EbD Teachers**

Providing professional development (PD) for teachers enables them to be more confident teaching the material and more effective at communicating the concepts and lessons to the students. To ensure EbD trainers well versed in ITEEA procedures and protocols in addition to being content experts, they are required to attend a weekend Authorized Trainer Institute (ATI). CCBC contracted with ITEEA to train a number of high school teachers and college faculty members to become trainers for ADA and EngD courses, and to arrange for the teacher PD training for the modified courses.

The PD for EbD teachers is five days in duration and is held in the summer. In addition to learning the course curriculum, during the week-long training the teachers build a community that will work together and provide support for each other as they begin teaching the new courses
at their schools. Although it is not necessary for every Local Education Authority (LEA) to have an ITEEA authorized trainer, having a pool of trainers within the state will facilitate scheduling of future training and minimize training costs.

**Professional Development for School Counselors**

During the 2013-14 school year, CCBC developed and implemented a training curriculum for school counselors that incorporates aspects of the NSF Educators’ Equity STEM Academy (EE-STEM) Academy grant (DUE-1104163) of which CCBC was a sub-awardee from the National Alliance for Partnership in Equity Education Foundation. The goal of EE-STEM was to increase the enrollment, academic performance, and program completion of women and other underrepresented groups in STEM programs by improving classroom pedagogy while counteracting discouraging micromessages that students may receive from the broader culture. Separate but overlapping curriculum was developed for elementary, middle and high school counselors that encompassed: STEM skill sets and job opportunities; micromessaging; neuroscience; “all about STEM;” and the EbD articulation initiative.

The original plan was to conduct a two-day 16-hour workshop for counselors, but after discussions with the BCPS Coordinator of the Office of School Counseling, it was decided to condense the training into one-day sessions targeted for the three school levels. As a part of the PD, counselors are connected to the Baltimore County Division of Workforce Development (DWD). The DWD, in concert with the county’s Department of Economic Development, acts as a broker for initiatives designed to develop a skilled workforce. Similar collaborations with state and county agencies are to be encouraged in other regions where the program is replicated.

At the conclusion of the PD, counselors were asked to complete a survey to measure the success of the training. The elementary and middle school counselors were given a standard survey used by Baltimore County for training, and the high school counselors were given a customized survey to get more detailed feedback on specific topics as well as on the presentation itself.

**Student Ambassadors**

To further encourage high school students to pursue STEM, CCBC is recruiting current Engineering Technology students to be Student Ambassadors. These Ambassadors will visit local high school technology classes and discuss topics related to engineering technology and how to successfully transition from high school to CCBC. Work done by the South Carolina Advanced Technological Education National Resource Center for Engineering Technology Education has demonstrated the effectiveness of using student ambassadors, as high school students are more receptive to a message delivered by someone closer to their age to whom they can better relate. (SC ATE National Resource Center, 2013). Student Ambassadors will work in pairs for comfort, to be better able to answer questions, and to represent a broader range of student diversity. Other participating community and four-year colleges will be encouraged to follow this model.
Replication of Program

To expand the GET ET program to other regions, CCBC identified and contacted the community colleges in Maryland that offer engineering technology and the supervisor of Career and Technical Education (CTE) from each LEA that feeds into those colleges. Information sheets were developed and given to each of the parties and meetings were held with interested colleges and LEAs to describe in more detail what the program involved and how to go about replicating it. EbD Collaboration Teams are being formed for each high school - community college/technical college alignment to help implement the program. These teams consist of representatives from the LEA’s CTE and counseling departments, community college personnel, an ITEEA representative, and local employers. The college is responsible for providing the overall coordination between the college, CCBC, ITEEA and the local LEA(s), and for arranging and providing facilities for the trainer, teacher, and counselor training. Together the college and LEA will 1) conduct a crosswalk between the college’s Introduction to Engineering Technology or similar class and the EbD curriculum to identify topics missing from ADA and EngD; 2) identify writers and trainers for ADA and EngD to create missing material and to become certified ITEEA trainers to conduct PD for local teachers; 3) work with ITEEA to oversee the creation and piloting of new materials (if required); 4) create an articulation agreement for the Introduction to Engineering Technology or similar class; and 5) conduct professional development for K-12 school counselors, and 6) train ADA and EngD teachers.

The LEA collaborates with the college and makes every effort to offer the EbD ADA and EngD courses in as many schools as possible to maximize the number of students who can take advantage of the articulated credit and follow the pathway into the college’s engineering technology program. The LEA is responsible for: establishing the schedule for and holding the counselor training in collaboration with the community college; and for selecting teachers to participate in the EbD PD which is to be conducted regionally if feasible.

Each LEA and community college, as they are added, will begin by modifying and/or creating supplemental resources for ADA and EngD to align with the community college’s introductory Engineering Technology class if necessary. New materials created by curriculum writers to fill gaps between the EbD courses and the college engineering technology curriculum will be made available to all EbD participating school systems via the EbD website “library” of supplemental materials. As students will normally take the EbD courses in successive years, the writing can also be done over a two-year time frame. The first year, the ADA material will be created and submitted to ITEEA by mid-March providing time for editing and posting on their portal prior to the ADA summer training. By mid-March of the following year, the EngD materials will be created and submitted to ITEEA for review, and the EngD teacher training will be held during the second summer.

Participating community colleges are encouraged to explore and develop transfer pathways to regional four-year institutions with the goal of maximizing the number of credits that may be transferred. The ease of transition from high school to two-year programs to four-year institutions will encourage student participation in the community college Engineering Technology program.
States that wish to replicate the GET ET program are encouraged to meet with representatives from community colleges that currently have or are considering creating an engineering technology program, as well as Career and Technical Education supervisors from LEAs across the state. The meeting(s) should cover the articulation program requirements and implementation process as well as counselor training and spatial skills development requirements.

Results and Discussion

Curriculum Alignment and Professional Development Training

After CCBC, MSDE and BCPS conducted a crosswalk between ADA and EngD and EGNT 101, writers were assigned to each of the four ADA units to create the needed materials. Due to multiple changes in personnel, including the lead writer, the writing process was extended into the summer of 2014. At that time, a writing workshop was held at CCBC with a representative from ITEEA present to answer questions and provide guidance to the writers. During the writing process, it was determined that a formatting template was needed for the benefit of the writers as well as the ITEEA editors. After reviewing the new materials, ITEEA chose to incorporate the new content, into the core ADA course. As a result, no materials were included in the supplemental material library (library). The new and revised materials were edited and uploaded onto the ITEEA portal along with new material lists and “first five days” activities and curriculum. Training for BCPS and other Maryland teachers was conducted at CCBC in July 2014 by an ITEEA authorized trainer and two of the curriculum writers who are being trained as trainers and will attend an ITEEA Authorized Trainer Institute (ATI) in May 2015. Following the training, modifications were made to the curriculum to incorporate suggestions made by the teachers attending the training. The BCPS teachers began teaching the new ADA curriculum in Fall 2014. Writers are now in the process of creating materials for EngD, including spatial reasoning development and assessment using the Purdue Spatial Visualization Test: Rotations (PSVT:R). The new materials are expected to be incorporated into the core EngD class and made available on the EbD portal by June 2015. Training for the BCPS EngD teachers will be held in June 2015 and the new curriculum implemented in Fall 2015.

Out of the 26 BCPS high schools, twelve offered ADA as an advanced technology education option in 2013-14, while only six offered EngD. Many schools steer students who are not in a state-approved career and technology program and are unsuccessful taking a foreign language into the advanced technology education graduation option and choose to offer ATA which is not as rigorous as EngD to maximize their chances of success. On the other extreme, some schools offer a more advanced Engineering Design and Research course and others offer Project Lead The Way pre-engineering curriculum. With the new articulation option available, more schools are expected to offer EngD starting in 2015 as evidenced by the enrollment of as many as 13 teachers in the summer 2015 EngD training.

Professional Development for School Counselors

The GET ET grant Co-Principal Investigator, who is CCBC’s STEM Liaison and a biology professor, developed and implemented a training curriculum for school counselors in BCPS
during the 2013-14 school year. Topics covered in the one-day training sessions included: preparation needed for students to be successful in an advanced technology program of study; micromessaging; development of the brain and the neuroscience of decision making, especially for teenagers; fixed versus growth mindset, technology education at CCBC; technical career pathways and opportunities in Baltimore County; investigating STEM careers; and developing strategies for advising students into STEM. The content was adapted according to the school level of the counselors in attendance. For example, the elementary school counselor training titled “The Child the Brain and the Aspiring Scientist” focused more on the brain, micromessaging, and STEM, and less on CCBC programs and articulation. The middle school training was titled “The Student, the Brain and, Like, Why Would I Want to be a Scientist Anyway?” and the content shifted more toward careers in STEM and the advanced technology - engineering technology articulated pathway. The high school counselor training, “Student Options in STEM,” covered each of the topic areas with a focus on the teenage brain and local STEM careers. The GET ET Principal Investigator (PI), who is CCBC’s Engineering Department Chair, covered topics associated with the articulation program, the differences between engineering and engineering technology, other technology programs offered at CCBC, and the benefits of attending a community college.

Training was conducted for 97 elementary school counselors, 35 middle school counselor department chairs and 18 high school counselor department chairs. The PD sessions, which were held at CCBC, received very positive feedback from each level of training. Of the 59 elementary school counselors who took the survey, 100% agreed with the following statements, “I enjoyed the opportunity to meet as a group and exchange ideas while focusing on relevant topics.” (80% responded Strongly Agree), “I have a clear understanding about how to apply the new knowledge and skills in my current school setting.” (53% strongly agreed), and “The professional development provided an opportunity to exchange ideas, collaborate with colleagues and refine my professional practices.” (66% strongly agreed).

The middle school counselor chairs had a very similar response. Each of the 14 who responded to the survey agreed with the statements, “I enjoyed the opportunity to meet as a group and exchange ideas while focusing on relevant topics.” (79% responded Strongly Agree); “I have a clear understanding about how to apply the new knowledge and skills in my current school setting.” (50% strongly agreed); and “The professional development provided an opportunity to exchange ideas, collaborate with colleagues and refine my professional practices.” (57% strongly agreed). In response to a question about what other topics they would like to learn more about in the future, one counselor responded, “Every topic presented is meaningful. No suggestions.” Another responded “growth mind sets, emotional intelligence.”

Feedback from the high school counselor department chairs was also very positive, as shown in the following table, with nearly all agreeing that their knowledge of the topics covered increased significantly. One of the counselors who responded “Disagree” informed the presenter that he thought it was a good presentation but he had a lot of prior knowledge. Through open ended questions it was determined that the aspects of the workshop that the high school counselors found to be particularly beneficial or significant included; the computer resources/websites for STEM; learning about how the brain processes and how it connects to STEM/neuroscience; increased awareness of how micromessaging impacts attitudes and perceptions and how
important it is to encourage students, especially females to take STEM classes; collaborating with other counselors and CCBC staff; and increased awareness of various STEM programs at CCBC. Suggestions for improvement included: providing ideas on how to increase African American/under-represented student participation in STEM; learning more about programs at CCBC; providing a list of speakers, activities (research based) that have worked in other schools and resources that can be shared with parents and students; and touring the facilities.

The counselors also highly rated the presenters with respect to how well they communicated ideas and shared information as shown in the following table.

| Responses to the Statement “My knowledge of the following increased significantly” |
|---------------------------------|--------|---------|---------|-----------|-------|
|                                 | Strongly Agree | Agree | Disagree | Strongly Disagree | N/A   |
| Link between learning processes and STEM | 8      | 10     |          |          |       |
| Local and national STEM issues  | 5      | 12     | 1        |          |       |
| Micromessaging as a potential cause of STEM issues | 6      | 11     | 1        |          |       |
| Student perspectives in STEM    | 3      | 13     | 2        |          |       |
| Engineering as a STEM pathway  | 4      | 13     | 1        |          |       |
| Ideas for useful strategies     | 5      | 13     |          |          |       |

The counselors cited a variety of training topics and content information that they said they could implement “tomorrow” in their school. A number of them intended to share more with staff and encourage more students to pursue opportunities offered through CCBC for engineering majors and advanced technology career completers, especially the articulated credit. Others focused on micromessaging, encouraging girls to take risks and go for the advanced math and science classes, exposing students to STEM, and “destroying stereotypes regarding women and minorities as far as their abilities to be successful in STEM.” Some noted that they would encourage students who are not good at math to still pursue STEM careers/programs, and that math is more about practice than ability. A number of counselors intended to use and explore suggested websites as well as studies/research about the history and/or current need for STEM employees.
**Replication of Program**

To expand the GET ET program to other regions, CCBC identified and contacted the community colleges that offer engineering technology to ascertain their interest in participating. In addition, the grant PI presented at two MSDE Technology Education Update meetings attended by the Career and Technical Education Supervisors from across the state. Meetings were held with two community colleges and the University of Maryland Eastern Shore (UMES) and their local LEA(s) all of who expressed interest in moving with the project. Issues raised by the LEAs included the difficulty small/rural schools have filling multiple advanced technology education classes, especially when other options are available such as PLTW; and the need to have advanced technology education classes that students will be able to complete. This is a controversial topic, as technology education teachers have students placed into their courses who are not interested in the topic and do not want to be there, detracting from the enjoyment, excitement and success of those that do.

UMES and Chesapeake College have adopted, or intend to adopt CCBC’s EGNT 101 course as their own introduction course. The PI shared with them the Common Course Outline and syllabus for the course and will provide additional course materials for their use. As a result, neither school will require additional curriculum to be written. Although Chesapeake College offers technical classes, it does not currently offer an engineering technology degree. They are in the process of developing one and welcomed the ability to replicate not just CCBC’s EGNT 101 class but other classes as well. As UMES is one of only a few colleges in the region offering a bachelor’s degree in engineering technology, having a close alignment with the community colleges will ease transfer of courses and maximize the number of credits that transfer. CCBC is now working to implement more formal arrangements with UMES for articulation of credit for other courses in addition to EGNT 101. Training for new ADA teachers will be held during summer 2015 and for EngD teachers during summer 2016.

Although the program expansion for Illinois is not scheduled to begin until 2015-16, representatives from the Illinois State Board of Education and Illinois State University have been contacted and made familiar with the program. The PI and an ITEEA partner met with the Illinois representatives during ITEEA 77th Annual Conference in March 2015 to discuss the program in more detail and provide marketing materials. The Illinois representatives have already begun discussions with colleges and LEAs to identify the best fit for the program expansion to their state.

The PI presented at the ITEEA Annual Conference to share the details of the GET ET program with educators from across the country. Materials are being made available through ITEEA that will enable any community college and LEA to replicate the program, including a timeline, PowerPoint presentations, and flyers describing the program and showing the results of the counselor training. The GET ET Co-PI has also developed PowerPoint presentations, handouts, and lists of links to public sources for school counselor PD. She will be creating training videos by topic using footage from the summer training sessions. The counseling office of each participating LEA will have access to the materials and will be encouraged to add materials to the library. The counselor PD may then be presented by the Co-PI or a local person identified by
the LEA or college and trained by the Co-PI. Following is a timeline of actions required to replicate the articulation program.

**Counselor Training Timeline**

<table>
<thead>
<tr>
<th>Month</th>
<th>Action Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>August – November</td>
<td>Notify high school counselors about new advanced technology education pathway (LEA)</td>
</tr>
<tr>
<td>March</td>
<td>Workshop with all high school counselors (Counselor trainer)</td>
</tr>
<tr>
<td>April or May</td>
<td>Workshops with middle school counselors and elementary school counselors (Counselor trainer)</td>
</tr>
<tr>
<td>June</td>
<td>Rewrite training materials based on workshop feedback (CCBC)</td>
</tr>
</tbody>
</table>

**Engineering by Design Timeline**

<table>
<thead>
<tr>
<th>Month</th>
<th>Action Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>July - September</td>
<td>Review of existing Advanced Design Applications (ADA) and Engineering Design curriculum (College and ITEEA)</td>
</tr>
<tr>
<td>October</td>
<td>Place <em>Introduction to Engineering Technology</em> topics missing from the EbD curriculum in ADA or EngD depending on where they fit best (College and LEA representatives)</td>
</tr>
<tr>
<td></td>
<td>Kick-off meeting to provide an overview of the program, plan for the year, review topic placement for the development of supplemental resources, and begin work on ADA (All - LEAs, college, ADA writers, EngD writers, and trainers)</td>
</tr>
<tr>
<td>October – January</td>
<td>Write new Supplemental Resources for ADA (ITEEA and ADA writers)</td>
</tr>
<tr>
<td>January weekend</td>
<td>ITEEA Authorized Trainer Institute (ATI) – how to run a training session (all ADA and EngD trainers)</td>
</tr>
<tr>
<td>February – April</td>
<td>Pilot and rewrite new ADA Supplemental Resources (ADA writers and trainers)</td>
</tr>
<tr>
<td>April weekend</td>
<td>ADA train the trainer workshop (ADA trainers)</td>
</tr>
<tr>
<td>May</td>
<td>Put ADA curriculum online (ITEEA)</td>
</tr>
<tr>
<td>June – 1 week</td>
<td>ADA training (ADA teachers)</td>
</tr>
<tr>
<td>June - August</td>
<td>Write new Supplemental Resources for EngD (ITEEA and EngD writers)</td>
</tr>
<tr>
<td>Aug – Sept weekend</td>
<td>EngD train the trainer workshop (ITEEA and EngD trainers)</td>
</tr>
<tr>
<td>Fall semester</td>
<td>Pilot and rewrite new EngD Supplemental Resources (EngD writers and trainers)</td>
</tr>
<tr>
<td>Spring semester</td>
<td>Put EngD curriculum online (ITEEA)</td>
</tr>
<tr>
<td>June – 1 week</td>
<td>EngD training (EngD teachers)</td>
</tr>
</tbody>
</table>

At the conclusion of the GET ET project period, at least 66 high schools will have had an opportunity to train teachers for the ADA and EngD courses with supplemental resources
specific to the engineering technology program offered at one of the eleven local community colleges participating in the GET ET program. The EbD trained teachers have the potential to reach an additional 3,300 students annually and engage them in a hands-on innovative approach to the study of engineering technology. The counselor training and the train-the-trainer model for educating college and career ready high school graduates who are prepared for further training in engineering technology may continue to be disseminated throughout Maryland, Illinois and other states ultimately reaching even more students.

Conclusion

At present, many students from underrepresented groups pursue the technology education option in high school simply to satisfy graduation requirements. Alignment of the high school EbD curriculum with a community college’s engineering technology program and receipt of articulated college credit will open the door of higher education to many students who may not have considered engineering technology, or even college, an option.

Like CCBC, the mission of many community colleges and some four-year public institutions is to provide an accessible, affordable, and high-quality education that prepares students for career success, and strengthens the regional workforce. The GET ET program supports this mission by creating a pipeline from high school to college to careers in engineering technology, and to some extent, engineering. By making an engaging hands-on engineering technology curriculum available to more students and by training counselors to identify and encourage students, especially non-traditional ones, to consider a career in STEM, many students will be reached who may not have considered a career in the field. By starting in elementary school and reinforcing positive STEM messages through high school, more students will end up in the engineering technology pipeline increasing enrollment of students in community college engineering technology programs and ultimately, the technology workforce.

References


