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Abstract

The launch of a new Engineering Technology undergraduate degree at a research intensive university prompted collaboration from six different disciplines within the College of Technology. With a flexible curriculum designed to meet existing and future workforce needs, the program of study incorporated both new and revised courses. One of the new courses is a gateway Introduction to Engineering Technology course designed to attract and retain both traditional and nontraditional students. In this introductory course, engineering technology is defined based on the skill set needed for the current and future economy. The gateway course employs a reverse course-content-delivery design whereby students engage traditional lecture-based subject matter in a user-friendly manner that encourages students to revisit lectures on-demand. Students work through a series of at-home assignments in a linear manner, labeled simply as *read*, *watch*, and *do*. These assignments build upon each other to develop both depth and breadth through repeated exposure and analysis of core concepts. This is consistent with learning theory literature, which is replete with studies showing that when students experience expectation failure, followed by a time of thorough and investigative feedback loops, learning gains are increased almost fourfold, from 20–30% to nearly 80% (Karpicke & Roediger, 2008). In addition, based upon student persistence theory (Tinto, 2003), common student experiences are developed for both engineering technology content and the social learning aspect of higher education to create learning-communities for the gateway students (Tinto, 1997).

Keywords: STEM education, course organization, mixed instructional delivery methods, learning communities, learning gains, engineering technology

Advanced technical education must respond to the ever-changing needs of the workforce. Because it is difficult to understand, predict, and forecast workforce needs, educators mitigate this lack of understanding by thinking dichotomously about the short-term and long-term results of student learning. Short-term goals and objectives revolve around the knowledge and skills of particular cognate areas that are generally organized as academic units divided into distinct departments on college campuses. Long-term goals cross the boundaries of subject matter experts and are increasingly interdisciplinary. Employers are increasingly calling for technical, higher education to produce graduates that are prepared for a global economy based upon a foundation of technical expertise. Beyond a particular technical core, economics today demands individuals who are technical, flexible, self-starting, engaged in change, and mindful. *Mindfulness* can be defined as continuous discovery, constantly looking for adaptive and innovative ways of doing things and not relying on the status quo (Langer, 1997).

Engineering technology educators acknowledge that there is a "half-life" of the specific subject areas of technology and engineering. Due to globalization and other factors, technology-specific knowledge is rendered obsolete at a more rapid pace than with other academic disciplines (Smerdon, 1996). This speed of change should give pause to instructors as they evaluate what to include in their courses. The decreasing residual application of knowledge gained during a typical 4-year degree program has significant implications for the long-term impact of technology education and the problem-solving and critical-thinking foundations that students need from graduation onward. Educators must evaluate prospective technical models prior to integration into course curriculum in order to determine if the technology change will result in improvement to a student's academic experience and overall learning gains.

This paper promotes a model for advanced technology education that employs interdisciplinary thinking and preemptive program-development techniques through a gateway concept. The anticipation of changing knowledge domains and competencies that engineering technology graduates will need over the next decade were seamlessly integrated to address these authentic problems within the curriculum (Senge, 1990).

Recently, Schwab (2010) noted the national emphasis for advanced technology education as a strategy for the preparation of our graduates to compete globally. The National Academies' report, *Rising Above the Gathering Storm* (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007), declared that federal needs revolve around preparing our workforce for requirements across the spectrum of the economy, specifically in the engineering and technology fields. Innovation is an increasingly important characteristic of the new economy that involves both the theoretical and applied disciplines (Stokes, 1997). This proposition has meant educating not only more engineers but also more engineering technologists. The National Academies' report on the state of education performance at all levels illustrates why an evolving and flexible academic curriculum is in order (National Academy of Sciences, National Academy of Engineering, & Institute of Medicine, 2007).

Indiana, like many other states, falls short of the workforce's educational attainment levels requisite to compete in a global environment (U.S. Census Bureau, 2011, Section 4, Table 229, p. 151). A key to continued competitiveness is having an educated workforce that is trained for the 21st century with foundational skills and competencies that will enable workers to succeed in fields not yet imagined. Currently, Indiana ranks 41st among all states (tied with Tennessee) for the overall percentage of its adult population holding a bachelor's degree (U.S. Census Bureau, 2011, Section 4, Table 229, p. 151). Furthermore, the state's demographics show an increasingly aging population, which further threatens Indiana's position as a tech-savvy business-friendly environment and may widen the gap between the skills the workforce possesses and what will be required, much less desired, in the next 5–10 years (Gamble, 2010). The potential problem is best exhibited by the major industries represented in the state. Indiana has a considerable manufacturing representation, constituting 19% of the total private sector employment. (Indiana

Business Research Center, 2013). The business climate report indicates that the Indiana workforce lacks a global mindset, believes itself to be entitled, and lacks sophistication (Northeast Indiana Fund, 2009). Manufacturing alone represents a need for a broad spectrum of essential skill sets and workforce competencies, large portions of which are addressed by the program components in an Engineering Technology (ET) degree.

To meet these needs, the ET degree program delineated in this paper was developed at a research-intensive institution in the Midwest. Engineering technology has been recognized as a field primarily focused on engineering and technology ideas and values and the broad-based technical skills required for the development of cutting-edge solutions through the application of these competencies (U.S. Department of Labor, U.S. Bureau of Labor Statistics, 2010). This is different than traditional engineering programs that focus largely on theoretical concepts in the engineering disciplines.

Engineering technology is an area that "'emphasize[s] the teaching of industry-standard technological information and skills'" as well as competencies and knowledge domains, "'prepare[s] graduates to be immediately productive in society,'" increases graduates' value to society, integrates general and technical skills and knowledge, and is "'responsive to changing market demands'" (Gentry, 1995, p. 52; as cited in National Science Foundation, 1996, p. 60). Although these principles are well defined and constant, the specific applications, exhibited through the demand for engineering technologists, continue to evolve at increasing rates, and thus this paper serves as a guide to educators in evaluating and revising engineering technology programs as society demands continue to change.

Development

Engineering technology could represent educational-development purposes for growing K–12 programs. Expanding the program to include a K–16 mindset could help educators understand a pathway approach to engineering technology. This pathway would help higher those in education to understand that the economy requires individuals educated across a broad spectrum of job opportunities. Barbieri, Attarzadeh, Pascali, Shireen, and Fitzgibbon (2010) describe an educational model whereby students self-select based upon personal preferences, in this case, either engineering or technology fields. From a national perspective, personnel trained not only in the areas of science and mathematics but with the full integration of engineering and technology disciplines represent the full STEM model. Literature, legislation, and other STEM initiatives fall short of fulfilling the full mission of STEM. Such programs are commonly subsumed under the *E* of STEM. Yet, literature and history suggests a specific need for and thus a call to action to develop programs specific towards the *T*.

The need for STEM education encompasses efforts from primary through higher education levels (Kelley, 2010). Interconnecting STEM areas requires blurring the current academic boundaries to fulfill these needs (Kelley, 2010; National Science Board, 2007). To guide the development of an engineering technology degree, principles of integration should be defined with the same diligence. In higher education, this integration is defined as an interdisciplinary process. "*Interdisciplinary* understanding has been defined 'as the capacity to integrate knowledge and modes of thinking drawn from two or more disciplines to produce a cognitive advancement . . .' (Mansilla, 2005, p.16)" (Kelley, 2010, p. 2). According to Kelley (2010), the advantage of interdisciplinary learning is to create understanding that is unlikely through a single discipline. The blurring of disciplinary boundaries advocates for development of integrated STEM curriculum and is a premise that guides educators in developing an engineering technology degree (Bredderman, Burghardt, Hacker, & Peruzzi, n.d.; Kelley, 2010).

Engineering Technology Plan of Study

The field of engineering technology has been well documented as an academic discipline (O'Hair, 1995). This ET degree was created based upon inquiry and discussion with multiple stakeholders including industry, alumni, and legislative representatives.

The ET degree program is based on a foundation of STEM fields and draws from cognate areas represented by many academic departments, including a broad range of program experiences. The Electrical and Computing Engineering Technology program offers an applications and lab based curriculum that combines practice with electrical theory. Technical and professional skills allow students in this program to analyze, design, and implement systems for control, communication, computers, or power. The Computer Graphics Technology program prepares students for careers in creating and managing the production of computer graphics within a wide range of industries. The Computer and Information Technology program prepares students for careers in information technology systems or networking. Students go into a number of diverse fields such as healthcare, manufacturing, and law enforcement. Students in the Industrial Technology program are prepared from a technical basis for the management, operation, and maintenance of complex technological systems across a wide range of fields. Graduates of the Mechanical Engineering Technology program are prepared to plan manufacturing systems based in automation and incorporating people, processes, and technology. Finally, the Organizational Leadership and Supervision program offers a practical approach to leadership recognizing interpersonal and change implementation practices.

The importance of good communication skills is consistently publicized as a workforce requirement for college graduates, especially for those in highly technical areas of study (Bruzzese, 2011). Therefore, to extend degree usefulness beyond technical proficiency, students should be able to document and present technical information in written and oral form to technical and nontechnical personnel (Bruzzese, 2011). As a program objective, ET graduates have the ability to recognize that industry needs incorporate important skill sets such as project management, collaboration, and recent operations innovations (such as lean manufacturing) combined with traditional engineering principles (Hotler, 2002). In order to complete the program objectives, the curriculum is broken down in the following areas:

- General Education Courses (46 credit hours),
- Required Technical Core Courses (51 credit hours)
- Technology Selective Courses (18 credit hours), and
- Electives (9 credit hours).

The ET plan of study and overall program objectives serve both students and industry clients by developing and employing technical knowledge, problem-solving techniques, and applied engineering and technology skills in traditional and emerging areas. ET graduates will be prepared to actively participate in ongoing professional development for professional career growth. The foundation of these characteristics enables an advancing career path that is evidenced through gradually increasing professional responsibility or job scope.

Technology faculty must respond to the requirements of student assessment and ensure that graduates of engineering technology programs meet both the expectations and standards of the institution and other stakeholders, such as private industry (EHR Advisory Committee, 1996), through accreditation by a nationally recognized body, such as the Technology Accreditation Commission (TAC) of the Accreditation Board for Engineering and Technology (ABET; Barbieri, Attarzadeh, Pascali, Shireen, & Fitzgibbon, 2010). ABET's outcome-oriented standards emphasize learner-centered instruction and measured learning

The use of general electives allows faculty and students to craft the specific academic concentrations within the ET program. The ET degree program is designed to remain rooted a technical discipline, but it is also designed to be flexible and adapt to unknown future career options and respond to the exponential growth of technical options in the general economy.

The challenge of flexibility includes introducing students to the discipline. Although each of the concentrations in the ET program share the same foundation, students need a planned and deliberate introduction to the engineering technology discipline in order to choose particular program offerings based upon what they want to do.

Students may meet unique regional needs through selecting concentrations within the overall ET program of study. The ET degree has concentrations that were developed based upon the workforce needs of particular growth regions based on regional economic clusters known as Indiana Economic Growth Regions (Indiana Department of Workforce Development, 2005). The Economic Growth Regions serviced by the Bachelor of Science in Engineering Technology encompass 33% of the state workforce (Workforce Development Associates, 2007).

Course Design

Ensuring flexibility in the degree program is a significant challenge because the program must also ensure that there is consistency across student experiences. This challenge also surfaces in the literature related to the academic success of engineering and engineering technology students. Studies have shown that institutions should integrate learning communities throughout their programs to further increase learning gains, student retention, and graduation rates in the STEM fields (Tinto, 2002).

The integration of these diverse ET degree components requires extensive faculty collaboration to provide a common student experience that is rigorous and ensures the necessary cohesion between the sets of courses and their respective, diverse, expected outcomes. Employing the concept of a "gateway" experience is key to introducing students to an interdisciplinary degree program and provides a means for faculty to collaborate across their particular units. An Introduction to Engineering Technology course has been created to provide this gateway experience. This course serves to establish a baseline set of student competencies that will be built upon in later courses.

The gateway course introduces students to the different disciplines that comprise engineering technology in a polytechnic manner and includes systems engineering, quality improvement, and management of processes and projects. The overall skill sets needed by a technology worker are introduced, including problem solving, communication, teamwork, and professional development. A goal of the course is to provide focus, including a holistic approach to technology systems. This class provides a transition point for students by introducing learners to a pseudocohort classroom experience at the beginning of the ET curriculum, which includes integrated use of active learning techniques, such as peer learning. In addition to introducing the diverse disciplines to students in a seamlessly threaded package, the gateway course provides a common experience that promotes more student involvement in the classroom via collaborative learning through *shared knowledge* and *shared knowing* (Tinto, 1998; see also Zhao & Kuh, 2004). Students construct and discover shared knowledge for an enhanced cooperative learning experience, which includes linked activities tied to the curriculum for a common coherent experience (Tinto, 2003). Shared knowing is based upon students sharing a particular transition point, such as becoming freshman, or an initial educational experience (Tinto, 2002).

Students in the gateway course actively participate through a social-learning model to explore issues and ideas. Instructors guide students as they progress through the development of learning communities in which students present and disseminate their individual and group research outcomes on the various topics assigned throughout the course (Brower & Dettinger, 1998). A focus on student learning underpins their peer-based active learning experiences and sets in place a foundational tenet that will be employed throughout the remainder of their academic careers (Cross, 1998). The method of designing content by integrated modules rather than discipline-specific content areas was done to aid the students in interpreting and evaluating engineering technology as an integrated whole. By designing the course to minimize the perceived differences between the various academic units, the expectation is that students will create connections between content and industry regardless of which department a specific content module came from.

For application activities, problems of a technical, operational, and human nature are introduced and investigated as part of in-class work. Graduates of the program will satisfy employers' desire to hire candidates who are continuously striving to expand their knowledge base about internal positions and processes outside of their immediate area (Di Meglio, 2009). With a very specific and rigorous content and modular-design philosophy intact, the program includes multiple delivery approaches to allow for different ET locations to coordinate classes in a traditional, distance, synchronous, asynchronous, or hybrid manner.

Modular Approach

For this gateway course, the content was created as modules intended to meet the course objectives, and to tie the diverse course content together. One module was created to address each objective presented in Table 1.

This course was delivered across the state at four geographically disparate locations that complicated the design and deployment. Therefore, a great deal of strategy was needed when creating the criteria for each module because content needed to be reusable, timeless, and effective. The modules provided the core content in the form of a self-contained, platform-agnostic audiovisual presentation. While there are an increasing number of academic and nonacademic institutions and individuals who are contributing to the bourgeoning amount of online course offerings, tutorials or minicourses, and refresher-lessons, the intent of those types of programs is significantly different than the intent of this program. The faculty were charged with developing course materials that could supplement classroom instruction to further cement the knowledge domains in a student's mind. The course designers wanted to ensure that instructors or students would not have to mentally remove irrelevant references while viewing online lessons.

Specific design criteria for modules were shared with subject matter experts who agreed to contribute to the overall course design, which included "timelessness" or plug-and-play design characteristics. The modules were to be recorded without reference to time, department, or any other external information that identified a particular module beyond the core content of the information delivered therein. In this way, no external references were given that might have otherwise conflicted with the use of a given module during a particular semester.

Table 1
Introduction to Engineering Technology Course Objectives

Students will be introduced to various aspects of computer modeling, including solid/surface modeling.
Students will be introduced to various aspects of computer simulations, including animation, and multi-media/web applications.
Students will be introduced to multitier applications including user and machine interface, application software, and database components.
Students will be introduced to the infrastructure of computer networks.
To provide students with an introduction to the technology and provide them with a working knowledge of basic electrical quantities (voltage, current, resistance, and power)
Understand the difference between AC and DC, their units (volt, amp, Ohm, Watt), their "role" in electrical technology, and safety as it pertains to working with electrical systems
Student will understand disciplined problem-solving tools and apply them for continuous improvement.
Demonstrate understanding and application of basic organizational and management concepts
Apply the general solution format known as GFSA, Given-Find-Solution-Answer.
Apply both U.S. Customary and S.I. (metric) units, and the factor-label method of converting units.
The student will learn how to form and work in teams and work in collaboration.
The student will understand how to lead multifaceted groups.
Students will understand and apply university library resources.

Therefore, having modular-consistency was crucial to the overall success of the modular approach. The subject matter experts and course collaborators were given the following criteria for the modules. Each module should be:

- Clear in its definition and use of acronyms or common terms from the field in question.
- Concise in its discussion of specific subject matter and avoid presenting tangents that may have otherwise related to the subject matter in a normal program curriculum but does not in this case.
- As short as possible to cover the required content, given that students would normally be watching these as a part of their homework assignment and attention spans are not very long (suggested length was between 25–45 minutes).
- Fully self-contained and not require links to external websites that may not exist in the near future.
- Executable on any operating system platform (i.e., the modules were to be platform agnostic).
- Auto-executable and not require students to purchase or install extraneous software.
- Devoid of any references to a temporal event that would potentially render the module outdated.
- Devoid of any references to any specific instructor, professor, or other persons

associated with the program, college, or university.

- Devoid of any references to any specific department, name, course numbers, acronyms, or other programmatic terms.
- Devoid of any references or instructions directing students to complete any portion of an assignment, task, etc. as part of the ongoing class.
- Devoid of any references to any other aspect of the actual course, course delivery timeline or method, in-class case studies or activities, course management system (e.g., Blackboard), or any other aspect of the course that may change in future iterations of this course.
- Produced on a technology platform that is consistent with the other modules, given that specific subject matter or content may require a specific technology.
- Produced on a technology platform that allows for minor changes or edits post-facto.
- Searchable via a digital Table of Contents (TOC) and allow for adjustable playback speeds should a student wish to replay or skip only specific portions of the video lesson.

Working to develop content that is generic yet can be reused easily was a challenge in some areas, such as the library module in the gateway course. Ideally, library content is directly tied to a task, or set of tasks, that students are currently working on in a class, thus leveraging the ability to apply the new knowledge in a specific context and assist the retention of new information or processes. For a collaborator who was not involved in all of the course development discussions, it was a challenge to develop the module so it will have the most benefit to the students and the work being done for the overall course project. This exemplifies why it is critical for the core modules to be discussed during class because without a pragmatic discussion and distillation of concepts introduced in a video lecture, students would be very unlikely to retain any knowledge in a permanent and applicable manner.

Throughout the semester students progressed through an iterative cycle in which the students would first be assigned homework, where the students would first read any assigned reading to introduce a content area; then watch the module assigned for that same content, which would help to further elaborate on material; and then complete a hands-on assignment. We called this the "read-watch-do" cycle of learning. The second part of the overall approach involved the in-class work following the read-watch-do cycle. Subject matter experts who agreed to provide content in accordance with the prescribed criteria were also asked to provide course materials to be used in conjunction with their respective video lectures. This content included suggested in-class, hands-on activities or additional lecture notes or discussion points that helped students digest and distill the concepts delineated in the video. During the in-class session, students take a prequiz, both to ensure homework completion and to inform the instructor about areas of confusion for the students. The students would then participate in an in-depth class discussion and distillation of the homework material. The discussions were directly tied to the module material and provided otherwise missing components to aid in the dissection and digestion of the modular content and providing application and relevancy of the content. The at-home modules allowed for faculty to spend class time creating the relevance necessary to increase learning gains rather than spending the lecture time merely introducing the material. Students assign a higher task value to assignments they see as relevant. Relevance is enhanced when the applicability of the content is explained and applied to real situations and tasks that students will be asked to complete as a professionals.

The class discussion was followed by another hands-on activity that was designed to be an advanced use of the original homework done before class. For example, a student may have been assigned homework to collect some data (e.g., observational data about resistor tolerances) and conduct a preliminary assessment and analysis of that data. After the class discussion, the instructor would then walk the students through a second, more in-depth analysis of the same data, which provided further relevance.

There was much discussion among the course design faculty on how to integrate the differing material into one cohesive and integrated course. The conclusion was to create a semester long project that integrated the course material and involved field trips, case studies, and practical, applied content. The problem or case study activity selected was related to wind power generation and distribution. The case is not presented in the modules in order to preserve their reusable or "timeless" characteristic and is instead directly incorporated into the classroom sessions. Designed in this manner, the case study can be changed as time and technology progression allows, leaving the core lecture content in the modules unchanged, and the faculty are responsible for taking the content from pure theory to real-world applications. The case study helped thread the different material together by integrating modules through student engagement.

Learning Communities

The faculty's goal was to have a case study in which students produce artifacts that demonstrate competency with the material and that is collaboratively built as a cohort. Therefore, one course feature is the inclusion of social learning. Social interaction, particularly dialogue, has received little attention in the engineering technology related pedagogical literature but warrants conversation. A fundamental feature of the gateway course has been the utilization of a learning community aspect to foster knowledge in a dynamic social setting. Many of the students obtaining a degree commute to and from, as opposed to residing on, campus. As a result, interaction outside of the classroom is limited. With the inception of the ET program, the intent was to create a holistic learning experience that compensated for student living arrangements and enabled relationship creation at the foundational level of the program by fostering social interaction and nurturing academic growth through collaborative activities.

Although academic success may be achieved on an individual basis, often the by-products of group alliances yield more insightful and intellectually grounded outputs for students, ultimately resulting in increased learning gains (Terenzini, Cabrera, Colbeck, Parente, & Bjorklund, 2001). In this course, students were assigned the task of collectively producing a research wiki, which was to contain research produced by students not only from their own course site but from all other sites offering this course. Each campus conducted a literature review, and each student posted his or her citations, analysis, and discussion of the literature to the wiki. These wiki-based literature reviews were then accessible to all students enrolled in TECH 105 throughout the state. In this way, students were exposed to a real-life situation in which they were required to produce a significant final product through the collaborative efforts of geographically dispersed individual contributors. By the end of the semester, the wiki created by the students included all relevant research articles, a synopsis of those articles, and final presentations and papers of the interdisciplinary issues related to wind energy and engineering technology.

Most importantly, the online dialogue was the first step in students beginning to view one another as colleagues or even friends. It is common knowledge that interaction between friends varies greatly from interaction between acquaintances. The course design took into account the premise that if friendships are established early on, the students would be socially fulfilled and student persistence and probable advancements in engineering, science, technology, and math would occur at significant points in the student's college career. It is believed that learning communities assist in the accomplishment of that goal. Stimulating learning in a community setting ultimately results in student persistence and learning.

In the learning community modules, students were given the opportunity to explore the effects of cooperation and competition among group members to solve a group problem presented in the form of a puzzle. Members were intentionally chosen to demonstrate cooperative or conflicting behavior. The objective was to raise student awareness regarding how cooperative behavior is more conducive to achieving results in a group setting. In addition to activities that foster social interaction, intellectual activities were also chosen. Students in a social learning context put more effort into social educational activities that enable them to bridge the academic–social divide, make friends, and learn at the same time (Tinto, 2003).

A second learning community activity was an all-classes field trip. Early in the semester, students from all sections (all statewide locations) attended an on-site industrial tour of a manufacturing plant. As a subgoal of the trip, students were matched with a peer from another location and provided with an opportunity to socialize while cooperatively completing a "Site Inspection Checklist" during a plant tour. The trip brought many of the research intensive university ET community together, even if only for a short time. The tour gave students the opportunity to interact with peers, business personnel supporting the degree program, and see principles of engineering technology applied to industry. These transactions were then reinforced and continued through the use of the class wiki.

The final learning community activity focused on being able to identify the factors of effective communication during problem solving, especially those related to graphical visualization of engineering data. Striving to understand the message with clarity and without interruptions can mitigate the chance for miscommunication. When communicating in a group setting, the possibility exists that not all group members receive and interpret messages the same way, resulting in ineffective communication. Students learned that active listening and reflection during the decoding phase of communication are key components to this skill set and, when done with intention, leads to a clear sense of understanding. There is statistical evidence that students who are involved with the people and activities of learning communities are significantly more likely than their less involved peers to show growth in intellectual interest and subsequently are more likely to get more out of their college education (Tinto, 2003). The progress, retention, and success of this cohort will be monitored as they progress through the ET program to measure if the camaraderie fostered through the gateway course made a substantial impact.

Results and Conclusions

The Gateway course is delivered across multiple ET locations. The flexibility of the ET degree meets the statewide needs of the Indiana workforce and community and is being viewed by the stakeholders as a model that can be deployed on a national scale by other mission-related organizations. Engineering technology as a discipline will provide graduates with a solid foundation in engineering principles, allowing for flexibility and specialization to meet particular industry and regional needs. Finally, the flexibility of the ET degree lends itself to diverse and remote delivery methods.

The ET degree is delivered across multiple locations to reach students that are embedded in their community. With a statewide mission, there is an opportunity to reach students who might not go through a more traditional path. The challenge of effectively allocating limited resources while providing a consistent level of rigor through a variety of delivery methods is also ever-present. The flexibility of the ET degree also allows for variability in the administration of the program while recognizing the challenge of employing local resources to deliver the content of the ET program, hence, the need to create flexible, reusable, and malleable program curriculum that can be tweaked to fit a specific regional-industry need.

A future outcome of this work that might be of interest to the academic community would be to understand how to create reproducible processes for interdisciplinary course design for ET programs. Coordination among faculty is a challenge requiring conversations leading to trust, for the purpose of science. "Werner Heisenberg (formulator of the famous 'Uncertainty Principle' in modern physics) argues that [the field of] 'Science is rooted in conversations . [. . . and] The cooperation of different people may culminate in scientific results of paramount the utmost importance'" (Senge, 1990, p. 238). With the roots of the ET program founded in science, technology, engineering, and mathematics, the cooperative learning model has been identified as the ideal framework, lending itself to academic achievement through group interaction. In order for the work to occur, dialogue among faculty is required to meet the needs of instructors to feel comfortable and at ease with the content. Prior to the course design phase, free flowing conversations and dialogue, peer introductions, familiarization, and acceptance must occur. During the course design, social and intellectual interaction for the purpose of learning was identified as a fundamental component of the program. It turns out that interaction is a primary artifact of the design process among faculty as well. If the only thing that is sustainable in an organization is the interaction among faculty, this may hold true as a result of this process as well.

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