Distance Education for Engineering Technology: Faculty and Student Perspectives

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Abstract – A multitude of computer-based educational approaches exists and are touted to revolutionize the teaching and learning process in distance education. Whether as a stand alone mode, online, offline, synchronous, asynchronous, virtual reality or any hybrid model, educational technology has grown to consume both the teacher and student. Technology has transformed our lives to the point where the work load and expectations often cloud the foundational pedagogy, theoretical backbone, and applied engineering fundamentals for both students and faculty in distance education. Has the emphasis grown to embrace the method of delivery over the content and competency of the student and teacher? This paper will present a "guide" for distance education from both the student and faculty perspectives. Curriculum, methods of delivery, evaluation, and assessment of teaching and learning will be emphasized.

Keywords: Distance education, distance learning, Engineering Technology curriculum, assessment of teaching and learning.

BRIEF HISTORY

During the mid-1960's, growth in the manufacturing sector of the western North Carolina (WNC) region created a need for technical and management skills to bridge an expanding gap. In 1965, new and expanded shop and laboratory space, and the creation of a B.S. in Industrial Technology enabled Western Carolina University to enhance course offerings to educate potential engineers, managers, supervisors, and technicians for employment in the region. A new facility was completed in 1971 that included state-of the art classrooms and labs in Graphic Arts, Drafting, Electricity/Electronics, Construction, Metals/Welding, Machine Shop, and Environmental Safety [7].

Based on steady growth in manufacturing, coupled with the rise in high tech applications, the university established a Manufacturing Engineering Technology (MET) curriculum in 1977. The MET curriculum sought and was granted ABET accreditation shortly thereafter. In response to the need for more electronics personnel in the WNC region, a B.S. degree in Electronics Engineering Technology was approved in 1988. The Department of Industrial Engineering and Technology served the region well for over 20 years. Graduates with B.S. degrees in Industrial Technology, Manufacturing Engineering Technology, Electronics Engineering Technology, and Industrial Distribution were actively recruited and employed by regional industry. However, in recent years, these traditionally strong programs began to experience problems of low enrollment, resource dispersion, and less relevance to industry needs due to a downturn in the manufacturing sector of the economy. This trend resulted in part, from global economic factors, outsourcing of manufacturing and high tech jobs, and niche competition [8].

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In 2002, as a result of regular program assessment, faculty in the Department of Engineering Technology at WCU began to detect a downward trend in enrollment. Faculty and administrators made the decision to develop a new program that would offer traditional core engineering technology courses coupled with courses that broaden the scope of the curriculum through a product development systems approach. The new curriculum would no longer specifically target traditional manufacturing markets, but would focus upon preparing students to respond to the rapidly changing industrial scene. The BS in Engineering Technology is currently preparing students for employment in the rapidly changing manufacturing and public service sector in Western North Carolina.

Development of Distance Programs

In the mid-70's, it became apparent that not all students who needed technical degrees were being served. With the end of the Vietnam War, many veterans were returning to the workforce under prepared. Many had earned educational assistance through the GI Bill. Western Carolina University responded to these non-traditional students with the development of the "in-service" program, a curriculum designed to award the B.S. in Industrial Technology degree on weekends. This approach evolved into the first "distance" program in Manufacturing Engineering Technology in the Morganton/Hickory area of North Carolina in the early 1980's. That program, along with Electronics Engineering Technology was offered in Asheville, North Carolina soon thereafter.

CURRENT STATUS

Rationale for Distance Learning

Not unlike many regions of the country, Western North Carolina has been particularly hard-hit by layoffs due to the increased globalization of furniture, textiles, heavy metals and other traditional manufacturing. Industry in Western North Carolina has had to undergo significant changes due to those global economic factors and the subsequent loss of thousands of manufacturing jobs between the years of 1999 and today [6]. In April of 2002, North Carolina had the third highest unemployment rate in the country and 50,500 fewer people were employed in manufacturing than in 2000 due to plant closings and layoffs, a problem reported as "near crisis proportion [6]." In 2002, the total employment in North Carolina decreased by 91,100 jobs [11]. Many counties in Western North Carolina had not experienced such dire economic conditions since the Great Depression [12]. Job loss has continued and the August 2010 unemployment rate for the 25 counties in Western North Carolina hovers around 11.0%, where it has been for the past 2 years [5].

The current economic crisis, coupled with the university's long-standing commitment to economic development in Western North Carolina, led the university to establish a campus-wide mandate for engagement with regional business and industry. Engagement activities focus on sustaining regional businesses and boosting entrepreneurial startups through innovative and creative projects that develop intellectual capital and technology transfer [3, 4, 2]. Additionally, current research suggests that creative and innovative engagement projects must be coupled with student learning to strengthen the competencies of ET graduates [9].

The main vehicle for extending the university's offerings to Western North Carolina's unskilled or under skilled workforce is through the current distance learning curriculum in Engineering Technology. After the development of the new on-campus Engineering Technology curriculum in 2002, a new distance curriculum also emerged. Western Carolina University had built a strong reputation for service to the region's workforce by offering a face-to-face, site-based curriculum since the inception of off-campus offerings in the early 1980's. However, due to revenue shortfalls, economic downturns, and more workers returned to education for career changes, alternative methods of delivery were implemented. The distance program is currently delivered to approximately 100 students through combinations of on-site, web-enhanced, on-line, Interactive Television (ITV), and a Virtual Computer Laboratory (VCL) system. Similarly, the number of resident on-campus students in the Engineering Technology program is 125.

Program Components

The current distance program in Engineering Technology enables place-bound individuals employed in business, industry and government-related occupations to pursue their four-year degree through part-time evening study. The program combines the benefits of the established on-site Engineering Technology curriculum with the convenience of locations near the students' homes. Instructional delivery is still primarily through face-to-face classes

supplemented by online components and interactive video. The intent of the degree program is to provide an appropriate educational experience that will qualify graduates for career advancement. Western Carolina currently has three off-campus locations for its Engineering Technology distance program including Asheville, Spindale, and Hickory/Morganton. Incidentally, these locations have been particularly hard-hit by the recent economic downturn.

Applicants to the off-site Engineering Technology program must have an Associate's degree in Pre-Engineering or an Associate of Applied Science in Engineering Technology. The student must complete a total of 124 semester hours of study, including the university's 42 hour liberal study component, math and science program requirements, and 45 hours of upper and lower level engineering technology classes

The primary focus of the Engineering Technology curriculum is on engineered systems with a secondary focus on product development. The revised program should fit the new Accrediting Board for Engineering and Technology (ABET) program criteria by offering a strong core based on traditional ET courses coupled with a broad exposure to technology. The BS degree in Engineering Technology follows the program criteria for accrediting by the Technology Accreditation Commission of the Accreditation Board for Engineering and Technology (TAC/ABET) in the Manufacturing Engineering Technology field. As specified, the program consists of coursework that ensures that graduates have proficiency in materials, prototyping and modeling. The program was accredited under the existing MET criteria and was reaccredited in 2011 with a three year report requirement [1].

METHODS OF DELIVERY

On-Site Instruction

The role of the local community college is critical to the success of the off campus Engineering Technology curriculum at Western Carolina University. Applicants to the off-site Engineering Technology program must have an Associate of Arts or Associate of Science degree in Pre-Engineering or an Associate of Applied Science in an Engineering Technology. Additionally, the student will be given credit for 18 hours of lower level (100-level) engineering technology courses and 12 hours of upper level (200-level) engineering technology courses that were taken as a component of their 2-year engineering technology degree. All of the Liberal Studies requirements (with the exception of the upper-level requirement) may be taken through the community college system. In addition, all of the Program Requirements can be taken at the community college as well. The option to take courses locally provides a "win-win" opportunity for both students and the local community college. Students benefit by remaining employed and taking courses at times that best fit their schedules. The community colleges benefit from increased enrollment, which in turn, results in increased funding from the state. Students must take their ETO lower level requirements at their local community college. They include Engineering Graphics, Engineering Materials, 3D Modeling, and Statics/Strengths of Materials.

Methods of Delivery

Web-enhanced learning is a modification of hybrid delivery method that incorporates face-to-face contact and alternative communication methods. Thus, web-enhanced courses emphasize human communication through a variety of teacher-student and student-student formats. This combination of distance learning and hybrid learning provides a means to offer multiple media for varying learning styles, but it does not imply that interaction is somehow more important in the modified online environment. As pointed out by Sorensen and Baylen, for any instructional medium selected, high-quality interaction in the educational relationship continues to be regarded as critical for successful distance education [10].   Through WCU, web-enhanced instruction is employed in a manner to provide alternate methods that enable students to review self-paced tutorials, review posted course notes, view videos of technical operations and engineering systems, and review slides of material covered in and outside of lecture.

WCU also uses communication technology to connect classrooms, and conference centers across the service region. Serviced through the North Carolina Research & Education Network, these methods allow for two-way video and audio teleconferencing and links local campus centers to distant sites and vice-versa. Both students and faculty are able to communicate in real-time in an environment similar to live on-campus settings. Advantages to this approach are obvious in that the faculty member can deliver the same course from one central location. Students meet in local

cluster groups and can interact within their group or between other clusters. Further, class sessions can be video-taped and made available for access at a later time for both students and faculty to review. However, there are drawbacks to this approach in that students are often reluctant to "speak-up" when poised in front on a camera. Faculty members have also indicated that the ITV approach creates a more sterile environment when students do not participate to open discussions. Virtual Computing Laboratories (VCL) offers another option to provide students and faculty access to software at all sites. The VCL enables students' access to supporting software 24 hours a day, 7 days per week at a very low cost to the university compared to the benefits. However, there are limitations to performance for software that implement a high level of simulation.

ASSESSING THE EFFECTIVENESS OF THE DISTANCE PROGRAM

In order to compare the perceived factors that make a distance program successful, 29 students and 7 faculty members were surveyed to obtain feedback on factors that were perceived as affecting the quality of distance programs. An online class of students enrolled in ET 362 (Engineering Logistics) was selected based on its diversity. Of the 29 students, 39% were from the Asheville cluster, 33% from the Hickory cluster, and 28% from the Spindale cluster. The response rate was 19 of 29 for a rate of 66%. Of faculty members surveyed, all faculty who had taught a distance class in the past 3 years received surveys. Seven surveys were delivered and six were returned for a rate of 86%. Two thirds of the returned surveys were from tenured faculty members at WCU, while the other third was from adjunct professors. Demographic information along with factors related to program strengths and weaknesses were included in the survey. The student and faculty surveys were similar, with all questions being multiple-choice with open ended responses allowed on each question.

Student Perceptions

Of the distance students surveyed, 78% are adult learners between the ages of 30 and 50 years old. None of the respondents indicated that they were unemployed, and 52.6% indicated they were employed full-time. Fifteen percent indicated that they were part-time employees, and 32% indicated they were employed in an engineering/technology area.

Strengths of the program centered around the flexibility of the program, methods of delivery, quality of instruction, and the capability of students to continue work while attending school. Most students liked the flexibility of the program, citing the availability of both face-to-face and online classes as a plus. Students also listed the convenience of the WCU distance program as a major strength. In fact, 53% of all students who responded listed the ability to obtain a BS degree while living in their own community was the major strength. The combination of face-to-face and online classes was listed by 37% of all respondents as another major strength.   One student made an excellent point: "Face-to-face classes are necessary for some classes like Hydraulics, which could not be done adequately online. But the online classes were great because they force the student to READ and outline each chapter, which only reinforces what has been assigned. Current event articles and projects also keep it real."   Students listed four areas that contribute to the quality of the program. They are instructional delivery, faculty expertise, laboratory facilities, and live projects. However, the single greatest strengths listed by student respondents were convenience and flexibility of the program.

Students were also candid about the weaknesses of the distance program. However, the weaknesses did not revolve around the quality of the professors or the curriculum itself. The major weakness was the limited number of classes offered at each location each semester. For the past 8 years, WCU has tried to offer at least one class at each of the three distance locations each semester. Unfortunately, budget limitations in the fall of 2011 prohibited classes from being offered at all locations, and only one face-to-face class and one online class were offered. Fortunately, after a reassessment of the budget, a full complement of classes will be offered again at the distance locations for the spring of 2012. The second weakness identified by student respondents was the limited interaction they have with professors. Standard procedure for professors is to travel to the distance location the day of the class, hold at least one hour of office time, teach a 3-4 hour class, and then return to Cullowhee after the class is over. There could easily be a travel time of 5 hours round-trip for professors teaching in Hickory. Other locations could require 2 to 4 hours of travel time. Possible solutions could include basing professors at distance locations, thereby increasing the number of distance offering and enhancing the availability of the professors.

There is a high degree of satisfaction observed by the responses of the students on the survey. 100% of all students surveyed said that their advisor was either good or excellent. 100% of the students stated that the quality of professors in the distance program was either good or excellent. Further, 63% of those students stated that the quality of instruction was excellent.

Faculty Perceptions

Faculty members involved in off-campus instruction were offered an opportunity to respond to a similar survey. Of those surveyed, 86 % responded. The faculty surveys assessed the quality of the distance program, as well as the quality and preparation of students, and student service satisfaction. The faculty felt strongly about giving the students an opportunity to evaluate student services issues that were out of the control of the professor, e.g., admissions, transcript evaluation, financial aid, etc. In addition, the faculty was given an opportunity to evaluate those services to the students. Demographically, 50% of the faculty fell into the 50 to 60 age group, 34% were classified as 40 to 50, and 16% were aged 30 to 40. As stated earlier, the majority of the distance instructors were tenured faculty. When asked WHY they felt the program was attractive to students, WCU faculty listed convenience, flexibility, and the quality of the program as their major factors. Also listed as factors, were the availability of the program and low cost.

Strengths of the program as perceived by the faculty were similar to the students' responses, but not identical. Faculty stated that the combination of theory and practical engineering fundamentals was the most important strength of the program. The faculty also felt that the availability of both face-to-face and online classes, and the availability of a baccalaureate level engineering technology curriculum in localized areas were strong points. Interestingly, faculty had different opinions than students when given the opportunity to list other strengths of the program. Generally, the quality, availability, and convenience of the program were major themes. Several comments were made regarding the quality and motivation of the students as being strengths.

Faculty also had strong opinions on the weaknesses of the program. Not surprisingly, some mirrored the students' perspectives. Faculty agreed with students' opinion that instructors are not as available off-campus as they would be on-campus. With on-campus teaching loads, and the lack of incentive to teach off-campus, professors who travel to the distance locations are stretched thin. While the inconvenience of travel could be considered a weakness of the program, the willingness of the faculty respondents to teach off-campus contributes to the success of the program. Limited availability of class offerings for off-campus sites was also listed as a weakness.

When faculty members were asked about their experiences with other departments regarding student service experiences, their responses indicated another weakness of the program. Forty percent of faculty respondents indicated that student services issues like admissions, transcripts, fee payment, financial-aid and degree audits needed improvement. Another 40% responded that those services were only average. Unfortunately that weakness lies outside the control of the Department of Engineering and Technology. Faculty members were adamant about working with other departments to improve the students' overall education experience.

Results of the survey suggest that the off-campus Engineering Technology program continues to be successful and students continue to take advantage of offerings at distance locations. The potential for new students remains high in all areas of Western North Carolina. Success of the current program also hinges upon articulation and transfer of the student's 2-year degree.

SUMMARY AND CONCLUSION

Results of the survey suggest that the off-campus Engineering Technology program continues to be successful and students continue to take advantage of offerings at distance locations. The potential for new students remains high in all areas of Western North Carolina. Success of the current program also hinges upon articulation and transfer of the student's 2-year degree; however, quality of the program and satisfaction of both current students and faculty remains vital.

Survey results also indicated a high degree of satisfaction for students in the distance program. Feedback indicates that graduates are promoted into engineering and/or engineering management positions as soon as they complete

their degree. Current students also indicate a high degree of satisfaction in the quality of the instructors and the program as a whole. A common reason given for satisfaction is the face-to-face delivery of Western's in concert with alternative methods of delivery. Presently, WCU is the only university in North Carolina to deliver Engineering Technology at a distance using live professors.

The distance program in Engineering Technology at Western Carolina University is currently enjoying growth and success. In order for that success to continue, adequate resources must be committed to sustain and further grow the program. One of the major factors for its success is the personal interaction between advisors/faculty and the students. The face-to-face delivery of instruction by tenured WCU faculty ensures a constant link to the main campus. Students believe they are getting the same quality instruction as their on-campus counterparts. Advisors regularly schedule visits to their classrooms and maintain regular office hours at each location. Some alternative methods of delivery have been more successful than others. Web-enhanced methods along with on-site instruction are preferred over ITV and web-based interactive video. VCL opens the door for extended methods of laboratory instruction and software access that was previously not available; however the response rate and reliability of the system has made this approach less that desirable.   With high investments into the infrastructure for running VCL, efforts will continue to improve the performance of this delivery approach.

Successes include a high-quality, face-to-face, curriculum taught by highly qualified tenured/tenure-track professors. Western's commitment to engagement with the region is admirable, and faculty /administrators are to be commended for their contributions toward building a strong distance program. Continued success of the program is also attributed to excellent community college partners who are committed to the success of their graduates. Another factor in the success of the off-campus program is its low cost and high value.

Today's successes provide tomorrow's challenges. In order for the off-campus program to continue to thrive, steps must be taken to ensure that challenges do not become inhibiting problems. Adequate faculty resources will allow the distance program to provide quality instruction to those who need it. In addition, adequate classroom and laboratory facilities will provide safe, high quality instruction to the deserving place-bound students who cannot commute to campus. Finally, proper program evaluation and assessment will provide information that will serve as impetus for change, if change is truly warranted.

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