AC 2009-1174: EFFECTIVELY DEPLOYING DISTANCE-EDUCATION (DE) LABORATORY COMPONENTS IN AN ENGINEERING TECHNOLOGY SET UP

Ranjeet Agarwala, East Carolina University

Andrew Jackson, East Carolina University

Jackson Sherion, East Carolina University

Effectively Deploying Distance Education (DE) Laboratory Components in an Engineering Technology Environment

Abstract

The goal of the Department of Technology Systems at East Carolina University is to support the economic development requirements of Eastern North Carolina by creating professionals to meet the general engineering and technology needs of its private and public sectors. The various programs in the department emphasize the application of engineering and technology theories to solve real world problems. For this reason students are engaged in hands-on activities beginning with their first semester and do not wait for several semesters or years to experience real engineering activities. During the last three years tremendous efforts have been made to modify and update the curricula of all the department's programs.

Due to the rapid growth of the department in the last few years, the department has embarked on a mission to include distance education (DE) capabilities in its various courses. To accommodate this, various components of the courses have been devised as stand alone modules woven together through a distributed environment. This helps sustain and strengthen the enrollment of the department by offering lab-centric courses remotely. The model will also minimize the burden of purchasing, support and maintaining lab equipment and will help reallocate excessive resources from face-to-face laboratory instruction.

This paper will describe various strategies for integrating a DE lab model into the existing curriculum. The model, which we will call ECU-DE Prototype model, will be realized through leveraging exiting DE resources with the proposed model, creating a scalable DE enrollment model (96, 48 students, etc,), integrating existing college and university computer hardware and software capabilities with the proposed model.

Background

East Carolina University

For nearly a century, East Carolina University[1] has served the people of North Carolina and the nation. From modest beginnings as a teacher training school, ECU has grown into an emerging, national research university with an enrollment of more than 23,000. Today, East Carolina is a constituent institution of the University of North Carolina and offers 106 bachelor's degree programs, 71 master's degree programs, 4 specialist degree programs, 1 first-professional MD program, and 16 doctoral programs in its professional colleges and schools.

With a mission of teaching, research, and service, East Carolina University is a dynamic institution connecting people and ideas, finding solutions to problems, and seeking the challenges of the future.

The following are fast facts and key numbers at ECU:
Total enrollment: 23,164
Undergraduate: 17,728
Graduate: 5,150
Doctoral (EdD and PhD): 334
Medical (MD): 286
• 14.9 percent of students enrolled are African Americans; 4.7 percent are other minorities.
• 12.6 percent of students are from out-of-state, coming from forty-seven states and the District of Columbia.
• 19.7 percent of first-time freshmen are from out-of- state.
• 189 students are from fifty-six foreign countries.

College of Technology and Computer Science
The College of Technology and Computer Sciences[2] unique slate of programs provides a technology-based program to match each student's ambitions and abilities. All of its programs prepare their graduates for twenty-first century technology-based careers. The college's graduates are equipped to make an immediate positive impact in modern industry. Within its state-of-the-art facilities, students work toward degrees in Computer Science, Construction Management, Design, Engineering, Industrial Distributions and Logistics, Industrial Technology, Industrial Engineering Technology, and Information and Computer Technology. Figure 1 depicts a high level view of various STEM educational offerings of the College.

Department of Technology Systems
The Department of Technology Systems[3] undergraduate programs span the technology workplace and give a career option to match every student's interest. Its program laboratories are housed in the new Science and Technology building with facilities and laboratories that are world-class.

The Department of Technology Systems offers undergraduate degrees in the following areas:

BS in Design (DESN)
BS in Design [5] focuses on academic preparation in the contemporary design practices found in the various engineering and architectural disciplines. The program emphasizes application of state of the art software, digitizing, and product realization/development and equipments.

Concentrations
Architectural Technology
Mechanical Technology

BS in Industrial Technology (ITEC)
The Bachelor of Science in Industrial Technology (BSIT)[6] Transfer Program is a degree completion curriculum designed for students who have been awarded a qualified Associate in Applied Science (AAS) degree in Industrial Technology or closely related field. The courses completed in the qualified technical AAS degree provide the foundation and half of the

courses required in the major for the Industrial Technology degree. This BS degree program has the flexibility to allow students to tailor a curriculum to their specific career goals.

Concentrations

Bioprocess Manufacturing
Industrial Supervision
Information & Computer Technology
Industrial Distribution & Logistics
Manufacturing Systems
Mechanical Technology
Architectural Technology

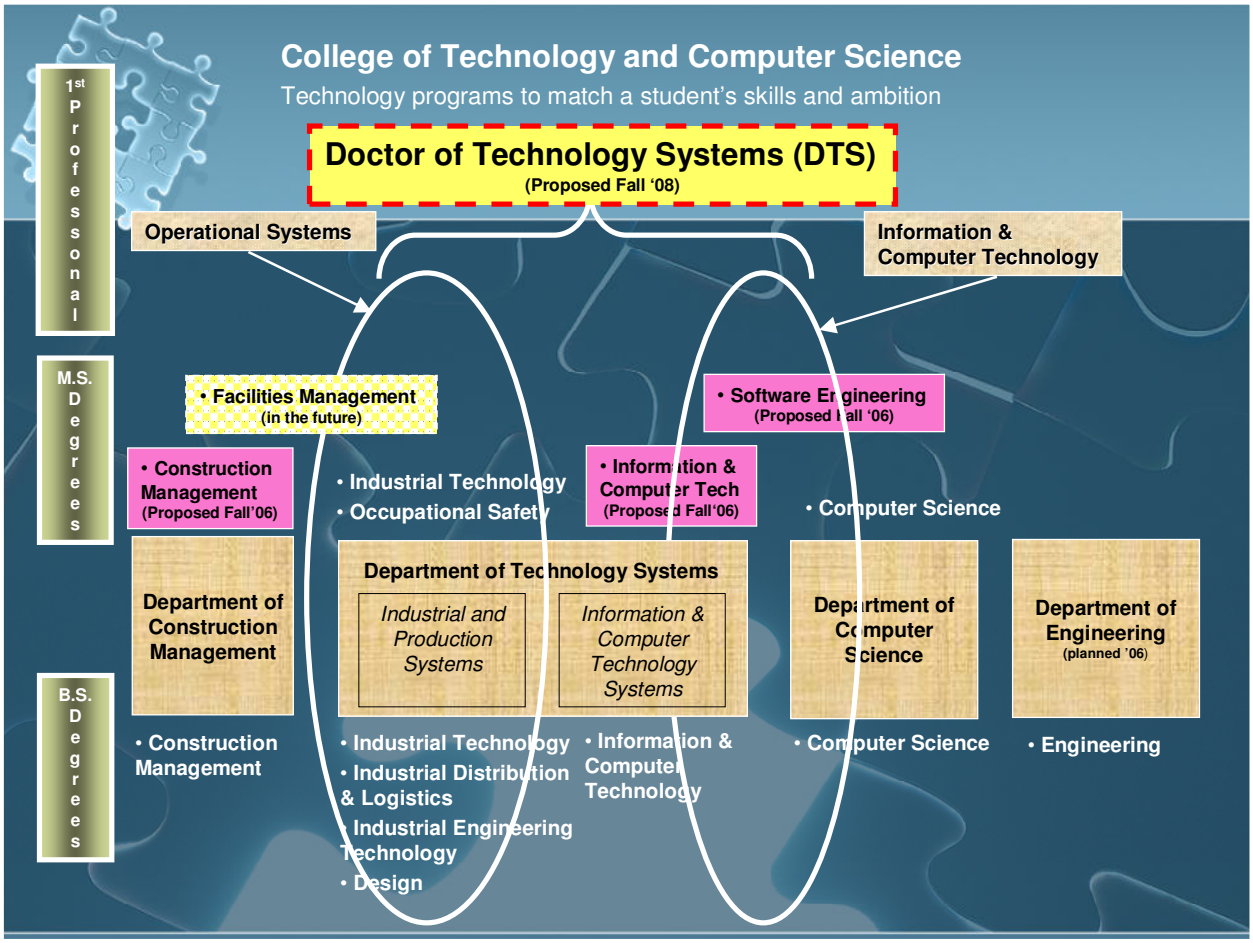

Figure 1: High Level View of Various STEM Educational Offerings in the College of Technology and Computer Science[4]

BS in Industrial Distribution and Logistics (IDIS)
This program[7] provides a unique combination of coursework that prepares students for successful careers in a range of challenging areas. Courses cover areas of the distribution and logistics industry including sales and branch operations, supply chain management, marketing, purchasing and procurement, warehousing and materials handling, inventory management, production planning, and quality control.

BS in Information and Computer Technology (ICTN)
The Information and Computer Technology (ICT)[8] program prepares students for many different challenges facing professionals in the information and technology field. At ECU, students in the Information and Computer Technology program of study gain the hands-on skills and knowledge they need to succeed in their careers. Courses include such areas as computer network installation and maintenance, routing and switching technology, and network security and intrusion detection, to name a few.

Concentrations
Computer Networking
Information Technology
Information Security

BS in Industrial Engineering Technology (IENG)
A unique aspect of the BS in Industrial Engineering Technology[9] is that students can pursue careers both in the field of manufacturing and in service areas such as facilities management. In addition, the curriculum prepares students for graduate study in the Master of Science degree in technology systems or occupational safety or in business, operations management, and similar areas

Example of a program flowchart for the Mechanical Technology concentration in the Design Program is provided in the next page and Figure 2. Other program flowcharts can be found on the respective websites of the above mentioned programs.

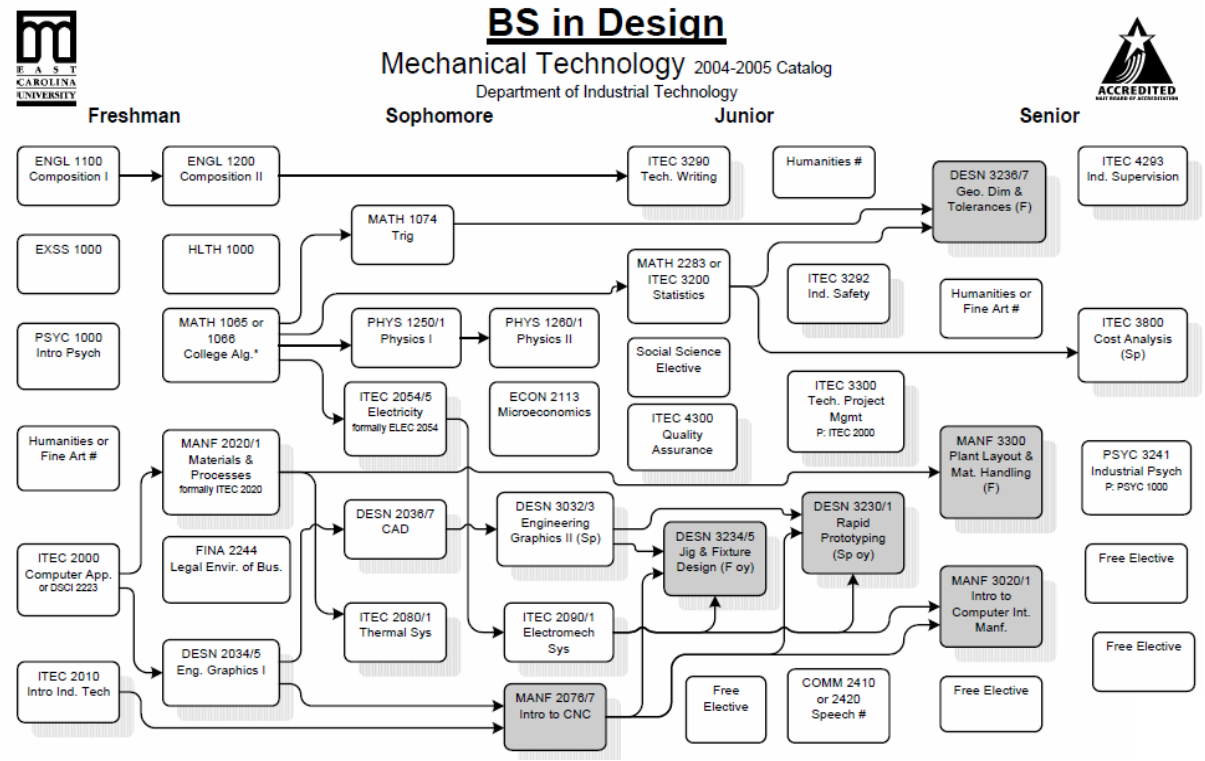

Figure 2: Bachelors of Science in Design [10] with Concentration in Mechanical Technology

Distance Education at ECU and the Technology Systems Department:

From a strategic view, distance education is a critical foundation of the department. From an undergraduate perspective, the department is a state leader in its very successful 2+2 programs in various technology fields. The 2+2 transfer program has matriculation agreements with more than twelve community colleges spanning over forty programs. Table 1 provides the historical data of undergraduate enrollment in the department since fall of 2002. The department has witnessed significant growth in DE enrollment since fall of 2002.

Table1: Enrollment in Distance Education as a Percentage of Total Enrollment.

Semster	**Total Undergraduate Enrollment**	**Total undergraduate DE enrollment**	**DE enrollment as a percentage of Total enrollment**
Fall 2002	454	79	*17.4 %*
Fall 2003	590	159	*26.9 %*
Fall 2004	750	212	*28.2 %*
Fall 2005	792	225	*28.4 %*
Fall 2006	***885***	***337***	***38.1 %***

ECU recognized the potential of online learning early and was among the first schools in the nation to develop and offer a degree completely over the Internet. Since then, the university has created more than 50 degree and certificate programs in health, education, technology and other areas. A number of new degrees are under development for online delivery, as well. Table 2 provides historical enrollment of DE students since fall of 2002 at East Carolina University as compared to on-campus students. This data is obtained from ECU's fact book [11].

Table 2: Distance Enrollment at East Carolina University since Fall 2002

Year	On Campus Only Headcount	% change from previous year	Distance Education Only Headcount	% change from previous year	Total Headcount	% change from previous year
2002	18,955	4.3%	1,622	31.0%	20,577	6.0%
2003	19,374	2.2%	2,382	46.9%	21,756	5.7%
2004	19,570	1.0%	3,197	34.2%	22,767	4.6%
2005	19,468	-0.5%	3,696	15.6%	23,164	1.7%
2006	19,891	2.2%	4,460	20.7%	24,351	5.1%

It is evident from Tables 1 and 2 that DE is a major instrument for education delivery in the department when compared to enrollment trends of the overall institution.

Table 3 provides a list of undergraduate courses that are currently offered as DE. For a complete description of these courses please visit ECU's course catalog at the following web address, "https://onestop.ecu.edu/onestop/index.cfm".

Table 3: Undergraduate courses offered as DE classes in the Department

Courses	Short Description of the Course	Lecture/Lab
ITEC 3000	INTERNET TOOLS TECH	Lecture
ITEC 3290	TECHNICAL WRITING (WI	Lecture
ITEC 3292	INDUSTRIAL SAFETY	Lecture
ITEC 3300	TECHNOLOGY PROJ MGMT	Lecture
ITEC 3800	COST & CAP PROJ ANALY	Lecture
ITEC 4293	INDUSTRIAL SUPERV (WI	Lecture
ITEC 4300	QUALITY ASSURANCE IT	Lecture
ICTN 3530	NETWRK ENVIROMENT II	Lecture
ICTN 3531	NETWORK ENVIRON II	Lab
ICTN 4040	COMMUNIC SECURITY	Lecture
ICTN 4064	REGULATIONS AND POLIC	Lecture
ICTN 4250	ENTERP NETWORK TECH	Lecture
ICTN 4251	ENTERP NETWORK TECH L	Lab
ICTN 4505	RHCT	Lecture
ICTN 4505	IPV6 SPECIAL TOPICS	Lecture
ICTN 4590	NETWORK MAIN & TRBLSH	Lecture
ICTN 4591	NETWORK MAIN&TRBLESL	Lecture
ICTN 4600	ENTER INF TECH MGMT	Lecture
ICTN 4601	ENTERP INF TCH MG L	Lab
IDIS 2771	INTRO TO LOGISTICS	Lecture
IDIS 3815	SUPPLY CHAIN LOGISTICS	Lecture
IDIS 6535	SUPPLY CHAIN LOGIS MG	Lecture
IENG 4023	PROCESS SYS APPLICAT	Lecture
IENG 4200	WORK METHODS ANALYSIS	Lecture

It is evident from Table 3 that though DE plays a major role in the dissemination of various courses in the department, only three out of twenty-four labs are offered online. Moreover, all these courses are upper level courses housed their respective programs. There is a larger demand for several foundation lab intensive STEM courses that are currently delivered online. This limits the capabilities of the department to address the DE needs of its students who are other wise constrained to face-to-face labs in these courses.

Activities and Work Plan:
Six foundation lab-intensive STEM courses which are common to all programs are planned for re-design by targets for incorporating DE labs over the next eighteen months. Through successful implementation of the proposed model, enrollment in these courses can be increased catering to the needs of a larger student body who wish to access this courses "**anywhere-anytime**". Figure 3 provides a high-level view of the activities and work plan.

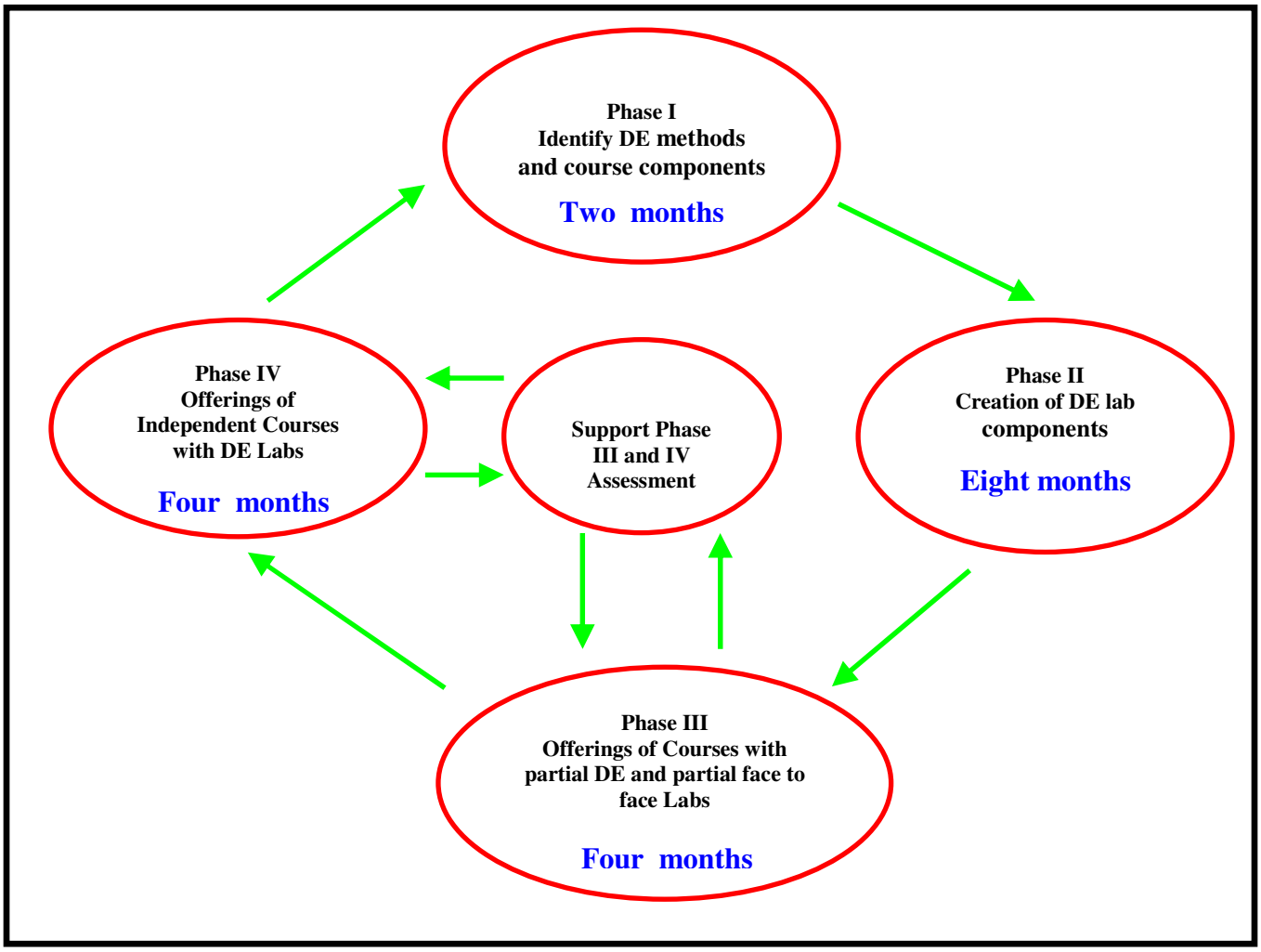

Figure 3: High-Level View of the Proposed Activities and Work Plan

The following six foundation lab-intensive STEM courses which are common to all programs and will serve as targets for incorporating DE labs in the model. These courses also serve as prerequisites for many courses offered in their individual program. The courses that will be candidates for DE labs are:

- ITEC 2055: Electronics/Electricity
  This course emphasizes the study of fundamental concepts of electronic components and circuits including survey study of communications and industrial control systems. In the lab, the student must demonstrate proficiency with numerous electronic measuring devices, create various circuits, and overall be able to handle himself or herself in an electronic shop environment.

- IENG 2021: Materials and Processes
  This course examines the factors, which influence the production and modification of materials into useful forms. Students learn about the various manufacturing processes and machinery used to convert raw materials into finished products. The course gives the student "hands on" experience with materials and processes used in industry.

- IENG 2077: Computer Numeric Control
  This course deals with the review of fundamental manual programming for numerical control machines. Topics include: CNC machine types, controls, safety, and coordinate measuring systems; CNC speed and feed calculations, tooling and fixturing; and programming CNC mills and lathes. This self-paced course gives the student "hands on" experience with CNC machines and simulations in virtual reality.

- ITEC 2081: Thermal and Fluid Sciences
  This course covers basic elements of design and analysis of thermal and power systems including boilers, air conditioning, refrigeration, pumps, compressors, heat exchangers, and piping systems. This course employs a thermo fluids lab for exercises. The objective of the laboratory is to provide the student with an introduction to thermodynamics and fluids mechanics experimentation & measurements and demonstrate basis flow phenomenon, including basic measurement techniques for flow temperature, pressure and other properties.

- ITEC 2091: Electromechanical Systems
  This course deals with the study of the design and analysis of electro mechanical control systems. This includes the fundamentals of programmable controllers as well as practical applications of interfacing mechanical, electrical, pneumatic and hydraulic systems and components. Here the students are required to demonstrate proficiency with numerous electronic measuring devices, create various circuits, and overall be able to handle himself or herself in an electronic shop environment.

Phase I: Identify methods to realize the implementation of DE model components of various courses and map it to various modes of DE Dissemination.

Table 4: Methods of DE Dissemination for Lab Intensive STEM Courses

Labs	Proposed Methods of DE dissemination
ITEC 2081	Tape, Virtual Instrumentation and Virtual Reality, etc.
ITEC 2091	Tapes, Virtual Instrumentation and Virtual Reality, etc.
ITEC 2055	Web & Virtual Instrumentation, etc.
IENG 2021	Tapes , CD-ROM, etc.
IENG 2077	Tapes, CD-ROMs, etc.
IENG 3021	Tapes, Virtual Reality, etc.

Phase II: a) Identify components of various courses, b)map it to various modes of DE Delivery, c)create new teaching materials. Example: ITEC 2081

Table 5: Methods of DE Dissemination ITEC 2081 Lab

Experiments	Modes
Viscosity Measurements	Tapes
Principles of heat Transfer	Virtual Simulation
Fluid Flow	Virtual Reality
Principles of HVAC	Web

Phase III: Offerings of labs as partial DE and partial face-to-face.
Example: ITEC 2091 (lab section)
Expriment 1, 9, 11: DE
Rest: face- to- face

Phase IV: Combined offerings of DE and face-to-face labs comparative assessment.
Example:
Offer two sections 2054/5:
Face to face 2054/5: 1 Lecture: 30 students & 2 lab sections of 15 Each.
DE 2054/5: 1 Lecture and 1 Lab: 30 students each.

Assessment (Complementing Phase III and IV): Comparison of face-to-face and DE laboratory components for similar course offerings.

Table 6 provides the Survey questionnaire (inspired by current institutional survey for DE courses [12] for the Assessment of proposed lab intensive DE courses.

Table 6: Assessment Instrument for Lab-Intensive DE courses

Distance Education (DE) Lab Assessment

Please rate the following set of statements on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree). If the statement is not applicable to this course or instructor or if you have no opinion about the statement, please select the N/A (Not Applicable/No Opinion) bubble. Please read each item carefully and click your mouse button on one bubble for each item.

1. The DE lab model served me better compared to Face-to-Face Lab Model .
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ◉ 6 ☐ 7 ☐ N/A
2. The teaching methods for DE lab were clear and easy to use.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ N/A
3. I had adequate access to lab resources.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ N/A
4. The distance lab component encouraged interaction with the instructor.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ N/A
5. Questions and comments were responded to in a timely manner.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ N/A
6. The distance lab component encouraged interaction with other students.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ N/A
7. Adequate technical support was provided in those areas where additional knowledge or assistance was required for my lab participation.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ◉ 6 ☐ 7 ☐ N/A
8. The software, CD-ROMS/ Tapes or other DE resource provided to me by the university was adequate.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ N/A
9. I had little technical difficulty participating in the distance lab component of the course.
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ N/A
10. The distance lab component was an effective means of learning in this course.
    ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ N/A

Successful implementation of the model will lead to offerings of lab-intensive foundation STEM courses to larger groups of students who are interested in pursuing education in various STEM programs of the Department. Table 7 provides anticipated enrollment in the various department programs using DE-based lab components in its various courses.

Table 7: Analysis of foundation lab intensive STEM courses with anticipated DE enrollment

Foundation STEM labs	**Semesters offered**	**Programs Involved**	**Number of Lab Sections**	**Current Enrollment Face-to-Face**	**Proposed Enrollment**
ITEC 2055	Fall Spring Summer	DESN, IDIS ICTN, IENG	Fall-3 Spring-3 Summer -1	16-20 per section	48-96 per course section
IENG 2021	Fall Spring Summer	DESN, IDIS, IENG	Fall-2 Spring-2 Summer -1	12-16 per section	36-72 per course section
IENG 2077	Fall Spring	DESN, IENG	Fall -2 Spring-1	12-16 per section	36-72 per course section
ITEC 2081	Fall Spring Summer	DESN, IDIS, IENG	Fall-1 Spring-1 Summer -1	12-16 per section	36-72 per course section
ITEC 2091	Fall Spring Summer	DESN, IDIS, IENG	Fall-2 Spring-2 Summer -1	12-16 per section	36-72 per course section

Conclusion

Successful implementation of the model will provide an effective tool for the students interested in matriculating in department's various STEM fields in an "anywhere-anytime" mode. This ECU-DE Prototype model will cater to the needs of an already large and growing student population in the region as well as the nation. Offerings of proposed DE labs for the various foundation STEM courses in the department will free the students and the department from scheduling constrains. This in turn will encourage and motivate larger groups of students to pursue education in STEM programs currently offered by the Department. Successful implementation of the proposed model will also minimize the burden of purchasing, supporting and maintaining lab equipment and will help reallocate expensive resources from face-to-face lab instruction.

References

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