The Distance Education Dimension and its Application to the EET Curriculum - A Proposed Model

Stephen R. Fleeman, Thomas Lombardo
Rock Valley College

Abstract

This paper explores the application of Distance Education (DE) to a curriculum in Electronics Engineering Technology (EET). The ideas discussed could be applied to other engineering and technology disciplines as well. The model presented here is in its design phase and has not yet been implemented. The goal of the authors is to establish a framework for the development of a DE model for an EET curriculum.

I. Introduction

Rock Valley College (RVC) has been exploring asynchronous (anytime/anyplace) learning methods since 1997. Several of our traditional classes have incorporated an asynchronous discussion component. In the spring of 1999, RVC introduced its first set of courses offered entirely over the Internet. These courses appeal to students who have full-time jobs and can't make the rigid, three- or two-days-per-week structure of a traditional class. For time-bound students, online classes provide an attractive option.

With enrollment trends in many EET programs on the decline, alternate delivery methods are well worth exploring. Some (particularly EET) educators who will dismiss prematurely the idea of a Distance Education format for EET courses. They often admonish proponents with, "You can't do labs, so it can't be done". The authors, both practicing engineers in addition to serving as educators, would prefer to take a more open-minded view. Applying DE to a laboratory-based curriculum is challenging, but this is certainly not the first obstacle EET educators have ever faced. The authors envision a "hybrid" delivery method, where the lecture material is completed online, and the lab work is still done in the laboratory. (The intent here is to address the needs of the *time-bound* student rather than the *place-bound* student.)

In this paper, we will explore the EET curriculum with respect to the national skill standards[1] developed by the Electronic Industries Alliance (EIA)[2]. Each skill standard will be given a "DE Suitability Rating", a number from 0 to 3, which describes how well the particular skill can be taught via Distance Education. At the extremes, we could say that Ohm's Law would have a DE rating of 3 (very suitable), while soldering would have a rating of 0 (not at all suitable). Along with the suitability ratings, we will discuss alternate delivery methods which can be used in areas where DE is not suitable, and we will also explore how some of the EIA skills are actually *better* taught via DE.

II. EIA Skill Standards

The EIA national skill standards can be used to design and/or evaluate an EET program regardless of the program's format. The EIA skill standards focus on five separate areas: desirable behaviors and work habits, technical skills, test equipment and tool skills, basic and practical skills, and additional skills.

Desirable behavior and work habits, while not objectively measurable, are critical to the worker's overall employability and success. This area includes work ethics and behavior, interpersonal relationships, and teamwork.

The area of *technical skills* includes general skills, dc circuits, ac circuits, discrete solid-state circuits, analog circuits, digital circuits, microprocessors, and microcomputers.

The area of *test equipment and tools* concentrates on the worker's ability to know and understand how the test equipment or tool works, and when, where, and how to use it.

Basic and practical skills concern technical literacy, communicating on the job, solving problems and critical thinking, proficiency in mathematics, and proficiency in physics.

Additional skills include (electronic) communications, electromechanics, and LASER applications.

III. Myths and Facts of Distance Education (and Classroom Education)

First, let us dispel with the myth that distance education (DE) is inferior to classroom lectures. Consider the typical lecture – two hours long, often in the evening (in the community college setting), material delivered in the order chosen by the professor, moving at the pace of the average student. Students' learning styles may not match the instructional delivery methods offered by the professor. The "average" pace will be too slow for some, and too fast for others. (To compound the difficulties, the students that work all day and take classes at night struggle against an attention span that is reduced by fatigue.) Is this the ideal learning environment? Obviously not, so why do some insist on criticizing DE because "It's not the same as classroom learning"? The traditional lecture format is often considered the "most efficient but least effective" mode of delivery. It is the most efficient approach because it delivers the most amount of material in the shortest amount of time. However, it is often the least effective delivery system because the students' retention of material is typically deficient. It is somewhat puzzling that the lecture format is the standard against which DE is to be measured.

Now, consider an online "lecture", which is typically delivered via the World Wide Web. There are two advantages to this. First, delivery is *asynchronous*, so the student can view the lecture whenever it is convenient, and as many times as necessary. Second, if properly designed, it allows the student to choose the order in which material is presented. For example, some students prefer theory before application. Others prefer application before theory[3]. A well-designed web-based lecture can have links to both theory and application, side by side, and the student can select the order. A study by Wallace and Mutooni[3] demonstrated that students in a web-delivered course module actually *performed better* than those who received a traditional lecture covering the same material. It is important not confuse "work at one's own pace" with "independent study". In a well-designed online course, there must be a certain amount of synchronicity. Students should all be working on the same module during the same week. It is not completely "work at your own pace"; it is more like, "Here's some material and an assignment – now complete it by next Sunday night." This prevents students from falling too far behind, and allows for more meaningful student interactions.

What happens to classroom dynamics including student interactions and student to professor dialogs? How can you get that in a web-based course? Obviously, one cannot simply put lecture notes on the web and pass that off as a web-based course. There must be interaction in the course, and this interaction can be implemented in the form of asynchronous conferencing. This can be facilitated by simple email, "listserves" (email mailing lists), newsgroups, or conferencing software such as First Class or WebBoard. A competent online professor will ensure that the students use conferencing as an integral part of the coursework. This can have the added advantage of developing written communication skills, collaborative learning skills, and "distance collaboration" skills, all of which are required by employers. Of course, the professor must be willing to work with students on developing the communication skills, otherwise the students will often perfect their skills at writing bad sentences. In addition, the web-based delivery helps to develop independent learning and time-management skills, which are also included in the EIA skill standards.

DE has the potential to not only meet, but also to exceed the standards set by lecture delivery. Of course, a poorly designed online course has the potential to go beyond the depths of a poorly delivered lecture.

Most EET professors are very concerned about the laboratory component of the typical EET curriculum. It must not be compromised by a DE format. Simulation via software is inadequate. Students cannot be expected to purchase thousands of dollars worth of laboratory equipment. *So how does a DE format in EET address the laboratory portion of the curriculum?* This will be addressed in the next section.

IV. The Model

Traditional Engineering Technology courses usually consist of a lecture component and a laboratory component. As mentioned previously, the lecture component can be delivered with a combination of web pages and conferencing. The web pages can be used to "deliver" the material, and the conferencing is used for questions and discussion.

Each topic can have a home page, with links to theory and application. Students who need to know *why* before knowing *what* can choose to look at applications first. Students who need to know *what* before knowing *why* can choose to look at theory first. Resourceful students can even open two browser windows, and hop back and forth between theory and application, reading either as many times as needed. Obviously, this feature offers a flexibility that transcends the traditional classroom lecture.

Conferencing is used in two ways. A student can post a question to the entire class or send a private email to the professor. Students should also be encouraged to post to the entire class, just like asking a question in class. However, some students prefer to ask questions privately. Educators should be willing to accommodate either. Students should be encouraged to answer each other's questions, by posting answers to the entire class. The professor acts as the moderator – correcting or enhancing student answers when necessary, answering questions that no other student is able or willing to answer, and "keeping the peace" by enforcing the rules of "netiquette".

The professor can spur online interaction by assigning each student a "discussion question". The student must post an answer to the discussion question for the entire class to read. Each student can be assigned a different discussion question, and students can be expected to respond to each other's answers. Students who are shy in a face-to-face environment will often be more "vocal" in an online environment. Additionally, a student's participation is automatically documented. In areas where class participation counts as a part of the grade, this documentation can help make grading less subjective. These techniques can help develop some of the "people skills" and communication skills defined by the EIA.

What about the labs?" The laboratory experience is a crucial part of an Engineering Technology (ET) curriculum. Computer simulation provides a separate, significant dimension to an ET curriculum, but is in not a substitute for achieving necessary hands-on skills! The authors are proposing a hybrid model. It is important to review the reasons for having the lab experience.

The laboratory component of a class has three primary functions: to help reinforce theory, to encourage students to learn how to use the test equipment, and to develop hands-on skills. Simulation does have its place in one respect – it is effective at reinforcing theory. In fact, one could argue that for the purpose of reinforcing theory, simulation is *superior* to working with actual equipment. It is quicker and easier to change variables and see trends with a computer simulation, giving time for more examples. Also, the extraneous (albeit significant) variables of a real circuit do not obscure the salient points. While it is important for students to understand those variables, it is helpful to permit them to grasp the underpinning theory first – then they will be *prepared* for the "real-life" complications.

Bourne[4] observed that students who performed a simulation before coming to lab completed the physical laboratory exercise in *half the allotted time*. Our experiences at Rock Valley College have been similar.

This leads us to the actual hands-on laboratory component. The authors propose a flexible, on-campus laboratory experience. (Again, we are addressing the needs of the time-bound student.) The logistics of an open laboratory environment may be suited to a senior institution such as a university (where graduate students can support the labs). However, at many community colleges, it is just not feasible. Instead, the authors envision a professor holding scheduled lab times, which can meet at various times during the week. The professor's commitment can be similar to that for office hours, but can be held in the laboratory instead.

As an example, assume an EET class meets four hours per week – two for lecture and two for lab. If the lecture component were delivered online, then both of those periods could be used as "semi-open" labs. The appropriate laboratory would be reserved for students in a particular class, and the professor is there, just as for a scheduled lab period. Students would be required to attend as many lab sessions as necessary to demonstrate their proficiency in a given area. The in-person lab also gives the student and professor some face-to-face contact. For students who cannot meet any of the scheduled times, appointments can be scheduled at the professor's discretion. All students would be required to indicate their intentions to attend a given laboratory session. They could also be expected to propose (via email) the experiments they wish to perform. This would give the necessary lead-time for the proper equipment and supplies to be made available.

V. EIA Skill Standards Matrix

This matrix cross-references the EIA skill standards, the RVC courses in which those skills are taught, and the DE rating of each standard. In the interest of brevity, samples of the matrix are included here. The entire matrix can be found at http://ednet.rvc.cc.il.us/~TomL/eetskills.htm. With the advent of Distance Education (e.g., web-based courses) it is important to define and apply a *Skill Standard Metric*. The purpose of this measure is to indicate the suitability of a given skill standard to Distance Education (DE). Specifically, Distance Education via the Internet may draw on text screens, interactive exercises, and computer simulation. The ratings are indicated by using numbers from 0 to 3. The rating numbers are to be interpreted as

0 = Unsuitable
1 = Somewhat Unsuitable
2 = Somewhat Suitable
3 = Very Suitable

As an example, a given skill standard may be deemed *very suitable* to Distance Education via the Internet. In this case, the particular skill standard will be denoted (DE 3). A hands-on skill may be judged as being *unsuitable* – (DE 0). This means the particular skill is best taught and practiced in a laboratory setting.

Skill Standards Area: Technical Skills - General			
Primary Course	**Course Number**	**Skill Standard Number**	**Skill Standard Description**
Fabrication II	EET 115	A.01(DE 0)	Demonstrate an understanding of proper safety techniques for all types of circuits and components (DC circuits, AC circuits, analog circuits, digital circuits, discrete solid-state circuits, and microprocessors).
Fabrication I	EET 250	A.02 (DE 1)	Demonstrate an understanding of and comply with relevant OSHA safety standards.
Troubleshooting	EET 255	A.03 (DE 1)	Demonstrate an understanding of proper troubleshooting techniques.
Fabrication I	EET 250	A.04 (DE 0)	Demonstrate an understanding of basic assembly skills using hand and power tools.

Skill Standards Area: Technical Skills - General			
Primary Course	**Course Number**	**Skill Standard Number**	**Skill Standard Description**
Fabrication I	EET 250	A.05 (DE 0)	Demonstrate an understanding of acceptable soldering/desoldering techniques, including through-hole and surface mount devices.
Fabrication II	EET 115	A.07 (DE 2)	Demonstrate an understanding of the use of data books and cross reference/technical manuals to specify and requisition electronic components.
Electronic CAD	EET 260	A.08 (DE 2)	Demonstrate an understanding of the interpretation and creation of electronic schematics, technical drawings and flow diagrams.
Electronics I	EET 134	A.09 (DE 2)	Demonstrate an understanding of design curves, table, graphs, and recording of data.
Circuits I	EET 131	A.10 (DE 3)	Demonstrate an understanding of color codes and other component descriptors.

Obviously, skills such as soldering and assembly are not suited to DE, given today's technology. Perhaps someday, virtual reality web-cams and high bandwidth Internet connections will change that, but for now, these skills need to be developed in a lab setting, hence the DE rating of 0. On the other hand, the resistor color code can easily be taught from a textbook or web page, so its DE rating is 3.

Skill Standards Area: Technical Skills – DC Circuits			
Primary Course	**Course Number**	**Skill Standard Number**	**Skill Standard Description**
Circuits I	EET 131	B.01 (DE 1)	Demonstrate an understanding of sources of electricity in DC circuits.
Circuits I	EET 131	B.02 (DE 3)	Demonstrate an understanding of principles and operation of batteries.
Circuits I	EET 131	B.03 (DE 3)	Demonstrate an understanding of the meaning of and relationships among and between voltage, current resistance and power in DC.
Circuits I	EET 131	B.04 (DE 1)	Demonstrate an understanding of the measurement of resistance of conductors and insulators and the computation of conductance.
Circuits I	EET 131	B.05 (DE 3)	Demonstrate an understanding of application of Ohm's Law to series, parallel and series-parallel circuits

Theoretical topics such as Ohm's Law are well suited to DE, where hands-on skills like measurement are better suited to a lab. The measurement rating is 1 instead of 0 because a student could purchase a meter and a few components and do some experiments at home.

Skill Standards Area: Test Equipment and Tools			
Primary Course	**Course Number**	**Skill Standard Number**	**Skill Standard Description**
Circuits I	EET 131	02 (DE 0)	Calibration standards
Circuits I	EET 131	03 (DE 0)	Capacitor/inductor analyzer
Circuits I	EET 131	04 (DE 0)	Current probe
Circuits I	EET 131	05 (DE 0)	DC power source
Circuits I	EET 131	06 (DE 0)	Digital storage oscilloscope

The standards in the above section are based upon the worker's ability to know and understand how the test equipment or tool works and when, where, and how to use it. EET131 is charged with *introducing* the various pieces of test equipment and tools. However, the equipment and tools will be used throughout the curriculum. Refined proficiency in use and understanding are expected to evolve as a student works through the EET curriculum. *These skill standards should be taught in the laboratory, which gives them a DE rating of zero (0).*

Skill Standards Area: Solving Problems and Critical Thinking			
Primary Course	**Course Number**	**Skill Standard Number**	**Skill Standard Description**
Microprocessors I	EET 140	C.01 (DE 3)	Identify the problem.
Microprocessors I	EET 140	C.03 (DE 3)	Identify available solutions and their impact including evaluating credibility of information, and locating information.
Microprocessors I	EET 140	C.04 (DE 3)	Evaluate options.
Microprocessors I	EET 140	C.05 (DE 3)	Set priorities.
Microprocessors I	EET 140	C.06 (DE 3)	Select/implement options/decisions including predicting results of proposed action.
Microprocessors I	EET 140	C.07 (DE 2)	Organize personal workloads.
Microprocessors I	EET 140	C.08 (DE 1)	Participate in brainstorming sessions to generate new ideas and solve problems.

The microprocessor course (EET140) includes fundamentals of assembly language programming. The course has been designed around several *problem-based learning exercises*. The course design includes the fundamental skill standards C01 through C08. Although brainstorming can be done asynchronously, the authors believe it is more efficient in a face to face setting. Additional teaming skills can also be fostered in that environment.

Skill Standards Area: Communicating on the Job			
Primary Course	**Course Number**	**Skill Standard Number**	**Skill Standard Description**
Composition/ Speech	ENG 101/ SPH131	B.01 (DE 3)	Use effective written and other communication skills.
		B.02 (DE TBD)	Use telephone etiquette including relaying messages accurately.
		B.03 (DE 3)	Employ appropriate skills for gathering and retaining information.
		B.04 (DE 2)	Interpret written, graphic and oral instructions.
		B.05 (DE 2)	Interact with co-workers and customers in a logical, clear and understandable manner.
		B.06 (DE 2)	Use language appropriate to the situation.
		B.07 (DE 1)	Participate in meetings in a positive and constructive manner.
		B.08 (DE 3)	Use job-related terminology.
Fabrication II	EET 115	B.09 (DE 3)	Write technical reports, letters and memoranda as appropriate to the audience (e.g., management, customers, co-workers, and manufacturers).
Fabrication II	EET 115	B.10 (DE 2)	Document work projects, procedures, tests, and equipment failures.

A web-based course with an asynchronous conferencing component has the potential to develop good communication skills. The majority of interaction is through email and/or conferencing, which means that a DE student will spend a greater amount of time writing than would be required in a classroom-based course. The asynchronous nature of the coursework means that the student will need to develop good time management skills.

VI. Conclusion

Distance education courses are not for everybody. Successful DE students need to be self-motivated independent learners, with good time management skills. Computer skills, written communication skills, and teamwork skills are critical for online students. Those skills are some of the same skills needed to be a successful technician or engineer in today's world. Is distance education appropriate for an Engineering Technology curriculum? Yes, if applied correctly.

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STEPHEN R. FLEEMAN
Steve Fleeman is an Associate Professor of EET at Rock Valley College. He earned an AAS in EET, a BS in ET, and an MS in IED from Purdue University in West Lafayette, Indiana. While teaching at RVC, he has worked concurrently as an electrical engineer at Hamilton Sundstrand in the areas of Test Equipment Design, and Ground Support Equipment. He authored Electronic Devices: Discrete and Integrated (Prentice Hall, 1990), and is currently writing a new textbook. Professor Fleeman has been developing methods for applying the EIA Skill Standards to the EET program at Rock Valley College as a means for Student Outcomes Assessment.

THOMAS LOMBARDO
Tom Lombardo is an Associate Professor of EET at Rock Valley College. He earned an AAS in Electrical Technology from Jamestown Community College, a BT in EET from the State University of New York (SUNY) Institute of Technology, and an MS in Advanced Technology from Binghamton University. Prior to teaching at Rock Valley College, he was an R&D engineer in the machine tool industry, specializing in microprocessor-based systems. Professor Lombardo has been active in the distance learning endeavor at RVC since its inception.