TEACHING AND LEARNING PORTFOLIO

by

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I. INTRODUCTION

This document is a Teaching and Learning Portfolio compiled as the culmination of work performed for the Delta Certificate program. As a portfolio, this document serves several purposes: it is a compilation of some of my work in teaching practice, tutorial and laboratory experiment development and course preparation. This portfolio is also a collection of personal statements which discuss my motivations to be involved in education, the evolution of my teaching philosophy, and how both practical teaching experience and the training in the Delta program has both taught me new techniques and opened my eyes to the depth of complexity of education.

Throughout the document I draw on my experiences and reflect on how these experiences are part of the three pillars of the Delta program: teaching-as-research, learning community, and learning through diversity. I present and reflect on these education experiences in chronological order to demonstrate the evolution of my teaching theory and method. Additionally, because many of the early experiences I will discuss occurred before I was aware of the Delta program, my reflections will oftentimes discuss the experiences in terms of the pillars although I had not considered it explicitly at the time. This is an important part of the development of my teaching philosophy – although people outside of the Delta program may not be aware of discussing education in these terms, the pillars are deeply intertwined in our education activities. It is my hope that reflecting on how the pillars affect education, even when the students (and maybe even the instructors) are unaware, can help me to continue to improve education technique throughout my career.
II. THE DELTA PILLARS

Throughout the document I will refer to my experiences in terms of the Delta pillars; thus, it is important to define the pillars, particularly what the pillars mean to me. The three pillars of the Delta program, teaching-as-research, learning community, and learning through diversity describe and encompass a wide variety of teaching experiences. I will discuss each separately, but, like the pillars of a building, each of the three pillars supports, reinforces and strengthens the others.

Teaching-as-research is a simple concept that describes the process of continually improving education skill and technique. In the context of the Delta program, we formalize teaching-as-research to include reading current literature on educational best-practices, as well as structured techniques for designing, evaluating and improving course content. In general, teaching-as-research encompasses an attitude of critically evaluating every aspect of classroom interaction; everything from group formation, and lecture content to teaching styles and learning goals evaluation is based on underlying hypotheses that we can consider, evaluate and potentially improve upon.

Learning communities describe a wide range of personal interaction both in and out of the classroom. Inside the Delta program, the learning community consists of people from disparate backgrounds that have a common interest in improving education (particularly for Science, Technology, Engineering and Mathematics fields). As educators, we must broaden the variety of learning communities: interaction between professors and students, and among groups of students are two simple examples, but we may also consider communities of student organizations (such as Society of Women Engineers (SWE) or the Institute of Electrical and Electronics Engineers (IEEE)), or the wider (non-academic) community. In many cases learning communities naturally form as a consequence of social interaction with classmates, but it is also the educator’s task to encourage and foster a supportive environment in the classroom, and to help form communities within our courses and encourage communication skills and participation in other communities that help to meet students’ needs.

Learning through diversity is the concept that we can use the inherent diversity present in the classroom to provide a higher quality and richer education experience. Classroom diversity may be present in any of many forms: ethnic, racial and gender diversity are some aspects of diversity, but we may also leverage economic diversity, social diversity, diversity of learning goals, and diversity of learning styles. Although no one person may be aware of all potential impacts, it is the educator’s task to be aware of potential differences, and put effort into creating and encouraging a diverse learning environment. It is important, however, to not be overzealous in the search for diversity; although part of learning through diversity is to acknowledge and encourage diversity, it is also the students’ right to be treated equally. Thus, it is important to encourage expression of all forms of diversity while not giving undue (and unwanted) attention to a student because of their difference.
III. BEFORE GRADUATE SCHOOL

As the son of a high-school teacher, I have observed the education process throughout my life. But despite early experience in observing and experiencing education practices, my teaching philosophy has evolved significantly over the course of my undergraduate and graduate studies. In retrospect, my father was deeply involved in what we might describe as teaching-as-research. Throughout his career, he kept copies and results of homework and examinations from every single class and assignment over his 32 year career. Although his research method would certainly be described as informal, these documents represented a wealth of practical experience and iterative, results-based improvement of his assignments, exams and education technique. On his retirement, there were many filing cabinets, binders and folders of categorized assignments dating back to his first years as a teacher. My observations at the time would have characterized all of this developed experience as talent, and indeed talent plays a part in diagnosing how to improve education. However, I ignored the methodical, iterative improvement of course instruction that makes education more than talent, and a learnable skill.

Even before undergraduate work, my father involved me in teaching activities, so I saw the benefit and enjoyment of teaching and helping others. Throughout my time in both post-secondary and undergraduate school, I was commonly involved in peer teaching and mentoring in many of my classes. As an interested, willing, but untrained educator I was often called upon to help my peers. On numerous occasions as an undergrad, I helped other students understand course material during group study. These learning communities that I participated in were certainly supportive; I better understood course material by explaining it to peers, and in turn my peers helped me to understand concepts as well. Throughout most of my undergraduate and graduate careers, learning communities formed naturally—I talked with students who sat close to me during lectures and tended to form study groups, project groups and longer friendships with those people. These learning communities were also prime examples of learning through diversity; we represented a wide range of racial, cultural, social and economic backgrounds, but shared a common interest in our studies. Although we shared interest in computer engineering, we still had other differences which at times made helping each other with course material difficult. However, most of the students I worked with were at a similar level to me, and thus educating was relatively easy. Although these early experiences gave me valuable experience in working with others and communication, I had an unrealistic belief that education was a simple task if the educator understands the material and desires to convey that understanding.
IV. EARLY GRADUATE SCHOOL

I carried these beliefs into my first interactions with students as a teaching assistant. At the time, I believed that effective education was only a matter of desire and effort—if I put in enough work, students would eventually understand. However, my early experiences as a teaching assistant were a perhaps rude awakening to the true complexities of teaching. There were some students that understood the material as I did, but those students often did not seek my help. Instead, most students I worked with had background experiences, learning styles, or levels of interest that differed from mine. This made it often a significant challenge for me to understand where the difficulty in comprehension lied. These experiences opened my eyes to the difficulty of education—it was not enough for me to desire to teach students, I needed to be prepared to teach students who were challenged by the material in new ways that I could not predict. Although these early difficulties could have been disheartening, I looked upon these challenges as motivation to improve my teaching and thus better educate the next semester of students.

A. Artifact 1: ECE 551 Tools Tutorials

In my second semester as a TA for ECE 551 – Digital System Design & Synthesis, I identified course tool tutorials as a problem—many students had significant difficulty with these tools. Although instruction on these tools was not formally part of the course curriculum, use of the tools was needed for every homework and project assignment. The tools were thus a critical part of student learning. I re-developed the tutorials for the tools, explaining their operation rather than listing a series of steps—providing more understanding and a manual of common operations. For these tutorials, I received the Gerald Holdridge Tutorial Development award. This initial experience in more in-depth effort at effective education opened my eyes to the potential for improving my educational techniques.

Creating a new project

1. If you just finished the previous lesson, ModelSim should already be running. If not, start ModelSim.
   a. Type `mvsim` at a UNIX shell prompt.

2. Create a new project.
   a. Select Create a Project from the Welcome dialog or File > New > Project (Main window) from the main bar.
      This opens a dialog where you enter a Project Name, Project Location (i.e., directory), and Default Library Name (Figure 12). The default library is where compiled design units will reside.
   b. Type `my_project` in the Project Name field.
   c. Click Browse to select a directory where the project file will be stored.
   d. Leave the Default Library Name set to work.
   e. Click OK.

Figure 1: Excerpt of Modelsim Tutorial (1 of 2) – This tutorial was adapted from a tutorial provided by the Modelsim Vendor. Some content was removed and other content added to correspond to the goals of the course.
Compiling and loading a design

1. Compile the files.
   a. Right-click anywhere in the Project tab and select Compile > Compile All from the pop-up menu.

   ModelSim compiles both files and changes the symbol in the Status column to a check mark. A check mark means the compile succeeded. If the compile had failed, the symbol would be a red 'X', and you would see an error message in the Transcript window on the right.

2. View the design units.
   a. Click the Library tab in the workspace.
   b. Click the "+" icon next to the work library.

   You should see two compiled design units, their types (modules in this case), and the path to the underlying source files (Figure 17).

3. Load the test_counter design unit.
   a. Double-click the test_counter design unit.

   You should see a new tab named 'sim' that displays the structure of the test_counter design unit (Figure 18). A fourth tab named Files contains information about the underlying source files.

   At this point you would generally run the simulation and analyze or debug your design like you did in the previous lesson. For now, you'll continue working with the project. However, first you need to end the simulation that started when you loaded test_counter.

4. End the simulation.
   a. Select Simulate > End Simulation.
   b. Click Yes.

Figure 2 - Excerpt of the ModelSim Tutorial (2 of 2)
Analyze is similar to compilation. It will check the syntax of each of the files to verify correct use of the language and that all code used is synthesizable.

Figure 1-5: Analyze Results Log

3. Elaborate the design

File->Elaborate
Change Library to WORK
Change Design to RISC_CORE(struct)
Click OK

Figure 1-6: Elaborate Dialog

The elaboration step will take several minutes. This step is similar to loading the design in Modelsim. The design is checked to make sure that the code is synthesizable, the sub-designs connect correctly and that there are no major errors in the implied circuit. (At the end of this step you may determine that latches were incorrectly implied and fix your code to remove them).

Figure 3 - Excerpt of the Design Vision Tutorial (1 of 2) - This tutorial was entirely new content; the industry tutorial was deemed inappropriate for the course, as it expected users to be familiar with all of the purposes of the tool, but unfamiliar with the user interface. In contrast, this version goes to length to explain and demonstrate the purpose of features.
Lesson 3 – Design Constraints

1. Check Design

Performing a design check can find inconsistencies in your design that may or may not be problems. Example check results are having the same input connected to two input ports, and having ports left unconnected (or certain wires within the port left unused).

Design→Check Design
Change Warning messages to "Display in detail"
Change Hierarchy to "Current level and all sub-designs"

The following is a summary of the results given by the check design. Note that what is given are warnings. This means that you should check the warnings to ensure they are expected and ok, or change code and/or Design Vision settings before moving on.

Figure 2-2: Compile Ultra Dialog

Figure 3-1: Check Design Dialog Box

Figure 4 - Except of the Design Vision Tutorial (2 of 2) - Again, this tutorial puts more effort on explaining the purpose of program features rather than simply demonstrating where to find the feature. This lesson begins a section on methodically explaining the meaning of each design constraint for circuit compilation.
Reflections on the ECE 551 Tools Tutorials

The purpose of the tutorials that I developed for the tools used in ECE 551 – Digital Systems Design and Synthesis was to convey both practical experience using the tools for that course as well as a general understanding of the features used in the tool and their meaning. As an informal teaching-as-research project, I identified that students in my first semester as TA of the course had difficulty using the course tools. Particularly, students were unable to use the tools other than to follow step by step instructions. These instructions forced the students to use the tools correctly, but left little room for the students to understand what operation they were performing with the tools, and no ability to use the tools without step by step instruction. In terms I later learned as part of Bloom’s taxonomy, I found that students had the lowest level of learning: the ability to recite and repeat instructions given to them, but no ability to understand what they were doing or apply that understanding to different situations.

For this reason, I undertook to develop tutorials that conveyed both practical experience and understanding of the tools. I spent significant effort in both refining the step by step instructions as well as adding explanations about the purpose and meaning of the operations students were asked to perform. With these tutorials, I achieved a goal of providing better practical experience using the tools. However, I now see that there were weaknesses in the implementation of my goal of general understanding of tool features. While developing the tutorials, I had not formulated my educational goals clearly, or defined how I planned on evaluating whether students understood the extra material I had added. In my naïve theory, I expected that with the presence of better information about the tools, students would read, understand and be able to apply that knowledge to the use of the tools. However, I had not developed clear tasks or evaluation of whether students did achieve that goal.

These tutorials still represent an important improvement for use of the course tools. However, with the experience I have now obtained, I would apply more rigorous technique to determine my goals for students using the tutorials, the exercises in the tutorials intended to convey information, and the method of evaluating whether the tutorial had achieved its intended purpose.
V. GRADUATE SCHOOL: TRAINING IN EDUCATION TECHNIQUE

In my second year of graduate school, I was the chair of the engineering college’s New Educator Orientation (NEO) program. Working together with Sandra Courter, we developed and presented an active learning workshop for inexperienced educators. For this workshop, we introduced participants to the concepts of teaching-as-research, group work as a learning community as well as various active learning strategies.

B. Artifact 2: Active Learning Workshop for the New Educator’s Orientation program

This artifact is the PowerPoint presentation used for the active learning workshop in my second semester as the chair of the NEO program. It is important to note that the workshop slides were used throughout the 75 minute workshop in small increments. As an active learning workshop, it is an important component to practice what we preach and create active learning groups within the workshop itself. A 75 minute workshop is a unique learning community—although the participants share some common interest in education, they were from a wide range of fields of study and were unlikely to continue to interact after the workshop. In this case, we specifically spent time on allowing tables to introduce themselves. There are several parts of the presentation that specifically setup an active learning exercise and there are additional spots throughout the presentation that Prof. Courter and I used as opportunities to create discussion in the workshop rather than to read the materials from the presentation. In each of the active learning exercises, we asked the small groups to assign roles to group members, but we also asked groups to change roles between exercises to encourage a wider range of interaction.
Workshop Outcomes
As a result of this workshop, you will be able to
- Build a case for active learning
- Identify active learning strategies
  - Starting with learning outcomes
  - Implementing strategies
  - Assessing their effectiveness for your student learning
- Recognize teams as a natural active learning experience

Figure 5 - Excerpt of the Active Learning Workshop. This slide (#3) clearly lays out learning objectives so that the entire audience knows immediately the goals and plan for the workshop.

What active learning strategies do you like? Dislike? Why?
- In small groups, create two lists.
- Assign roles: leader, recorder, reporter, timekeeper
- Determine time for activity.
- Be advised when 3 minutes are left.
- You have 3 minutes!
- Time's up!

Figure 6 - Excerpt of the Active Learning Workshop. This slide appears about 20 minutes into the workshop, directly after a slide where we discuss that the average attention span is between 15 and 20 minutes. This is the first of five different active learning techniques employed throughout the workshop.
Reflections on the Active Learning Workshops

These active learning workshops were an excellent opportunity to experience all three pillars of the Delta program. Under the guidance of Prof. Courter, we created and facilitated a workshop that included teaching-as-research, learning communities and learning through diversity. In addition to the benefit of passing along practical expertise in good education practice, these workshops also gave me valuable experience in implementing active learning, evaluating the efficacy of our activities and using those observations to improve on the next iteration of the workshop. During the workshops, participants were actively involved in conversation throughout and interested in the presented techniques. Importantly, many of the incoming attendees were cynical about active learning, but throughout the experience attendees became interested in using active learning techniques in their classroom activities after experiencing active learning during the workshop.

In addition to developing the active learning workshop, I also facilitated a diversity workshop together with the Assistant Vice-Chancellor and the Office of Equity and Diversity. During this diversity workshop, I helped to facilitate discussion of various diversity issues. An important part of learning-through-diversity for the educator is to simply be aware of the kinds of diversity that will be present in their classroom. New educators may be accustomed to some kinds of diversity and yet completely unaware that other forms of diversity will affect their education. This workshop facilitated discussion of racial, cultural, ethnic, economic, and social diversity and methods for educators to take advantage of diversity in the classroom to be more effective educators.

At the same time, as I continuing teaching assistant, I participated in the Teaching Improvement Program (TIP), a program for TAs and professors that presents workshops on improving teaching methods. Although brief, these workshops formed a valuable learning community. Graduate students and professors from throughout the engineering college participated in sessions to discuss grading, syllabus design, learning styles, and new technologies in education among others. Like the New Educator’s Orientation program, these learning communities were also short lasting, but instructors put special effort to treat both Professors and teaching assistants equally, fostering a unique environment of discussion about education rather than the employer-employee relationship often encountered during the regular semester. While participating in the TIP programs and working with Prof. Courter, I became aware of the Delta program.

VI. THE DELTA PROGRAM COURSES

During my third and fourth year of graduate school, I took several Delta classes that educated me in best practices, common education terminology, and the three pillars of the Delta program. These courses put to words some of the experiences that I had had over my teaching experience to that point. I had experienced teaching-as-research, learning communities and learning through diversity throughout my education, but it was the Delta courses that put those experiences into perspective. I may have informally used different teaching techniques to reach students, but to best educate students, I had to understand the influence of differences in social, economic, ethnic, racial and gender background on students interests. These courses re-grounded me to view my role as a teacher from a different perspective – I was no longer a peer that merely recited my own path for understanding. Now, I was an educator, finding student challenges and reforming my educational techniques to meet their needs.

In this section, I present reflections on the Delta courses as a whole—their education impact, the learning community and how the course impacted me. In section VII, I present artifacts from these courses including education materials, evaluation, and surveys.
The College Classroom course was the first Delta program course I took, and it was my first experience in learning educational best-practices, reading scholarly articles about education technique, and discussing education with groups of students that shared my interest in education.

**Reflections on The College Classroom Course**

The college classroom course that I took was a particularly interesting case study in educational technique. In addition to the normal topics of that course, the particular semester that I took the course was also the first semester where Delta has an online version of the course with remote interaction with students at the University of Colorado at Boulder, Howard University, Vanderbilt University, Fisk University, and Michigan State University. It was of particular interest to try out different techniques in course organization to perform the research of what sort of online course organization and teaching techniques work best. For the course, we spent several sessions with online-only interaction (individual reading and online discussion via message boards), several sessions with remote interaction using a conference call, and several using full video chat features. It was often a lively discussion about how those three different organizations work and their relative strengths and weaknesses in addition to the discussions that arose from our normal course readings.

The course content was an important first step in educational best-practices. Throughout the course, we had readings that still commonly serve as the starting point for lively discussions about education with people both within and outside of the Delta program. I still commonly consider my educational theory in terms of fundamental concepts such as Bloom’s taxonomy that I first learned in this course. Most importantly, however, was the lively discussion and variance of opinions on the best-practices. These discussions not only brought up common techniques, but also exposed me to a variety of opinions on the positive and negative aspects of the techniques. It was these discussions that began my practice of attempting to evaluate teaching technique and iteratively improve practices—what I now consider the fundamental basis of teaching-as-research.

The instructional materials development course was my first formal experience in attempting to apply the knowledge acquired in the college classroom course. In addition to considering the literature best-practices when developing course materials, this course demonstrated a practical and methodical way of creating materials. Using this method, the goals, reasoning and evaluation of instructional materials is laid out clearly. Indeed, the method of setting out goals for the materials and evaluate whether those goals are met is just as important as the instructional materials themselves.

**Reflections on the Instructional Materials Development (IMD) Course**

The IMD course has made the process of course development much more concrete for me. This is a process that can be used at any level of development, from a small part of one lecture period to the entire curriculum development of a degree program. Learning this process has emphasized just how far the required set of skills for a degree can change over a period of time and that the curriculum needs to be constantly re-evaluated to maintain relevance.

For the course that we worked on, all of the group members were initially blinded by believing that there weren’t really any problems with the course material – probably because all of us successfully got to this point in our careers with similar coursework. As we followed the process of evaluating the class and determining problems that students have, it opened my eyes to see that there are issues that are common among students but that I didn’t personally experience. Furthermore, the process of evaluating and categorizing the problems caused me to reconsider what the important content really is. We had been concentrating on portions of the content that didn’t improve the main educational goals of the entire course.
Overall, this class has made the concept of course development much more concrete so that I feel like I could either modify a class or create a new class from scratch by following the guidelines we developed during class. I think that our project reflects the kind of development process that should be performed for every change in a class, however I will try to remember in the future that there likely are problems for students that I did not think of or personally experience.

For my Delta internship, I also worked on the course redesign for ECE 352 – Digital Design Fundamentals. Specifically for the internship, I took the sequence of laboratory exercises that were covered in ECE 351 – Digital Logic Laboratory – a course previously taken the semester after ECE 352 – and redesigned the sequences to contain similar content, but reorganized to coincide with the lecture sequence and ordering already present in ECE 352.

**Reflections on the Internship**

I performed my Delta internship in the same semester as I was taking the Instructional Materials Development course. The two experiences provided related but differing experiences. In the IMD course, we spent our time concentrating on one specific perceived learning problem/objective and applying backwards design to that problem. In contrast, my internship had a more broad goal of redesigning the entire sequence of laboratory exercises for the course. Because I was taking both courses simultaneously, I naturally was thinking about both projects and techniques simultaneously. Whereas the IMD course concentrated on the design process for course materials, my internship experience concentrated on evaluation of results. With the support of my internship cohort, we discussed effective survey techniques, evaluation of survey results, design of teaching-as-research experiments, and how to draw conclusions and relate those conclusions to literature.
VII. Delta Course Project Artifacts

In the Delta courses I participated in, I created several educational materials that were put to use in the ECE 352 – Digital Design Fundamentals course sections running concurrently with the classes. ECE 352 is a sophomore-level class taken by computer science, electrical engineering and computer engineering students. The course covers a range of topics from basic logic, hardware design, and computing that is of general use to all three disciplines; computer engineering students must also take other courses on digital logic design—computer science students and electrical engineering students may take other courses, but are not required to. In each semester, there are normally two sections of 60-70 students each, with laboratory sections of 12-18 students to present practical implementations of course material.

The artifacts presented in this section represent the work performed in the Instructional Materials Development course and my Delta internship. In each case, the artifact represents a more rounded appreciation of all three Delta pillars: each material applies teaching-as-research, using a hypothesis of student learning and some measurement ability to judge the efficacy and iteratively improve, the artifacts demonstrate both group work and interaction between the students and professors that form a learning community, and in each case materials were carefully considered for learning through diversity to include a diverse set of teaching methods, avoid potential cultural bias and encourage classroom diversity. In particular, artifacts 3 and 4 represent an important part of developing a learning community between instructors and students; merely expressing interest in students’ opinion of the course, course materials, and student evaluation helps to form an inviting, collaborative learning environment. Although I spent particular effort to consider best-practices, diversity and learning community when designing course materials, this is not to suggest that there was no lesson to be learned once I had achieved an appreciation of the pillars and how to incorporate them into practical education efforts. The process of teaching-as-research is applied throughout all of these artifacts, and as I will reflect on, there were still cases where my hypothesis was too narrowly focused, or the designed material was effective, but inappropriate for the particular course.

C. Artifact 3 – Background Experience Pre-survey

At the beginning of the semester of instructional materials development, our hypothesis for problems in course instruction was that course material was generally understood well and the topics were simple enough. Our premise was that existing instruction already did a sufficient job, and our project for the course was going to be part of the course redesign already underway. We expected that the topics were easily understood, but lecture examples and course projects were not sufficiently compelling. For our part, we expected to evaluate the existing instruction and potentially reorder topics to ensure that the laboratory exercises and lecture content were correctly aligned. To test our hypothesis that the course instruction was already sufficient, we created a background experience survey for students that had already completed ECE 351 and ECE 352, the two course part of the redesign.
Excerpts of the pre-survey. The different sections cover qualitative topics such as how the students felt prepared in general, or their opinion on too many or too few design examples, and more discrete goals such as understanding of specific important concepts to take away from the course.

The survey was designed to determine the students’ attitude toward the lecture examples as well as the students’ confidence in their ability to apply the important design techniques taught in class. Specifically, the survey was intended to help answer the following questions:

1. How well did the introductory courses prepare students for their future coursework?
2. How interesting and helpful were the in-class examples?
3. What material should have been covered in more/less depth?
4. How effective was the course project?
5. Did the material increase the students’ interest in computer engineering?
6. Can students confidently apply hierarchy to designs?
7. Do students use component testing?
8. Are students confident in their ability to create a design given a well written specification?
Unfortunately, the quiz was not compulsory, so we had only 10 respondents in the time allotted for performing the survey. As stated earlier, our initial hypothesis was that students are not compelled by existing in-class examples due to their simplified nature. Additionally, we thought that most students were confident in their ability to use hierarchy, component testing, and design specifications, but the simplified examples did not maintain or generate student interest in computer engineering. However, the results of the survey showed that students in general found the current examples compelling and sufficiently instructive, as demonstrated by Figure 8 and Figure 9. Furthermore, all of the students surveyed felt that there were neither too many nor too few examples presented.

Despite the general approval of the current format of examples, students expressed that they were not as confident in their ability to apply hierarchy, perform component testing and analyze specification documents as we expected them and want them to be. Figure 10 and Figure 11 illustrate this point. Although these results appear to be positive, students completing ECE 352 should have a very high level of confidence and understanding after completing ECE 352. Furthermore, anecdotal evidence from conversations with instructors from ECE 352 and later courses indicates that although students know that the “correct” answer is that they should use good design practices such as hierarchy, they do not necessarily have a fundamental understanding of why that is.

These concepts are fundamental to the material taught in the course, as well as material in a number of the following courses. It is therefore our belief that all, or most all students should be strongly confident in their
abilities to perform these tasks. Based on these survey results, we changed our instructional material development efforts to focus on improving student comprehension of these very important topics.

**Reflections on the Pre-survey**

Shown in Figure 7 is the template for the pre-survey: the actual survey was an online survey sent to students of ECE 551 – Digital System Design and Synthesis and ECE 552 – Introduction to Computer Architecture to assess how well those students understood topics covered in ECE 351 and ECE 352, two pre-requisite courses. As most students taking ECE 352 have little or no prior knowledge of digital design, students have few true "misconceptions" that they must overcome. The challenge instead that we initially wanted to address was a perceived lack of motivation for students to continue to study computer engineering after taking this course. We believed that this was due to the lack of sufficiently complex real-world examples being used to justify the usefulness of the content being taught.

We first examined the design examples given during the lecture portion of ECE 352. Lecture examples are difficult to develop for this course because interesting examples tend to be large, complex problems that are not feasible to cover at the students’ level of understanding. Conversely, examples that are feasible to develop and present tend to be simplified to the point that we believed that students would not find compelling, and therefore would not see the connection to the designs they would need to develop in future courses and the workforce. Furthermore, existing lecture examples do not address bad design techniques. The consequences of poor design-hierarchy, unit testing, interface design and group work are not reinforced by the examples.

In retrospect, the survey was so specifically tailored to our initial hypothesis, that there was insufficient detail to help identify underlying problems with the course based on the data we gathered. Although we were able to determine that our initial hypothesis was not correct, we were unable to quantitatively measure other hypotheses. In terms of teaching-as-research, our narrow hypothesis prevented an evaluation sufficiently broad to determine other potential outcomes. Specifically, although our experience did not match students’ stated confidence in using common design techniques, I now see that the questions were leading questions that would tend to encourage students to answer affirmative even if they were less confident. Even so, students’ confidence was under what we expected, which led us to working on a design rubric for digital design projects, yet it would have been helpful to design the survey to better evaluate student understanding of the various design techniques we cover with the design rubric.

**D. Artifact 4 – A Design Rubric for ECE 352 Projects**

As part of my Instructional Materials Development course, we developed a design rubric and corresponding examples of good and bad technique to reinforce the concepts of hierarchy, testing strategy, and using a design specification to determine separation of datapath and control elements. The rubric covers 8 categories of design quality. The rubric is intended to be able to be used for multiple purposes; first, the rubric should effectively disseminate learning goals and expectations. Next, the rubric can be used for students to self-evaluate projects or evaluate sample projects as a course assignment. Finally, the rubric can be used as an evaluation guide for teaching assistants and semester-to-semester coordination between Professors. Because of these multiple purposes, the rubric encourages learning-through-diversity; a single document can be used to teach in multiple methods. Furthermore, the rubric explicitly encourages learning communities and communication by specifying an entire category for group work. To assist both our development of the design rubric as well as students’ understanding of our descriptions, we also created several diagrams demonstrating the difference between “good” and “bad” design styles. It is our hypothesis that a design rubric such as this will emphasize the entire range of digital design aspects instead of just correctness, and this well-rounded appreciation will also lead to
Students with more confidence in applying and using common techniques such as hierarchy and separation of datapath and control.

<table>
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<th>3 – Exemplary</th>
<th>2 – Sufficient</th>
<th>1 – Needs Improvement</th>
<th>0 - Unacceptable</th>
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</thead>
</table>
| **Hierarchy** *(Organization)* | • Design units separated and named to aid comprehension of purpose of unit  
• Number of levels of hierarchy is appropriate for clear understanding of each unit and the design as a whole | • A few design units with unclear names  
• Most design units separated well, purpose of units clear  
• Number of levels of hierarchy is appropriate, but minor improvements could aid understanding | • Design unit separation and naming is difficult to understand  
• Number of levels of hierarchy makes it difficult to understand some units or the design as a whole | • Design units contain unrelated pieces of logic  
• No naming convention, or names do not correspond to design  
• Number of levels of hierarchy makes it nearly impossible to understand the individual units or the design as a whole |
| **Separation of Datapath & Control** | • Datapath and control can efficiently be tested in isolation  
• The datapath clearly shows the progression of data through the system  
• The control clearly and completely generates the signals used to operate the datapath | • Datapath and control can be tested separately, with minor reduced efficiency  
• The datapath incompletely shows progression of data, or generates some control  
• The control incompletely generates signals, or has datapath elements | • Datapath and control are mixed together. It would be difficult to test separately  
• The datapath does not clearly show data progression. Control is mixed throughout  
• The control generates few of the signals, much of the control is mixed in with the datapath | • There is no separation of datapath and control, they cannot be tested separately  
• It is difficult to determine the progression of data  
• Control is mixed throughout the datapath, confusing the difference between the flow of data and the signals that control data |
| **Teamwork** | • Team met often, with efficient separation of work and team decision making  
• Work was separated into equal parts, with significant effort in making sure that the parts will be compatible  
• Team members understand the entire design, and how their components fit into the whole | • Team met some, but separation of work and design decisions were not fully considered  
• Work was separated with minor inequities  
• Minor incompatibility in separation of work  
• Team members understand their components, with an incomplete understanding of the entire design | • Team met a few times, but separation of work and design decisions were ad hoc  
• Significant inequities in work  
• Significant issues in the compatibility of separated work  
• Team members incompletely understand their components, with little understanding of the entire design | • Team met rarely, with little to no separation of work, or group design decisions  
• Some group members did not participate at all, while others completed all of the work  
• Designs of group members are incompatible  
• Little to no understanding of individual components, or the entire design |
| **Correctness** | • All individual components entirely correct  
• Combination of components entirely correct | • Few minor errors in individual components  
• Combination of components mostly correct | • Many errors in individual components  
• Combination of components has significant errors | • Many large errors throughout individual components  
• Combination of components cannot be determined due to systematic errors in individual components |

Figure 12 - Excerpts of the Design Rubric. The rubric both represents a range of good design properties and techniques as well as delineates expectations. The last row is particularly important—commonly students consider correctness to be the only evaluation, but this demonstrates that actual correctness (correct operation of the design) is only one part of the project, so designs that operate well but with poor planning, testing or design technique will still negatively impact the overall project.
Figure 13 - Diagrams representing a good (a) and bad (b) testing strategy for a 4-bit Full Adder. In (a), the testing strategy represents use of hierarchy, exhaustive testing and well reasoned test-cases and would be categorized as 3-Exemplary. In (b), the testing does not use hierarchy, but does exhaustively test, and would be categorized as 1-Needs Improvement.

Figure 14 - Diagrams representing a good (a) and bad (b) method for control and datapath separation for designs. In (a), the separation of control and datapath is exact and clear (3 – Exemplary). In (b), there are minor portions of control not directly handled by the control module (2 – Sufficient).

Figure 15 - Diagrams representing a good (a) and bad (b) method for interface design between two modules. In (a), the interface between the two modules is exact and requires no translation or glue logic to operate correctly (3-Exemplary), and in (b) there is glue logic between the modules that requires both timing and concept changes (1-Needs Improvement).
Figure 16 - Diagrams representing a good (a) and bad (b) strategy for hierarchy of design. In (a) every piece of logic is a part of a module, and hierarchy is often used and well designed (3-Exemplary). In (b) there is very little use of hierarchy, and it is not easy to understand the purpose of portions of the design (1-Needs Improvement).

**Reflections on the Design Rubric**

The design rubric embodied the qualities that we desired to students to achieve in their project designs, and clearly showed the different design levels for the various design categories. Although we were happy with the descriptions and diagrams, it became apparent that it was not appropriate to add a large, unguided design element to the ECE 352 course. The timing and workload of the course simply does not allow for such a large additional project beyond the current coursework. Unfortunately, this meant that this particular artifact was not implemented as a part of the ECE 352 course. In retrospect, this is an excellent learning experience: we designed a course element that met its intended purpose and did a good job of conveying the information, but it was inappropriate for other reasons. This teaches a valuable lesson in multiple ways. First, no matter the quality of a teaching instrument, we must still evaluate whether it is appropriate for a specific class. Second, it demonstrates that there are more evaluation metrics for course materials than just whether the material conveys the intended material. Finally, it demonstrates that each part of a course must integrate with the rest—this rubric would work well if it fit in with the expectations and goals of the rest of the course. This demonstrates the importance of defining an appropriate hypothesis and experiment for teaching-as-research; if other constraints prevent implementation, we cannot correctly evaluate new teaching methods. Despite this, I still expect that the rubric is valuable and I plan on modifying it as necessary to apply it to other design courses.
E.Artifact 5 – Laboratory Exercises

For my Delta internship, I redeveloped the laboratory exercises for ECE 352 – Digital Design Fundamentals based on the course content of ECE 351 – Digital Logic Laboratory. In the fall of 2006, the College of Engineering began implementing a new common first year for all engineering students (across Chemical, Mechanical, Civil, Electrical and Computer engineering disciplines). As part of this change, the electrical engineering department created a new course for first-year students, and reorganized content to coincide with changed credit requirements for first-year students. This credit change required reducing the credit load of ECE 352 from 4 to 3 credits, and entirely removing the ECE 351 course. However, we still felt that the practical design experience from ECE 351 was a critical learning experience, so the redesign included integrating a laboratory component into the ECE 352 course.

The lab exercises needed to be modified to reorder content and remove some of the content that was only appropriate for ECE students. The ECE 352 course is an interesting learning community comprised of students from computer science, computer engineering, electrical engineering, and often other engineering disciplines; these students each have different goals for the course. This diversity creates a rich learning environment, but also creates challenges—as educators we must ensure that all of the course content is appropriate for all of the students. For this course, the laboratory component is an important learning community; it consists of two or three students which work together on a significant portion of the coursework to help each other to learn and apply course content. Furthermore, because of the diverse audience, it is quite likely that lab partners will be from different fields of study, which will emphasize the variety of learning goals and styles present.

In the original ECE 351 course, students were expected to complete ECE 352 as prerequisite, so each lab experiment was more in-depth and required broad knowledge of digital design at the beginning. Because of this, for ECE 351, it was appropriate to assign an unguided final project where students were responsible for implementing a project of their own choosing. However, because the laboratory and lecture content will be concurrent instead of in subsequent semesters, we needed to create a final project, and ensure that each lab exercise built on the prior exercises and could be used for the final project.
1-2 Lab Work

ON REPORTS: All lab results and all answers to questions or discussion are to appear in the lab reports of individual students. All tangible lab results are to be identical; when a printout of results is specified, a copy should be made for each team member. All answers to questions or discussion are to be the work of individual students, not the lab team. Evidence of collaboration on these aspects of a report within or between teams will be noted and is subject to University disciplinary action.

In this experiment you will measure the propagation delay for an inverter in the High-speed Complementary Metal Oxide Semiconductor (HCMOS) logic family under different conditions.

Equipment Needed

In addition to the equipment already on the lab bench, your instructor will have you check out a plastic tray containing:

1) an ECE351 logic board.
2) a power supply module for the logic board,
3) two scope probes,
4) a logic analyzer probe,

Figure 2 - Logic Board Layout

Warning – Lab Equipment Handling: Much of the lab equipment is small and delicate. In particular, this applies to the FPGA boards, scopes, scope probes, and logic analyzer probes. So please be careful and handle the equipment with a light and careful touch and do not use the scope probes with the grabbers removed. Perform wiring on the board ONLY with the power and other cables disconnected!

Lab #1 - Sequence 01  3  S07

Figure 17 - Excerpt from the first lab exercise. A key feature of the labs is step by step instructions for the exercises, with progressively fewer step-by-step instructions throughout the semester. We use a format where Red outline boxes denote warnings.
5) Calculate $V_{VOL} = (V_{OH} - V_{OL})/2 + V_{OL}$ and align cursor V1 with this value.
6) Move cursor V2 so it does not appear.
7) Select cursor t1 and align with the intersection of $V_{IN}$ and cursor V1.
8) Select cursor t2 and align with the intersection of $V_{OUT}$ and cursor V1.
9) Read out the value for $t_{PHL}$.
10) Transfer, save, annotate and print the result for each team member. Annotate the axes and waveforms and include two labels: 1) team member names, and 2) $t_{PHL} = \text{(value)}$ ns.
11) Change the triggering to negative edge and repeat all steps for $t_{PLH}$.
12) CHECKPOINT: Show your $t_{PLH}$ measurement to your instructor.
13) Answer the following.

2a. Use the measured $t_{PHL}$ and $t_{PLH}$ to find both $t_{PC}$ and $t_{PD\text{average}}$.

**ADVANCED** – The delay we measured is significantly less than the delay listed on the part’s datasheet. The part lists worst case delay of 19nS, and typical delay of 11nS. What we measured is significantly less because:
1. The spec is made to cover a wide range of temperatures
2. The spec assumes a much higher output load of the inverter (our load is only 1 gate). Think of the load like a bucket that needs to be filled. With a small bucket (small load), the bucket fills quickly, so the delay is small. However, if there is a larger bucket (large load), it takes more time to fill the bucket (charge the output capacitance).

**LOGIC FUNCTION VERIFICATION**

**Objective**: To determine the function of a logic gate using a counter to provide the inputs and the digital signal (logic analyzer) mode of the scope to observe the results. The logic gate you will examine has three inputs and a single output, and is purely combinational in nature (i.e. no sequential logic). The three inputs are connected to JP4 pins 1-3, and are driven by a counter built onto the logic board to provide the inputs for testing the gate. We will observe these inputs and the resulting logic gate output in order to determine the function of the logic gate

**SETUP**
1) Disconnect board power.
2) Remove the two scope probes and the connected black lead extensions.
3) Attach the ground for pod 0-7 of the logic analyzer to GROUND. Arrange the probe cables so that they are out of the way and the pod is at the back of the board.
4) Attach probes leads D0, D1, and D2 to the inputs, JP4-1, JP4-2, and JP4-3 respectively, and probe lead D3 to the output, JP4-4, as shown in Figure 4.

Figure 18 - Excerpt from the first lab exercise. In addition to the Red boxes, Orange outline boxes denote advanced (extra) information for deeper understanding of lab material, and Green outline boxes denote measurements or calculations that must be handed in as part of the lab report.
Reflections on the Laboratory Exercises

We designed the content for the new laboratory sequence so that the complexity is appropriate for concurrent lecture content. In addition, we designed the lab content to serve a wider range of potential students including electrical engineering, computer engineering and computer science students. In order to minimize the number of course elements changed at the same time, we based our initial implementation on the previous sequence. We modified the sequence to correspond to a different content ordering, removed material not appropriate for computer engineering, computer science, and electrical engineering students, and designed the entire sequence to build into a cumulative course project. Because we were concerned about the impact of the new labs on total course workload, we decided to err on the side of slightly under-working students. We expect to gradually increase the expectations/requirements of the lab assignments in successive iterations to achieve a balance between value in teaching and student workload requirements. To ensure that all students experienced group work, groups of three students were allowed in cases where a student dropped the course, or there were an odd number of students in a lab section.

The laboratory exercises in general went well. Throughout the semester, we monitored the progression of lecture content to ensure all the required material was covered at least one week before the related lab session. In some cases, we modified or moved lab content to correspond to the timing of the lecture. In the first semester, we were somewhat limited in how we could shift content—the particular students were the first of a new group for a department course reorganization so some students had taken the (new) prerequisite and others had not. Although this situation is unusual, it does demonstrate that in addition to all other goals on interactivity, correct level of comprehension, and diversity, we must also have some flexibility; each semester of instruction will be slightly different for many reasons, and it is important that the content is not so strictly timed that a slight difference might upset plans for all other course content.
Throughout the semester, we monitored the progress and attitude of students both through post-lab surveys and through informally taking notes on the kinds of questions and problems students encountered. In addition, we surveyed a group of students in a following course to determine their opinion of the prior lecture organization, lecture examples, course project, and confidence applying critical design skills.

For this monitoring process, we were particularly interested in the following questions.

1. Is the workload of the lab a reasonable substitution for the course project from previous semesters?
2. Does the lecture alignment give students sufficient experience before they apply the content in labs?
3. Is the physical design experience superior to the simulation-only approach from previous semesters? (i.e. – Does the added complexity of physical design distract students from the course content, or motivate students by allowing them to see complete designs in operation?)
4. Are the design experiences in this lab sequence sufficient to replace ECE 351?

Most students understood the course content, lecture examples, and the relation to the labs on course project. Overall, we felt that the physical design experience (previously only supplied in a separate class) helped students to understand and apply course content, and enhanced student understanding. From student evaluations, the content was generally liked, but there were some complaints of workload despite our particular efforts to err on the side of less work. However, as instructors, we also noticed that students were generally less prepared for the lab sections than we expected. Anecdotally, we saw that many students began work on the pre-lab later than we expected, and therefore were displeased to find out how much work was typically required for the pre-lab session. We were particularly surprised about this, since we emphasized that students should begin work on the pre-lab early in nearly every lecture session. In this case we determined that part of the problem was simply nomenclature, so we renamed the “labs” for the following semester, as I will reflect on in further detail in Section VIII.
**F.Artifact 6 – Sample Evaluation of Laboratory Exercise**

![Lab Evaluation – Lab 3]

<table>
<thead>
<tr>
<th>Section Number</th>
<th>TA Name</th>
<th>Select TA Name</th>
</tr>
</thead>
</table>

This evaluation is not graded or tracked for who completed it. The data will be used solely to improve the labs for later labs this semester and future semesters.

Please rate your opinion for the following questions on a 1-4 scale where 1 = strongly disagree, 2 = disagree, 3 = agree, and 4 = strongly agree.

This lab increased my confidence in completing combinational designs

| 1 | 2 | 3 | 4 |

The homework I completed with the pre-lab increased my confidence in completing combinational designs

| 1 | 2 | 3 | 4 |

**The BCD to 7 segment display:**

Design was well explained/defined

| 1 | 2 | 3 | 4 |

Design helped to understand combinational designs

| 1 | 2 | 3 | 4 |

Design was too complex

| 1 | 2 | 3 | 4 |

How much time did you spend completing the pre-lab?

- 0-1 Hours
- 1-2 Hours
- 2-4 Hours
- 4+ Hours

This lab could be improved by:

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**Figure 21 - Student Evaluation of Lab exercises. Each lab contained a section on increasing their confidence in the respective lab’s education goals, a section on the lab description itself and a section on the time spent to complete the exercise.**
Reflections on the Surveys

Although the surveys served their intended purpose, there were several organizational problems that made them less useful than we had hoped. First, because we primarily used printed forms instead of an online survey, it was harder to compile and analyze the data, and thus we were unable to respond to criticisms as quickly as we might have been able to if the survey results were more quickly accessible. Furthermore, the printed version was more prone to be lost or unused since students often wanted to finish the lab section and quickly leave, whereas an online version could have been more convenient to fill out. Finally, in future versions, I would attempt to broaden the scope of the surveys: they were primarily designed to study course workload and alignment with lecture content, but with different questions I could have also done a better job of evaluating additional educational goals. However, it is important for such surveys to be short and simple, so there must be some balance between the number of things I would wish to evaluate and the overall length of the survey.
VIII. PRACTICAL EXPERIENCE IN EDUCATION TECHNIQUE

In the semester after my Delta internship, I implemented and evaluated changes to the sequence of lab exercises as the main instructor for one of the sections of ECE 352. As part of the ongoing process of teaching-as-research, we made some changes to the laboratory exercises as improvements suggested by the results of the first implementation, and formed a new hypothesis to test for the second iteration. In particular for the lab exercises we:

1. Reordered content within the assignments, most notably to include a portion of the first assignment as part of the tutorial, and then include an off-week with no assignment to coincide with the first midterm. We wanted every applied homework due date to be at least one week after the prerequisite content was covered in lecture.

2. Clarified and updated expectations, assignment instructions and laboratory questions. In some cases, questions were holdovers from the ECE 351 content, but were less applicable in the current implementation. In other cases, our true goals for a question didn’t correspond to the range of answers we received. Throughout the exercises, we updated the applied homework documents to improve student understanding, and our ability to evaluate their work.

3. Changed the title of the labs to “Applied Homework” and “Demo Sessions”. Most of the students in the prior semester were accustomed to “labs” where little or no work is required in advance of the lab and all work is started and completed during the lab. However, for our exercises, most of the work was required in advance. Students needed to design, implement and test their work in advance of their demonstration session, with little work needed if they correctly completed the work in advance. This miscommunication of standards and expectations caused many students in the first implementation to inadequately prepare for the in class portion. It is our hypothesis that a more appropriate title sets expectations for both the amount of work, and when the students need to perform the work (before, during or after the lab).
Reflections on the ECE 352 Course Instruction

The simple change of renaming the “labs” and “lab sessions” to “applied homework” and “demo sessions” had a remarkable effect on student attitude and achievement. With that renaming, the percentage of students who disliked the exercises or felt that the workload of the applied homework exercises was unreasonable decreased to almost zero. In addition, students were generally more prepared for their demo sessions and thus had better achievement for both pre-demo and post-demo evaluations. The other changes to the sequence of assignments also made the general process go more smoothly; we did not require any last-minute reorganization or changes to the content as in the first implementation. Overall students were generally pleased with the applied homework exercises, the workload and how the exercises assisted in understanding course material.

This experience strengthened my resolve to improve as an educator and reinforced my philosophy. As an instructor I experienced the need to adapt my teaching and communication techniques to a wide range of students. One lecture sequence for this course was particularly well-received; for a series of lectures, the students interactively chose a problem to solve, decided on the goals and parameters for the solution, and developed the system that met the goals under my guidance. The students chose to design a door security system. Together, we developed the system specification, including aspects such as how to provide identification, success (correct entry) and failure (unauthorized access) scenarios, and reset conditions. Many normally quiet and reserved students became very involved; the creativity of potential solutions demonstrated the application of all of the topics the students had learned throughout the semester and provided a needed motivation for the use of their newly acquired skills.
IX. MY TEACHING PHILOSOPHY

Teaching and education encompasses more than a series of classroom interactions, coursework or examinations. As an educator, the process of teaching influences and guides all of my interactions with students, both in courses and research. An educator is an ambassador to other communities; effective education fosters collaboration between disparate departments, encourages community participation and interest in research activities, and broadens the impact of research by more effectively disseminating achievements. An effective educator must exhibit a wide range of qualities; they must be knowledgeable and versatile, demanding of student achievement yet approachable and adaptable, passionate and inspiring but also reflective and sensitive to student needs. Educators must use teaching-as-research to constantly evaluate and improve education skill. Each student has different educational needs— it is the ultimate skill of the educator to gauge the right combination of techniques to encourage, motivate and educate the student. These interactions define the classroom experience, and thus our value to students.

Recruitment, Student Retention and Diversity

In the recent past, engineering and science fields have had particular difficulty attracting and retaining students—especially in traditionally underrepresented racial, ethnic and gender groups. Although student recruitment, retention and diversity are issues that may appear to be separate, they are in fact deeply intertwined. Each student chooses their career path for a variety of reasons – a student’s interest in engineering is influenced at least in part by a confluence of their social, economic, ethnic, racial and gender background. My personal excitement for computer engineering is primarily grounded in doing work that has not yet been attempted. Other students might study engineering as a means for economic change or for its potential to improve society.

As an educator, I work to use a wide range of projects and design goals to inspire excitement in computer engineering. To improve learning through diversity, it is not enough to be aware of potential classroom diversity, I must be prepared to educate in different ways to take advantage of diversity and improve education quality. There are many high-profile projects that provide compelling examples, from the One Laptop Per Child project, to high-tech medical imaging to modern personal communication and entertainment gadgets. Students can thus see how course material applies to real, interesting projects, even early in their education. These projects play an important role, especially in early coursework where it can be difficult to tie course materials to the real world.

In addition to racial, economic, and gender diversity, I particularly emphasize social diversity for both undergraduate and graduate education. A common misperception of undergraduates is that science and engineering fields leave little opportunity for creativity or social interaction. However, creativity, teamwork and social interaction are some of the most important characteristics of graduates of these fields. Regardless of a student’s career path, a computer engineer almost always works in groups and must communicate technical work to other engineers. Government, industry employers, and graduate schools all desire candidates with excellent communication and teamwork skills. Students that switch to other fields of study because they would prefer to “be creative” or “have more interaction with people” are often our most promising students; they are skilled in not just science and mathematics, but also communication and teamwork. It is thus critical that we retain these students by highlighting the opportunities for creativity and group-work in our classes. As an educator, I assign group projects, use interactive teaching methods, and assign problems and projects that have multiple “good” solutions that students can choose to pursue. In addition, I encourage students to seek engineering projects in community service; these projects allow even beginning students to actively and oftentimes creatively contribute to an engineering project that affects the community, applies the course knowledge, and provides a real world experience beyond the classroom. These projects both create learning
communities and encourage students to find a variety of learning communities that can support students as they work towards their education goals.

Technology in Education

An important part of educating students is to understand their background and teach content to their ability using terms and techniques that are familiar to them. In today’s education system, this means that an educator must be well-versed in rapidly-evolving consumer technologies. Websites, audio and video podcasting, and tablet PCs are just a few examples of now-common technology. These technologies may be used for supplemental lectures, effective communication outside the classroom, self-guided interactive lessons, or effective dissemination of lecture content to name a few possibilities. Effective uses of technology should embody the same kinds of characteristics as an effective educator – adaptability, effective communication, presentation of course materials in diverse ways, and yet equally demanding of student achievement. As an educator, it is my task to use and embrace these technologies, constantly strive to improve the use of technology, and find new technologies that can be used to ensure that course instruction is constantly improving. However, technology is not limited to assisting course instruction; new technology may also be used for community outreach, self-taught online information, or research community collaboration. Effective technology for education is also by nature effective technology for communication, thus it is also my duty to translate these improvements to help disseminate research improvements to the general community.