Work in Progress: Transforming Introductory Laboratory Experiences into Learning Communities

David L. Soldan, Ph.D.[1], Anil Pahwa, Ph.D. [2], and Zachary Maier[3]

Abstract - **An introductory level logic design course with a laboratory experience has been part of the curriculum for over fifteen years. Its objectives have included the recruitment and retention of students in electrical and computer engineering. Laboratory exercises have been done mostly on an individual basis. The purpose of the current work is to bring electrical and computer engineering students together as they enter the curriculum and foster the formation of long-term learning communities. Our implementation of learning communities are centered on the laboratory experiences. Students in laboratory learning communities will be encouraged to develop friendships as well as teamwork, learning, and leadership skills. Each element of this course is being analyzed to determine ways to build learning communities, integrate learning about learning, and include discovery experiences. These changes will help students integrate their knowledge and convert it from surface knowledge to enduring understanding.**

Index Terms – introductory curriculum, laboratory experiences, learning communities, learning styles

INTRODUCTION

In many cases, high school and college are two very different environments [1]. Along with the noticeable difference in students' living arrangements and social lives comes the often-overlooked transition that students undergo in the classroom. Suddenly taken from an environment where emphasis is placed upon memorization and regurgitation of material, students are expected to use the problem solving and critical thinking skills necessary to success in an engineering field. Many students have had little prior experience dealing with these types of issues [2]; consequently, it is not uncommon for a freshman engineering student to do poorly in classes and leave engineering [3]. However, if this transition between learning methodologies can be controlled and gradually applied, it should be possible to increase the performance and retention rate of these students [4]. This work in progress is attempting to implement such a program in an introductory computer engineering class. Specifically, the program will use modified laboratory curriculum to slowly step students away from a 'rote' type of learning to a 'problem solving' type of learning. This program is further enhanced by a focus on learning in community and teamwork.

LABORATORY EXPERIENCE

The modification of laboratory experiences will be used to move students away from a rote learning style to a problem solving learning style. Currently, the laboratory experience is mostly prescriptive except for the final project. In most exercises, students are told what to do and when to do it, with little individual problem solving. Essentially, this serves as an extension of the high school rote learning process. Suddenly, when students are faced with a final project (i.e., construction of a traffic light controller or a similar open ended problem) and not given a prescriptive step-by-step procedure, much confusion ensues. At this point, most students exhibit an acute lack of problem solving skills. However, the purpose of modifying the laboratory experience is to alleviate this sudden change in expectations. By starting the semester with a fully prescriptive lab, and slowly evolving to a fully problem-solving lab, students develop new skills in a completely controlled environment. In fact, many students may not even realize what is happening to their learning style!

To implement this, lab questions were rewritten so that they fit into one of three categories: *background*, *on your own*, and *thinking ahead*. *Background* questions are fully rote learning – examples of questions in this category would include something like 'look on the datasheet for...,' 'look online to find...', 'according to the textbook,' etc. *On your own* questions are a mixture of rote and problem solving learning – these questions challenge students to 'explain why your textbook says...' or 'given that this chip will invert a signal, figure out how to...' Finally, *thinking ahead* problems lead students to think about 'how would you test this circuit' or 'to build a counter, I will need to...'.

Using these designations, the goal will be to start with a lab that contains information and questions broken down as follows: 80% *background*, 10% *on your own*, and 10% *thinking ahead*. By mid-semester, the students will have progressed to a lab broken down into 20% *background*, 60%

[1] David L. Soldan, Ph.D., Kansas State University, soldan@ksu.edu
[2] Anil Pahwa, Ph.D., Kansas State University, pahwa@ksu.edu
[3] Zachary Maier, Undergraduate, Kansas State University, zmaier@ksu.edu

on your own, and 20% *thinking ahead*. Finally, by the end of the semester, students will successfully complete a lab that contains 100% *thinking ahead* questions. For a graphical representation of this process, see Figure 1.

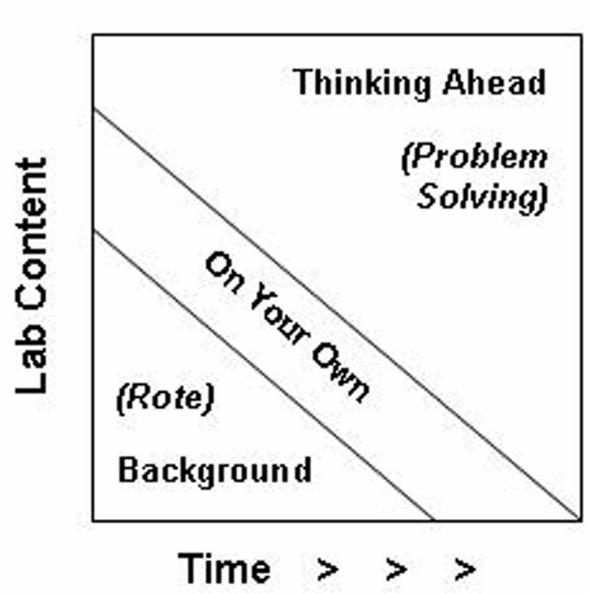

FIGURE 1
EVOLUTION OF LABORATORY CURRICULUM

By implementing a gradual shift in the contents of the lab, students will adapt as the labs evolve. As the *background* information slowly disappears, students will be motivated to find the "missing" information without being told to do so. In the same way, as the *on your own* information slowly disappears, students will be motivated to apply their acquired knowledge to the existing problem. Fundamentally, by implementing a stepped program, students will slowly learn how to utilize problem-solving tactics. This skill should improve their performance on written exams, as well as throughout the remainder of their collegiate career.

EXPECTED RESULTS

Unlike numerous studies of learning styles that have only anecdotal data to support claims, this work in progress will produce comparable and statistically analyzable results. Examination of data (including students' overall GPA, students' GPA in non-engineering classes, and students' performance in the introductory engineering class) will allow for a distinct comparison between the original exercises and the modified exercises. Already data has been gathered for the past three semesters (utilizing original exercises), and data collection of the modified exercises will begin in the fall 2006 semester.

The primary method that will be used to measure success of the program is the comparison of the students' grades in the introductory engineering class versus their average grade for all other classes in the same semester. Currently, existing data shows a gap between the two numbers – performance in the introductory engineering class falls below the average for all other classes that same semester. However, if the modified exercises are successful, the student performance in the introductory engineering class will rise, and possibly surpass the average of all other classes (which should remain constant). It is also possible that the program will be extremely successful, and that overall performance will rise – including both the introductory engineering class and all other classes.

Secondarily, the success of the program will be evaluated using statistical data from surveys. Students are queried on their enjoyment of the program, their attendance to classes, self-evaluated success. Also, students are given an opportunity to make any additional comments. The evaluation of this data is expected to reinforce the data gained through the primary method. Specifically as self-evaluated success increases, so should student enjoyment of the class.

WORK IN PROGRESS

This project has been ongoing for the last two semesters. Initial data has been gathered on student performance. The laboratory exercises are being modified to help improve the development of learning communities. Full implementation of the modified experiences is planned for the fall 2006 semester.

REFERENCES

[1] Murray, Bridget, "Teaching Students How to Learn", *Monitor on Psychology,* 31, 6, June 2000.

[2] Polack-Whal and Anewalt, "Work in Progress – Research Methods: Teaching Students How to Learn About Learning", *35th ASEE/IEEE Frontiers in Education Conference,* October 2005.

[3] The National Academy of Sciences, "Educating the Engineer of 2020: Adapting Engineering Education to the New Century", 2005.

[4] Weinstein, et al, "The Design and Evaluation of a Course in Strategic Learning", *National Association of Developmental Education 1997 Conference*, Denver, Colorado, March 1997.