AC 2007-2494: A COOPERATIVE LEARNING MODEL IN MULTI-DISCIPLINES ACROSS UNIVERSITIES IN FRESHMEN COURSES

Mehrube Mehrubeoglu, Texas A&M University - Corpus Christi

Dr. Mehrubeoglu received her B.S. degree (Electrical Engineering) from the University of Texas at Austin, and her M.S. degree (Bioengineering) and Ph.D. degree (Electrical Engineering) from Texas A&M University (TAMU). After working as a research engineer and software engineer at Electroscientific Industries, where she developed new algorithms for machine vision problems, she joined Cyprus International University as the Department Chair of Computer Engineering. After returning to Texas she taught at TAMU-K. She has been with TAMU-CC since Fall 2005. Dr. Mehrubeoglu's areas of research include machine vision and image processing applications, public health, engineering/technological solutions to problems, and effective teaching.

Lifford McLauchlan, Texas A&M University-Kingsville

Dr. Lifford McLauchlan completed his Ph.D. at Texas A&M University, College Station. After spending some time in industry, he returned to academia. He is an assistant professor at Texas A&M University - Kingsville. His main research interests include controls, education, adaptive systems, intelligent systems, signal and image processing, and watermarking.

A Cooperative Learning Model in
Multi-disciplines across Universities in Freshman Courses

Abstract

Instructors are constantly seeking innovative methods to teach students the engineering concepts in freshmen classes. Freshmen classes are particularly important for student retention, since these classes are the students' "first impression" of the engineering department or program. Additionally, the freshman classes are where the students are expected to begin learning soft skills besides the fundamental concepts. In this paper, a cooperative learning model and its first implementation are presented. The cooperative learning model and exercises involve multiple freshman groups from two universities, Texas A&M University – Corpus Christi and Texas A&M University - Kingsville, encompassing electrical engineering freshmen, engineering technology freshmen and freshmen students representing general engineering. The tasks involved in the cooperative learning project stimulated student interest and engagement in addition to enabling the students to acquire information, knowledge and skills that the instructors outlined in their corresponding project objectives and outcomes. Evaluation was performed by the successful completion of the project, student satisfaction surveys, and the student acknowledgement and awareness of challenges and resolutions along the way. Student deliverables and presentations demonstrate the increased retention of concepts using the developed cooperative learning model.

1. Introduction

Introduction to Electrical Engineering and Introduction to Engineering Technology are two very important freshman courses in the electrical engineering and engineering technology curricula. These two courses expose the students to topics in their related fields and help them understand prospects and expectations in these fields. In addition to engineering and technology related topics, these courses cover methods and skills necessary for the students to be successful in their chosen area of study. The skills emphasized in these courses range from simple math skills to use of software, internet, as well as engineering problem solving techniques. Besides the technical skills, the students are also expected to develop soft skills that are necessary in the engineering and technology fields, such as teamwork, ethical and professional responsibilities, communications, and time management, all deemed an integral part of the learning experience, and necessary by the ABET accreditation guidelines.

Since introductory courses play an important role in student retention and success, there is a need to generate new ideas and develop creative teaching strategies to ensure student interest, attention and learning. Many groups studied innovative methods to achieve the desired classroom goals. The following section reviews some of the relevant findings in the literature. The proposed method and its pilot implementation are discussed in Section 1.2.

1.1. Literature Survey

In their 1995 paper, Orsak and Etter discuss a collaborative form of education using the internet and MATLAB[1]. The authors predicted three of the essential ingredients of an engineering education for the current century as team skills, communication skills, and diversity. Our approach to cooperative learning in freshman classes addresses all three of these ingredients. The authors use a collaborative education approach to teach digital signal processing concepts to two senior groups in two universities, and report the success of the adopted methods.

Lisa Huettel *et. al.* from Duke University describe an introductory course on fundamentals of electrical and computer engineering that employs a theme-based curriculum to link the engineering topics to be taught to real-world problems[2]. The authors emphasize the importance of real-world related applications. In our cooperative learning exercises, the students have the opportunity to work with the results of an independent group, and their results, in turn, is utilized by yet another group, giving students the experience of being engaged in real-time exercises.

Hutchison *et. al.* investigate factors influencing the beliefs of self-efficacy of the freshman engineering students[3]. The group's work revealed nine factors that contribute to the student confidence. These factors are understanding the material; motivation; teaming; computing abilities; receiving help; completing assignments; problem-solving abilities; enjoyment, interest, satisfaction; and grades. The cooperative examples described in this paper address all of the above mentioned factors with the exception of grades. No grades were assigned in this project. Delivering the results in a timely manner was accepted as success of the students and the project.

Michael Prince studied the literature on active learning[4]. Active Learning refers to "any instructional method that engages the students in the learning process."[4] Prince defines collaborative learning as "any instructional method in which students work together in small groups toward a common goal." Finally, cooperative learning involves "a structured form of group work where students pursue common goals while being assessed individually." The proposed project in this paper utilizes all the three learning styles.

The positive effects of cooperative learning are apparent in literature. In their extensive literature survey, K. A. Smith *et. al.* find that the level of college-level student success, when learning cooperatively, is much higher than when learning competitively or individually[5]. The studied papers reveal that cooperative learning promotes 'meta-cognitive thought', persistence in reaching goals, intrinsic motivation, and "transfer of learning from one situation to another". Cooperative learning not only helps establish positive peer relationships, which are necessary for student success, but also ensures that students become academically involved[5]. Pucher *et. al.* stress the importance of intrinsic motivation in particular in the successful learning process[6], especially in the case of problem based learning (PBL).

Mix and Balda discuss an approach to motivate and teach freshman electrical engineering students in the introductory electrical engineering class[7]. The authors' work shares similar goals as the introductory classes described in this paper, such as teaching the students problem-solving skills; further developing students' communication skills; and engaging the students in group work.

1.2. Proposed Method

Because introductory courses affect student retention and success significantly, it is paramount to develop and implement new and novel teaching techniques that capture student interest, keep their attention, and ensure their active participation in the learning process. With this in mind, a multi-week collaborative project model has been developed to engage students from two different universities, one with freshman engineering (Texas A&M University – Kingsville, TAMUK) and the other with engineering technology (Texas A&M University – Corpus Christi, TAMUCC), classes. The purpose of this project model is to create cooperative tasks among students from different classes and universities in an effort to emphasize team and collaborative work; communication skills; proper problem solving techniques suitable for engineering and engineering technology; and responsibility to complete and communicate deliverables effectively and timely.

The developed project model requires that students acquire information and solve problems under time and scheduling constraints. The deliverables of one group are necessary for the other groups to complete their tasks. In this project model, the first student group produces data the other sections need to complete their tasks. The data is delivered via the internet or other instructor-controlled media to the second group. In turn, the second group continues working on the succeeding project tasks producing new results necessary for the third groups' completion of the project. The assignments reinforce teamwork, time management skills, and computer skills, and increases student awareness of the consequences of the success and failure of their responsibility to deliver correct and timely results. The instructor can determine the level of technical skills necessary to carry out the project.

In this paper, a pilot project that engages students from multi-disciplines and universities using the developed cooperative-learning model is presented. The student groups represented include those from an introductory electrical engineering class (TAMUK), a general engineering class (TAMUK), and introduction to engineering technology class (TAMUCC). The project chosen for the students involves use of math, computer, internet, communication, time management, engineering problem solving, and introductory engineering skills in a fun and interesting manner. The project is adapted to give the students a sense of solving a puzzle using the listed skill set. Initially, the students in the freshman general engineering class at TAMUK are assigned to solve a code using a cipher and guidelines from the instructor. The discovered code is then communicated to the introductory electrical engineering students at TAMUK, who use this code to determine the next level of code by performing a pre-determined set of tasks and a cipher. The second code is delivered to the third class (freshmen engineering technology class at TAMUCC), who apply the code to complete their set of assigned tasks. The results from the third group can be shared with first group to continue the process. The loop may continue as long as the instructors deem appropriate.

Section 2 describes the two versions of the developed Cooperative Learning Model. Further details of the application example are presented in Section 3. A summary of assignment sheets distributed to students can be found in Section 4. Evaluation and Discussion of results follow in Section 5. Conclusions are presented in Section 5.

2. Cooperative Learning Models

The model created for cooperative learning between classes and universities is based on solution of a sub-problem, and data exchange between the classes. Two versions of the cooperative learning model have been developed. The first involves *sequential* problem solving, where the first group works on its tasks first. The second group does not start on its tasks until the deliverables of the first group are completed. The third group waits for the deliverables from the second group. The results of the tasks from the third group can then be sent to the first group, and the cycle continues as the instructors deem necessary and viable. Table I summarizes the learning matrix for the collaborative learning model where the tasks are performed sequentially.

Table I. Learning Matrix 1: Weekly Tasks Performed Sequentially

Step	**Overall Week**	**Group**	**Tasks**	**Dependency**	**Deliverable**
1	1	1	A	None	D1_1
2	2	2	B	D1_1	D2_2
3	3	3	C	D2_2	D3_3
4	4	1	D	D3_3	D1_4
5	Repeat Steps 2-4 as time permits, until teaching objectives are reached, replacing the first digit under dependency with the number for the previous week, and the second digit under deliverables with the number representing that week.				

In this table, the single letters **A-D** in column 4 refer to the set of tasks required to complete the deliverables. **Dx_y** refers to the deliverable by group **x** for week **y**.

In the second cooperative learning model, all the groups work on a version of the same sub-problem at the same time. The deliverables from three groups become ready at the same time, and are exchanged among groups at the same time. For instance, the deliverables from Group 1 are communicated to Group 2; the deliverables from Group 2 are sent to Group 3, and the results of the tasks of Group 3 are sent to Group 1, all at the same time. In the second week or stage, the new results are exchanged in a similar manner. In this model, all groups perform the similar tasks at the same time, but solve different puzzles, or codes. Table II shows the steps involved in the learning matrix for *simultaneous* delivery of tasks.

In Table II, **A-I** stand for the set of tasks for each deliverable. **Dx_y** refers to the deliverable by group **x** for the week **y**.

The advantages of using the sequential learning model include the fact that no major changes to the content or the syllabus of the course is required, since the students are involved in the entire project for only a week or two minimum, in the case of a three-group cooperation. The instructor can thus continue with the individual course content during the remainder of the time. The subtasks can be geared more specifically to the needs of the particular student group. One disadvantage is related to the feel of continuity of the project, if one or more of the groups do not follow the same schedule.

Table II. Learning Matrix 2: Weekly Tasks Performed Simultaneously

Step	Week	Group	Task	Dependency	Deliverables
1	1	1	A	None	D1_1
		2	B	None	D2_1
		3	C	None	D3_1
2	2	1	D	D2_1	D1_2
		2	E	D3_1	D2_2
		3	F	D1_1	D3_2
3	3	1	G	D2_2	D1_3
		2	H	D3_2	D2_3
		3	I	D1_2	D3_3
4	4	Repeat Steps 2 to 3 (replacing the last digit in deliverables with the number for the week, and the first digit in dependency with the number for the previous week) accomplish the teaching objectives			

The main advantage of implementing the simultaneous learning matrix resides in the fact that the students in all groups are exposed to all aspects and steps of the project directly; in a way they are involved in at least one task of each of the three projects, though each task is different in each project. There are three final deliverables, one from each group, delivered at the same time. The students get a more holistic idea of what is involved to get to the final delivery from the initial tasks. The disadvantage remains one of a coordination issue. An additional drawback in multi-disciplines would be finding a project where all steps of a project are relevant to all groups of students.

3. Application Example

In this paper the pilot project implemented made use of the Sequential Learning Matrix. The project was implemented as part of the laboratory exercises. The targeted skills included problem solving, technical laboratory skills, internet use and search for all groups. Other skills, such as reading data sheets, implementing a simple DC circuit, and correct connection of a 7-segment displays were objectives specific to individual groups. The student tasks and deliverables are summarized in Section 3.1.

3.1 Student Tasks and Deliverables

The collaborative learning model applied in this project worked well for the three groups, since the learning outcomes for the three classes had considerable differences. With the sequential learning model, the students could pursue alternate exercises when the project tasks were completed to obtain both dependent and independent deliverables. Dependent deliverables would be those that were to be communicated to another group. Independent deliverables consisted of specific outcomes that helped the students meet other learning objectives.

3.1.1 Group 1: Objectives, Tasks, Deliverables in Step 1

The electrical engineering freshman class (TAMUK) constituted Group 1. This group used a set of rules in the form of a puzzle to encrypt a code. The resulting encrypted code, which was in jumbled letters and symbols, represented a description of a circuit in letters (i.e. 'two resistors are in parallel', 'voltage across resistor one is 5V'). The encrypted code was the deliverable that was communicated to Group 2. Group 1 performed other tasks which resulted in results that were not needed for the tasks of Group 2 or Group 3, but addressed the learning objectives and outcomes for Group 1 in particular.

3.1.2 Group 2: Objectives, Tasks, Deliverables in Step 2

Group 2 constituted the freshmen representing the general engineering students (TAMUK). This group received the encrypted code. The encrypted code was decrypted and modified by the students based on new rules. The resulting decrypted code consisted of letters that the students were to deliver to the third group. In addition, the students in Group 2 implemented the letters on the 7-Segment display using instructions on the assignment handout.

3.1.3 Group 3: Objectives, Tasks, Deliverables in Step 3

Freshman engineering technology students (TAMUCC) formed Group 3. This group received the modified word code, and applied a cipher and new formula to come up with a list of numbers, which they implemented on 7-Segment Displays. For this class, looking up data sheets for 7-Segment Displays, writing a report with schematics of the pin connections was part of the objectives of the class, and was done a week before independently. The decoded numbers were the dependent deliverables for Group one, who used these numbers in building a simple DC circuit, and for measuring values across simple resistors.

The application matrix in the following section summarizes the dependent tasks and skills used in this cooperative project.

3.2 The Application Matrix

Table III shows a summary of tasks and deliverables that affected the cooperative learning experience in this project.

The cooperative learning application matrix above shows not only the tasks and deliverables directly related to the project, but also alternative tasks and deliverables that are in line to the specific learning objectives of each group. This cooperative learning application matrix was implemented as part of laboratory assignments. Other exercises independent of the project were also carried out. With good coordination and scheduling, the project enhanced both the teaching and learning experience and with increased student engagement.

Table III. Cooperative Learning Application Matrix 1: Application to Three Freshmen Groups (Electrical Engineering, Group1 (TAMUK); General Engineering, Group 2 (TAMUK); and Engineering Technology, Group 3 (TAMUCC))

Step	Tasks	Group	Dependency	Deliverable	Week	Targeted Skills
1	1. Encrypt Code using a cipher	**1**	None	Encrypted Code in letters and symbols	**1**	Problem solving, teamwork,
2	1. Decrypt and modify code with a cipher and new set of rules	**2**	Encrypted code from Group 1	Code word in letters	**2**	Problem Solving, teamwork
	2. Display the decrypted and modified code word letters on 7-Segment Display	**2**	Decrypted word	Lit-up 7-Segment Displays	**3**	Problem solving, teamwork, technical laboratory skills
3	1. Look up pin connections and power specs for 7-segment display on the internet from the vendor	**3**	None	7-SD Schematic diagram, report and schematics on 7-Segment Display	**2**	Internet search; reading data sheets; writing reports (communication skills)
	2. Decode the code word with new rules	**3**	Code Word in letters	Decoded digits	**3**	Problem solving; teamwork;
	3. Implement the decoded digits on 7-segment displays	**3**	Decoded word in digits	Lit-up 7-Segment Display	**3 or 4**	Technical Laboratory Skills
4	1. Use the decoded digits to determine circuit parameter values	**1**	Decoded word in digits	Circuit implementation; Measured values;	**4**	Problem Solving; Fundamental Electrical Engineering Concepts; technical laboratory skills

4. Student Assignments and Deliverables

Excerpts from the student assignments are presented in the appendix. Each assignment was prepared by the instructor of the corresponding class, with the individual goals of the class as well as overall goals of the project in mind. Table IV. summarizes the student responses to the following survey question concerning the objectives of the lab assignments.

Survey Question - Do you think the lab assignment was successful in meeting the following objectives (please respond on a scale of 1 to 10, 1 being 'not at all,' 10 being 'most definitely':

a. working in a team,
b. research skills,
c. reading data sheets,
d. technical lab skills,
e. learning cooperatively,
f. decoding the encrypted code (digit) and display on the 7-segment display,
g. continuity from previous labs, and
h. student engagement/participation.

Table IV. shows that all objectives had at least an 8.00 average out of 10.00. Thus, one can surmise that the students perceived that the lab assignments were very successful at meeting the objectives. The average of all objectives was an 8.69.

Table IV. – Lab Assignment Objectives

Objectives	Average Score
Working in a team	8.25
Research skills	8.00
Reading data sheets	8.50
Technical lab skills	8.50
Learning cooperatively	8.50
Decoding the encrypted code	9.75
Continuity	8.25
Student engagement	9.75

On the survey, the students could also comment on the assignments. Some of the student comments are included below. As can be seen from the survey results and comments the students found the exercises to be rewarding and useful.

"It was a good introduction to teach students the basics of breadboards, wiring, power distribution, and IC components. It was a lab that allowed students to have fun, while at the same time, increasing their knowledge of electronics. I would say the most interesting aspect was the challenge it provided. Students had to first figure out the wiring of the display, then figure the voltage needed to power it, and finally make it give the correct display. This lab is very helpful [for] the future …, I have already gone back to it twice in my current classes."

"I encourage more labs such as this which provide students with a challenge ... This is a quality that most college courses lack. Everything in other courses is cut and dry. Its read this chapter, take notes, write a paper, take a test. Labs like this make students think and teach them that engineering is not cut and dry…"

"The most interesting aspect of the 7-segment display was probably the problem solving aspect, considering there were numerous variations of the display present. Then the reward of seeing your number presented."

5. Evaluation and Discussion

This first attempt to the collaborative learning experience went smoothly with the exception of communicating the final results to the group that were to use them. Since the instructors did not prefer the students communicating with each other directly to keep the ciphers hidden from groups not using them, the deliverables were communicated to the students by the professors themselves.

The Instructor observations indicate that the entire experience was a positive one for all students in the three groups. Positive feedback from students about the hands-on exercises, and the 'simulated pressure' of obtaining the correct code gave the students a sense of belonging to a big project. The students in different groups did not meet with one another. This is a realistic representation of real-life projects that may be taken across disciplines or companies in the industrial world.

All students successfully completed the tasks. Working in groups increased the students' success of obtaining the correct results for the deliverables in a timely manner. The students acquired the targeted skills and knowledge in the classes as well as being actively involved in the individual tasks. One improvement to this cooperative learning effort will be developing an instructor-controlled web interface for students to deliver their results. The project can then be conducted by students more independently. The depth and length of the cooperative project is strictly based on instructor preferences. The two versions of the developed cooperative learning model permit such flexibility.

6. Summary and Conclusions

In this paper, a cooperative learning model has been presented that engages students in multiple disciplines and universities. The cooperative learning model can be implemented in a sequential or simultaneous mode. The learning matrices summarizing the tasks, deliverables and flow of information for both the sequential and simultaneous execution of tasks give the instructors the flexibility to spend as much or as little as they desire with the collaborative learning project. The preliminary implementation and exercises received great interest from students, and engaged them in tasks that they knew affected others. Based on the instructor evaluations, the main objectives for each class participating in the project were met. One of the challenges of the implementation phase involved the coordination of the delivery of results from one group to the next. Originally, the internet was intended as the media of communication; however, the instructors delivered the results to the students instead. Even so, the project was a success, considering student involvement, and the learning goals achieved via the sub-tasks and deliverables. A controlled internet-based interface for data exchange is among the goals for the next implementation of the cooperative learning exercises.

7. References

[1] Geoffrey C. Orsak and Delores M. Etter, "Collaborative SP Education using the Internet and MATLAB," *IEEE Signal Processing Magazine.* pp. 23-32, Nov. 1995.
[2] Lisa Huettel, April Brown, Leslie Collins, Kip Coonley, Michael Gustafson, Jungsang Kim, and Garry Ybarra, "A Novel Introductory Course For Teaching the Fundamentals of Electrical and Computer Engineering," *ASEE Annual Conference Proceedings,* 2006-1373, Chicago, Illinois, June 2006.
[3] Mica A. Hutchison, Deborah K. Follman, Melissa Sumpter, and George M. Bodner, "Factors Influencing the Self-Efficay Beliefs of First-Year Engineering Students," *Journal of Engineering Education*, pp. 39-47, Jan. 2006.
[4] Michael Prince, "Does Active Learning Work? A Review of the Research," *Journal of Engineering Education*, pp. 223-231, July 2005.
[5] Karla A. Smith, Sheri D. Sheppard, David W. Johnson, and Roger T. Johnson, "Pedagogies of Engagement: Classroom-Based Practices," *Journal of Engineering Education*, pp. 87-101, Jan. 2005.
[6] R. Pucher, A Mense and H. Wahi, "How to Motivatge Students in Project Based Learning," *6^{th} IEEE Africon Conference in Africa*, Vol. 1, pp 443-446, Oct 2-4, 2002.
[7] Dwight F. Mix and Juan Carlos Balda, "ELEG 1003 – Introduction to Electrical Engineering: An Approach to Motivate and Teach EE Freshmen," *Proceedings of the IEEE Frontiers in Education Conference*, Vol. 3, pp. 1215-1218, Pittsburg, Pennsylvania, Nov. 5-8, 1997.
[8] Martin Gardner, *Codes, Ciphers and Secret writings*, Dover Publications: Mineola, N.Y., 1973.
[9] P. Meenen, III and R. Adhami, *Fundamental Concepts in Electrical & Computer Engineering*, Universal Publishers, Boca Raton, FL,USA 2005.

8. Appendix

The appendix includes excerpts from the assignments used in the learning model. These are found in sections 8.1-8.4.

8.1 Group 1 (Electrical Engineering Freshmen, TAMUK) Assignments

The following is part of the assignment that Group 1 received. The objectives, theory, and other information have been omitted in the interest of space.

"… with the CIPHER encode the following message. Also give the across R3 voltage rounded to the nearest whole number and encode the value at the end of the phrase

THE CIRCUIT PARAMETERS ARE AS FOLLOWS, R4 3, R2 6, R3 9, VS 30. R2 AND R3 ARE IN PARALLEL AND THEIR COMBINATION IS IN SERIES WITH R4 AND THIS IS THEN IN SERIES WITH VS. THE VOLTAGE ACROSS R3 IS

CIPHER

A	a)	D	K	Z	7	V	d)
c)	S	.	e)	C	9	P	G
>	<	^	'	"	%	~	/
U	X	L	4	8	I	B	M
3	b)	E	R	W	6	Q	*
,	0	1	;	:	O	5	N
T	F	Y	f)	J	?	!	

The message is encoded using the CIPHER according to the following rules. There may be repeated numbers or characters in which case you may choose one of the repeated ones to apply the following rules to.[8,9]

The message is broken into pairs of characters, including numbers, letters, punctuation and spaces, and it is then encoded. If a pair is the same character repeated, then place an X in between and encode. If there is an odd number of characters the place an X onto the last pair to make sure there is an even number of characters.

If the pair is on the same row, use the first two letters on the row.
If the pair is in the same column, use the first two characters in the column.
If the pair is in different columns and rows then use the letter or number in the row for a letter or number that is in the column of the other number or letter of the pair.

The encoded message is then given in groups of four."

8.2 Group 2 (General Engineering Freshmen, TAMUK) Assignments

"… Use the CIPHER below to decode the encoded message obtained from Group 1. Display the corresponding letter or number according to the sub-group number assigned to you. Sub-groups 1, 2, 3, 4, 5, 6, 7, and 8 should correspondingly display letters 1, 2, 2, 4, 5, 6, 8, and 8.

An example encoding for a message

TEST

is the following:

Y32F

The encoded message is as follows:

FZDQ   UX<Z

Show the displayed letter on the seven segment display and show the entire decoded message on your handout to one of the assistants or the instructor. Turn in the assignment. Include all names of people in your group on the assignment.

CIPHER

H	A	D	K	Z	7	V	G
2	S	.	O	C	9	P	0
>	<	^	1	N	5	~	/
U	X	L	4	8	I	B	*
3	"	E	R	W	6	Q	M
T	F	Y	;	J	?	!	

The message is encoded using the CIPHER according to the following rules.[8,9] There may be repeated numbers or characters in which case you may choose one of the repeated ones to apply the following rules to.

The message is broken into pairs of characters, including numbers, letters, punctuation and spaces, and it is then encoded. If a pair is the same character repeated, then place an X in between and encode. If there is an odd number of characters the place an X onto the last pair to make sure there is an even number of characters.

If the pair is on the same row, use the first two letters on the row.
If the pair is in the same column, use the first two characters in the column.
If the pair is in different columns and rows, then use for each letter or number from the pair, the letter or number in the same row that is in the column of the other number or letter of the pair.

The encoded message is then given in groups of four…"

"… Display the encoded letters on the 7-Segment Displays…"

" … Modify the digits in the code and encode into words …"

8.3 Group 3 (Engineering Technology Freshmen, TAMUCC) Assignments

As in Sections 4.1 and 4.2, the objectives, theory, and other relevant information have been omitted.

"… Find the pin connections for the 7-Segment Displays using the internet …"

"… Write a pre-lab report explaining details on how to light up the LED's for different digits. Draw a schematic diagram showing the pin connections…"

"… Find the digits represented in the encoded word, and modify them according to the formula: N = Y MOD M, where N is the new digit, Y is the birth year, and M is the day of the month of the student's birthday.

"… Display the new digits on the 7-Segment Displays …"

These digits are communicated to Group 1 to complete the cycle.

8.4 Group 1 (Electrical Engineering Freshmen) Assignments after Group 3 Deliverables

" … Use the digital values communicated on Group 3's 7-Segment Displays to find the value of the circuit components, in the order that they were originally coded. Build the circuit and measure the indicated parameters according to Ohm's Law…"