

## SESSION NUMBER: 1102

### Effective Writing Assignments to enhance student learning in “Introduction to Circuit Analysis”

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#### ABSTRACT

In facing challenges of declining enrollment, retention, incorporating higher technical content, and improving student learning, an integrated reconstruction of pedagogy and curriculum is being sought. This paper describes the design and development of short writing assignments. The short writing assignments are designed based on three strategies: *‘Mock Presentation to High School Students’*, *‘Web Search to linking the subject to real world application’* and *‘Identification of Unresolved lab problems’*. These short writing assignments are incorporated into “Introduction to circuit analysis”, a freshman course in a 4-year engineering technology curriculum at Miami University, OH. These assignments are simple, informal, and easy to collect, check and/or grade, even for large classes.

In addition to end-of-course rating instruments, three classroom assessment techniques are used to evaluate the reaction to the assignments in ‘real- time’. These are: 1) Weekly questionnaire, 2) One minute paper, and 3) Small Group Instructional Diagnosis (SGID).

A brief overview of the method, discussion of each writing assignment, grading, including a sample assignment is presented in this paper. This paper summarizes the engagement of students in solving meaningful problems, and developing the course material linked to actual practice while employing assignments that are worth evaluating.

#### I. INTRODUCTION

The Engineering Technology Department at Miami University, OH offers Associate degree (Electrical, Mechanical) and Baccalaureate Completion degree (Mechanical and Electro-mechanical) programs. “Introduction to Circuit Analysis” is a freshman course required for Electrical and Mechanical majors. Students with other majors such as Computer Science, Architecture, and Chemical also take this course to substitute as an outside major requirement. The students comprise of fresh graduates from high schools, returning adults, and employees of companies who need to improve their knowledge and skills.

This “Introduction to Circuit Analysis” course provides an understanding of basic electric principles including calculating voltage and current in dc, ac circuits with resistors, capacitors and inductors etc. The general objectives in this introductory circuit course are to understand the relationship between electrical quantities, construct, analyze, and test electrical and electronics circuits using both calculations and instruments, conduct experiments to obtain data and make improvements in designs, read, understand and analyze electrical schematics, problem solving, collaborative learning. The course is a combination of a lecture and a lab (1 hour and 50 minutes). The class meets twice a week (15 to 20 students).

While teaching the technical content of the subject, efforts were made to help students to improve their concentration, listening skills, writing skills, reading skills, and mathematical skills as well as develop their study skills. Three weekly short writing assignments are incorporated to achieve these goals based on three strategies: ‘*Mock Presentation to High School Students*’, ‘*Web Search to linking the subject to real world application*’ and ‘*Identification of Unresolved lab problems*’

To assess the progress of the students through out the course, weekly questionnaire, one-minute evaluations, small group instructional diagnosis (SGID) are used. These assessments helped to measure the students’ understanding of the subject and to check the time spent on the assignments.

This paper describes the development of strategies, implementation of short writing assignments and regular and periodic assessment during the course. The impact of the writing assignments on students’ progress is evaluated. It was concluded that student’s engagement with disciplinary subject matter showed measurable improvement due to the implementation of the writing assignments.

## II. DEVELOPMENT OF STRATEGIES TO ENHANCE LEARNING

One of the main concerns is the passive role of students in the classroom where they appear to ‘receive’ ideas and information ‘sent’ by the instructor. Johnson, Johnson, and Smith<sup>1</sup> conclude that although lectures are appropriate in many circumstances, they tend to reach only those students who “learn auditorially, have high working memory capacity, have all the required prior knowledge, have good note-taking skills and are not susceptible to information processing overload”. The average students’ attention span was observed to be ten to twenty minutes and needs to be improved<sup>1,2</sup>.

Several teaching strategies are suggested in the literature to involve students more in listening to and processing a lecture. Out of the wide range of strategies for promoting critical thinking in the class room, John C. Bean<sup>3</sup> insists that ‘*the most intensive and demanding tool for eliciting sustained critical thought is a well designed writing assignment. When we make students struggle with their writing, we are making them struggle with their thought*’. As Valora<sup>4</sup> suggests, new ways of writing in the classrooms should be investigated and, if appropriate with learning objectives, implemented.

The traditional method of assigning writing is to assign a term paper due at the end of the semester. About half way through the semester students submit proposal for topic. In many cases no further contact between the teacher and the students occurs. At the end of semester the teacher collects and grades the papers. This method is suitable for skilled upper division students and does little to enhance learning of course content.

One of the most notable is the relationship between the amount of writing for a course and the student's level of engagement – whether engagement is measured in time spent on the course, or the intellectual challenges it presents, or students' level of interest in it- is stronger than the relationship between student's engagement and any other course characteristic<sup>5</sup>. John C. Bean<sup>3</sup> says that 'emphasizing writing in a course increases the amount of subject of matter that students actually learn and in many cases actually increase the total coverage content'. A careful designing of assignments focusing on course goals can make students learn more through from writing assignment than from any other academic activity<sup>6</sup>.

Writing is recognized as a means of both engaging students and developing their thinking skills among the engineering faculty. One of the main concerns is that the use of writing assignments does not fit the discipline and that might shift class time away from content<sup>7,8,9</sup>.

In order to promote learning through writing, proper contexts and topics had to be selected. In view of how the course has been presented in the past years and the response and behavior of students, three areas have been identified as appropriate contexts for writing. Most commonly, students face numerous problems in the labs; the first strategy for writing was created around the lab activities. More precisely, students write about the problems they face during lab work and solutions sought through the lab work. The second context for writing was based on the 'research' that is needed to relate subject matter to real world experience. So- web searches have been opted as the second context. It is believed that the best way to learn is to write the concept and explanation in one's own words and teach to someone else. The third writing assignment is targeted towards enabling students prepare a topic in writing and presenting it to high school students. The two short writing assignments (mock presentation, web search) were administered alternately every week. Students submitted the unresolved lab problems list every week along with their lab report.

## **II.I. Development Of Strategy “Unresolved Lab Problems”**

A strategy “Unresolved Lab Problems” is created. The objective of this strategy is to provide context for problem solving, facilitate collaborative learning, and increase depth of learning

Every week during the lab period, students while actively participating and conducting the experiment outlined in the syllabus will write a list of lab problems and difficulties encountered. Examples of lab problems could be, difficulties in measuring, ambiguity in operating the meters, and confusion in understanding the circuit or equation etc. A handout with specific instructions is provided to write the problems they face during lab work (Appendix-I). Students are asked to submit this along with their lab report.

This activity helps students to work in teams and learn from each other and improve their trouble shooting skills. The writing helps them to identify the problem and express it in technical terms. For example, in one class, the team was measuring current in a circuit, they were able to measure the voltage and not the current. In the discussion they figured out that the Ammeter fuse was out; they replaced it and obtained the results. The next week, they had the same problem. The previous weeks' discussion and writing made them recollect the experience and helped them to resolve the problem quickly.

## **II.2. Development Of Strategy “Web Search” To Enhance Learning**

The second strategy for writing is “Web search”. The main goals here are:

To put the topic of reading into a broader context

To open up other communities of readers/writers interested in the subject

To build skills of informal research and web searching.

After doing a reading assignment (syllabus contains the schedule of reading assignment for each class), students search the web for anything that connects in some way with what they have read. Students must compile and present a print out of the relevant page(s) at the site and then write a brief summary of how the web source connects to the reading. An example of a handout is shown Appendix-II.

Few examples of topics are listed below:

1. Some key terms for web search: Electric Charge, Engineering Notation, Atom, Battery, Volt. (Week 1)
2. Search the web to find out electric energy produced by “wind” (week 3)
3. “Holiday lights” an application of series circuit. (Week 5)
4. Literature search on Superconductors and applications (week 7)
5. Write a column in an electrical engineering magazine “Spectrum” on “Electric field strength”. (Week 9)

## **II.3. Development Of Strategy “Mock Presentation” To Enhance Learning**

“Mock presentation to High school students class” is the third strategy implemented in this course. The main goals here are:

To help students to learn the material well enough to teach it,

To translate reading material into their own words/terms,

Compels students to organize information in preparation for explaining it.

Students are given a context for “Teaching”. The context and the imaginary audience are specified for this imaginary lesson. The handout contains a circuit, and required data and other instructions. An example of a handout is shown in Appendix III. Students are required to prepare a 3-minute lecture to present it to a High school class. The following is the list of topics chosen for this short writing assignment:

1. How to determine unknown voltage in circuit? (Week 2)
2. Explain the fundamentals of resistance. (Week 4)
3. Understand and explain the fundamentals of current and voltage. (Week 6)

4. Explain charging and discharging of a capacitor. (Week 8)
5. Understand the concept of energy. (Week 8)
6. Explain relationship between electricity and magnetism. (Week 10)
7. Calculate electrical values in a combination circuit using the fundamental laws. (Week 14)

### III. ASSESSMENT RESULTS and DISCUSSION

The questions in the Weekly questionnaire, and one-minute paper are designed to help measure the students' understanding of the subject and to check the time spent on the assignments. Students' errors, mistakes and misunderstandings can give us valuable insights into their thinking processes and provide clues about how to redesign and sequence instruction. Assessing students understanding of concepts as course progresses helped to adjust instruction to improve the quality of learning (Angelo and Cross, 1993). Weekly Questionnaire was administered randomly about 5 times over the semester. At the beginning of the semester one-minute evaluations were administered every week and later spaced bi weekly (total 7). The assessment of teaching effectiveness and learning was mostly from the student's perception. Center for the enhancement of learning and teaching has helped tremendously throughout the project. As this program was implemented for the first time, there was no external help either in terms of teaching assistants or other faculty members.

#### III.1 Weekly Questionnaire

At the end of the class, students are asked to fill out a weekly questionnaire. *These weekly questionnaires are conducted randomly throughout the semester.* The number of students participated in these assessments ranged from 9 to 12. The Table-1 below shows a list of questions included in the questionnaire and their frequency. Students responded to the following questions on a scale of 1 to 4 with 1 being the lowest. The average response for each question is calculated and observed. The areas where the average is close to 3 are observed more closely and efforts were made to improve it. For example, in order to improve the response to the criteria "effectiveness of homework problems for the test", a group help-session was arranged before the test. The students worked in casual structure-free environment. They worked on homework problems during the session. As a result, the scores improved from 60% to 80%.

When asked about weakness and strength of the course, the responses were mainly math and formulae (see Table-2). They were addressed by providing individual extra help sessions following the end of class period.

For the question on how the professor facilitated the learning process, students responded more and more positively throughout the course. The average response is plotted chronologically in Figure-1 and shows continuous improvement.

Figure 2 shows an indication on improvement on how effectively the professor is teaching from students' perspective. The gradual increment and not dropping below 3 is a positive indication that the teachings are reaching the students.

The perception of students on how and if they sought help of the professor was evaluated with a Yes/No type question. The student response, shown in Fig-3, points out the students sought more and more help from the teacher as the course progressed.

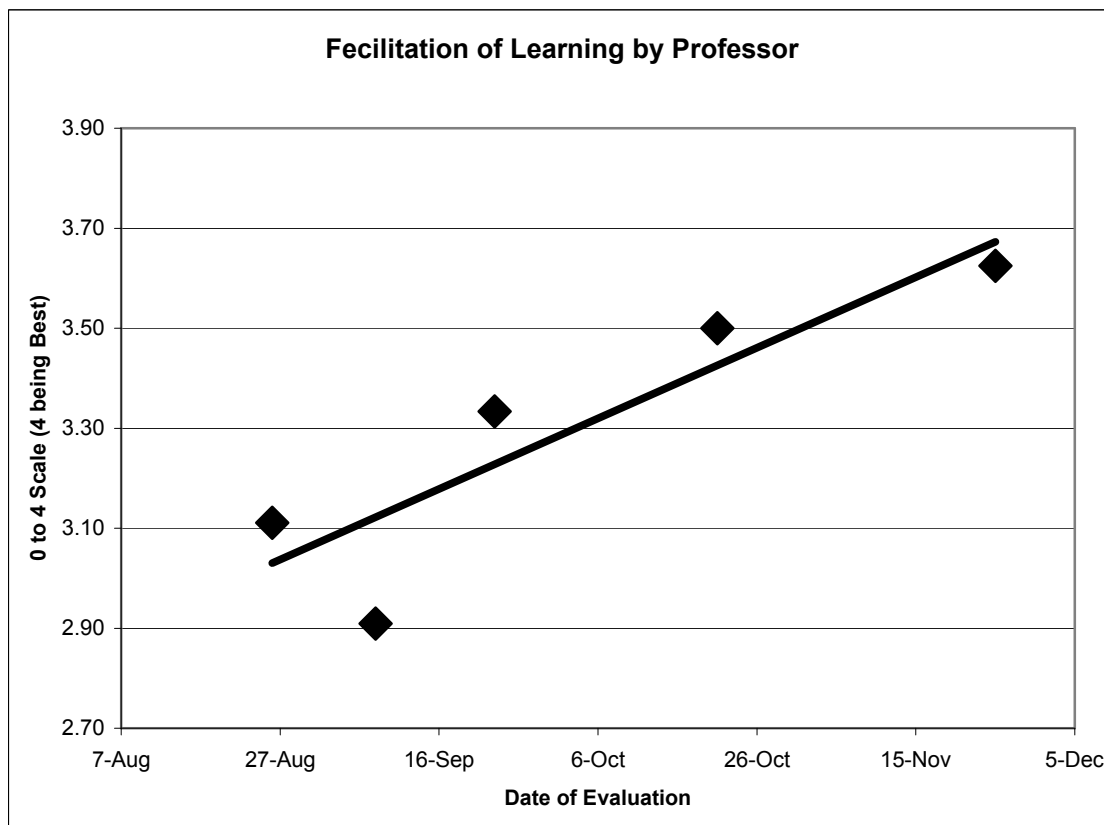
Another question of importance was the hours spent by students outside the classroom. Figure-4 summarizes the gradual progress in students spending more and more time for class work outside the classroom.

**Table 1. Questions and Reponses**

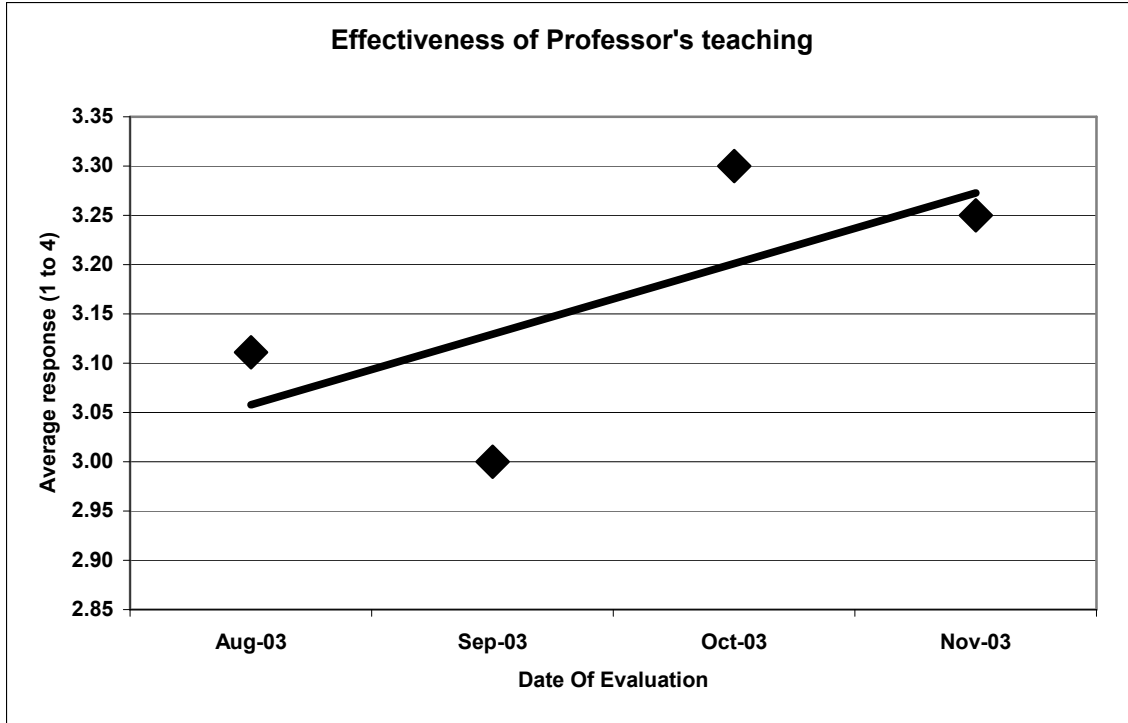
On a scale of 1 to 4 (1 being the lowest) rate the following:	Average response				
	26 <sup>th</sup> Aug	8 <sup>th</sup> Sep	23 <sup>rd</sup> Sep	21 <sup>st</sup> Oct	25 <sup>th</sup> Nov
• At the start of the course, professor clearly defined the method of grade determination.	3.78				
• The objectives, expectations, requirements and content of the course were clearly stated.	3.56				
• Meeting prerequisites of the course	3.67				
• Class room activities were effective tools for learning	3.25				
• Class worksheets helped to understand subject better.					3.75
• The Short assignments are helpful and helped to understand the subject better.					3.13
• The Professor effectively facilitated learning	3.11	2.91	3.33	3.5	3.63
• Professor's teaching effectiveness	3.11		3.00	3.3	3.25
• Lab activities were effective tools for learning?	4.00	3.09			3.75
• Adequate advance notice of test was given?			3.83	3.90	
• Homework problems were effective to prepare for the test?			3.17	3.70	
• Test was administered and graded fairly and consistently			3.83	3.7	
• Homework problems were effective instruments for learning.			3.00	3.10	

**Table 2. Strengths and Weaknesses**

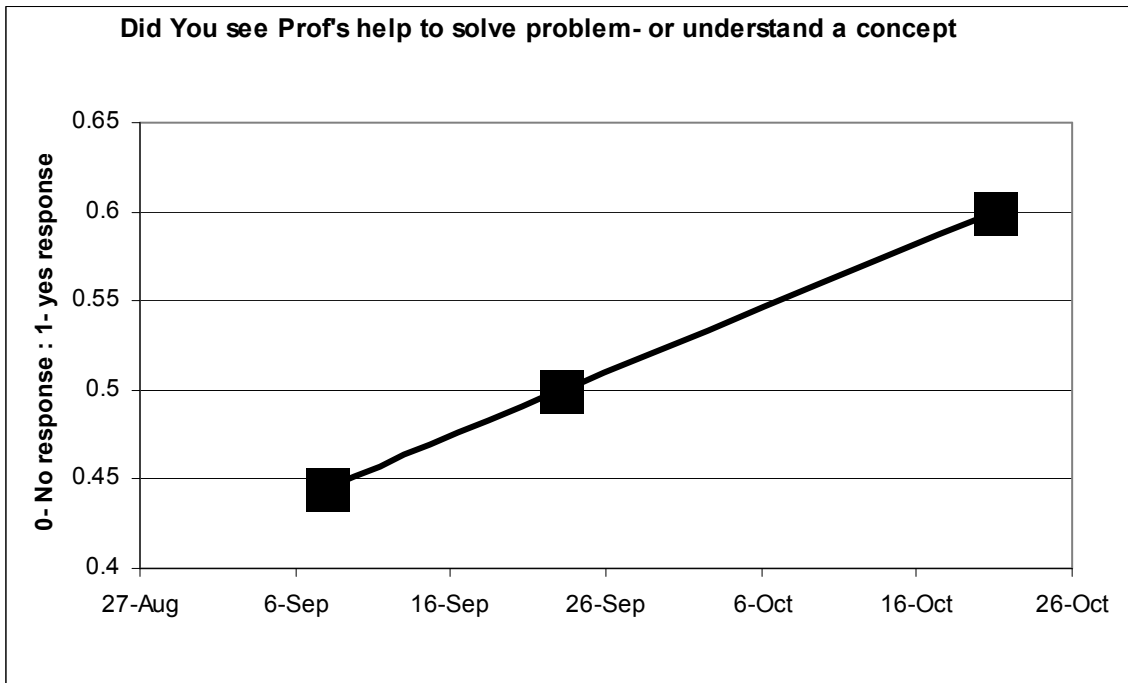
Criterion	Frequency (number of times this question is asked)	Comments
<ul style="list-style-type: none"> <li>What is the weakness of this course so far?</li> </ul>	2	Math, Formula, time, attention to detail
<ul style="list-style-type: none"> <li>What is the strength of this course so far?</li> </ul>	2	Lab, practical applications, understanding basic electrical/ electronic concepts



**Figure 1. Student response regarding Professor's facilitating learning**

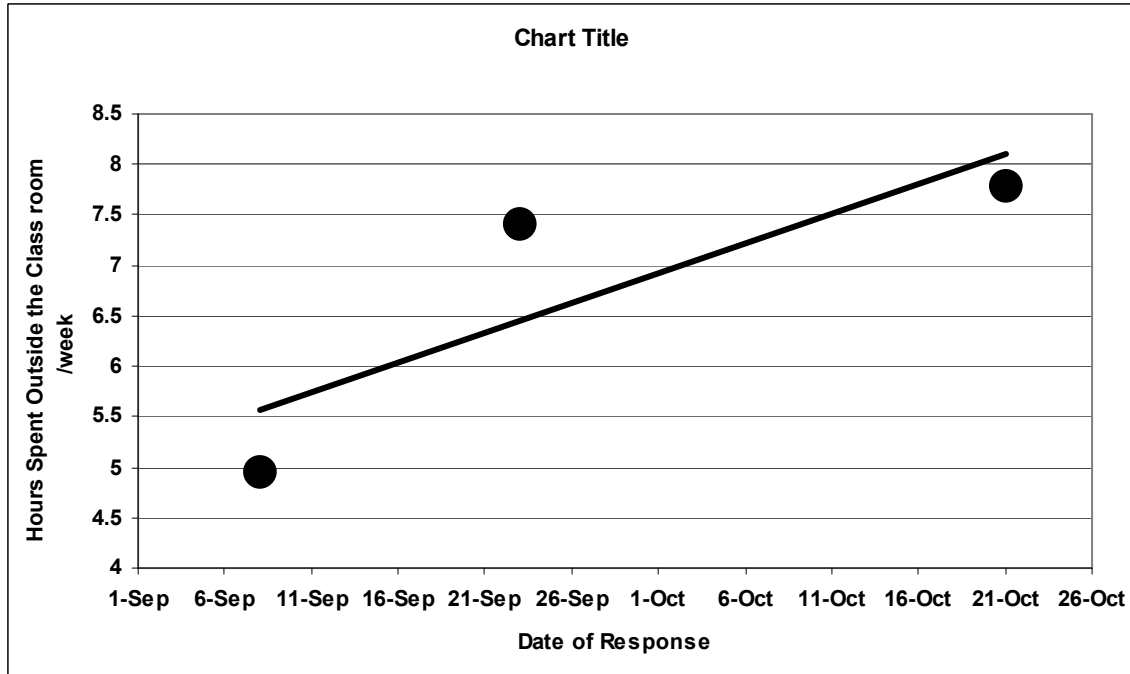


**Figure 2. Student response regarding Professor's Teaching Effectiveness**



**Figure 3. Student response on "seeking professor's help in resolving problems"**





**Figure 4. Student response “hours spent outside the class room”**

### III.2 One-minute evaluation:

This assessment is widely used and gives students a chance to demonstrate their understanding of the content just presented in class. At the end of the period students are asked to write answers to “brief questions about the material that had just been discussed in the class”. Students check their answers when the correct answers are discussed in the beginning of next class (about 10 minutes).

A few of the questions that are used in the one-minute evaluation are listed in Table 3. The answers to the question “*What is resistance? Write in your own words*” are presented in Table-4. The answers demonstrate the difficulty in conceptualizing fundamental principles. Having students articulate what they do and don’t understand about something just after having been introduced to it has proved to be of significant value. This interaction has helped focus on honing in the teaching as well as learning of basics more thoroughly.

**Table 3. One minute evaluation**

Week	Topic covered	Questions Asked at the end of the class
1	Conversions, Voltage and current	1. Convert 50 KHZ to megahertz 2. How is voltage measured? 3. How is current measured? 4. Give an example of a voltage source.
2	Resistance	1. What is resistance? Write in your own words 2. What is your understanding of ‘color code’

**Table 4. Example of responses to the question “What is resistance? Write in your own words “**

1. <i>Opposing Force</i>
2. <i>The Limit of pressure to an object</i>
3. <i>Something that slows or stops the flow of current</i>
4. <i>The opposition to the electron flow</i>
5. <i>Resistance restricts the flow of voltage within a circuit</i>
6. <i>Opposition to current or voltage flow</i>
7. <i>A force going against the flow – i.e., electrons colliding</i>
8. <i>The ability of electrons to flow easily or uneasily through a conductor</i>
9. <i>The force a wire/ conductor resists</i>
10. <i>Used to -----</i>
11. <i>Resistance is the opposition to energy that converts it into another form of energy such as heat.</i>
12. <i>Resistance is how much is holding it back</i>

### III.3 Small Group Instructional Diagnosis (SGID)

The other assessment “Small Group Instructional Diagnosis (SGID)” is used to capture the strengths of the course and recommendations from the students. This assessment is facilitated with a faculty from the Department of “Communications Across the Curriculum”. This session lasted about 20 minutes. 9 class members were present. The class is formed into small groups of 3 persons. The groups were instructed to choose a spokesperson to discuss the strengths of the course and recommendations. After each group wrote their list of strengths and recommendations, the class met together again to share their responses and for further discussions. A poll was taken for the whole class to see how many agreed to for the list of strengths emerged from the discussions.

#### III.3.1 Strengths of the Course

Below given a sample of questions asked on the “strength” of course:

**Table 5. SGID results**

<b>Criterion</b>	<b>Number of students agreed</b>
Instructors’ positive attitude about student learning	9
Instructor is very concerned about students and their grades	9
Instructor helps make the labs successful	9
It is easy to do well in this class	9

#### III.3.2 Student Suggestions for Improving the Course

Some of the suggestions made by the students are:

- “Provide an optional break mid-way through the lecture” (class is in session for 1 hour and 50 minutes)

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- "Allow students more time to work with each other"

These suggestions were considered. Half a way through the lecture an optional 5- minute break was provided. Additional group help-sessions were arranged as part of class activities.

### III.3.3 Grading criteria

The following table shows how the short writing assignments are graded. The mock presentations are graded for organization of the material and clarity of expression to help the high school students understand. The web searches are graded for how well the information is summarized and number of cites in reference to the subject matter.

**Table 6. Grading Criteria**

Unresolved Lab Problems	4% of the total grade	Check/ Uncheck	
		Mock Presentation	3% of the total grade
		Clarity	2%
Web Search	3% of the total grade	Summary	2%
		Sites	1%

### III.3.4 End of semester course evaluation

The student evaluation shown in the table below indicate a definite improvement in teaching and learning efforts.

**Table 7. End of semester course evaluation**

Term	Number of students participated	Overall instructor evaluation	Professor's teaching effectiveness
Fall 2003	10	3.6	3.7

This effort was quite strenuous in terms of time needed for preparation and implementation. The time spent on preparing the class documents almost doubled.

Spring 2003 enrollment is increased by 35% for this course.

## IV. CONCLUSION

Initial skepticism about implementing writing assignments diminished as students made positive comments in weekly questionnaire such as, "I like the Mock assignments better than the web searches but both are helpful" and "Yes they have helped me understand the majority of the concepts we have went over in class" etc. When students were enquired orally how the web search was going after the first assignment, some said they had trouble looking for information on Internet (these are entry level students). This feedback helped to arrange a formal web search tutorial with the help of University librarian

Some of the other comments from the students are: "The web search short assignments are interesting. By doing these I have little better understanding about the types of technology it has on all our lives" and "I think we would learn just as much by doing the homework".

The department unanimously agreed to the writing in the content area. A senior faculty who reviewed the material commented as “the amount of work you are requiring for a first course could become overwhelming. Your questionnaire on unresolved lab problems is very good. This helps determine problems associated with the labs. This will be a good assessment tool for the next ABET visit. Versions of this questionnaire could also be used in other EET courses”.

The implementation of writing assignments proved to be a valuable tool in enriching the student experience in the classroom. It enabled students to focus on the course work more seriously and sought teacher’s help more readily. The perception of student about the professor’s effort gradually improved throughout the course.

Students’ feedback is very important for successful implementation of these writing assignments. The feedback must be taken as the course progresses and not at the end of the semester. Modifying the assignments and accommodating students’ suggestions is extremely useful to improve the effectiveness of the teaching.

There are plans to implement one short writing assignment per week (either web search or mock presentation), biweekly one minute evaluation, and biweekly questionnaire in freshman and soft more level courses.

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#### **BIOGRAPHICAL INFORMATION**

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Suguna Bommaraju received M.S.E.E degree in Electrical Engineering from Purdue University, IN. She also has an M.S.E.E in Power Systems, and B.S.E.E in Electrical Engineering from India. She is Assistant Professor at Miami University, Middletown, OH. She teaches introductory courses in electrical, electronics and digital areas. Her research interests lie in the fields of stability of large-scale dynamic systems and fault analysis circuits and systems.

## APPENDIX I

### UNRESOLVED LAB PROBLEMS

Resolved and unresolved labs problems for the week of Oct-30th:

Name: \_\_\_\_\_

Date: \_\_\_\_\_

\*\*\* If you didn't have any problems, mark NONE in the appropriate area\*\*\*

\*\*\* If you have more than two problems to list, please use an additional page to list the problems with appropriate identification (Part number) \*\*\*

Part 1	Things we tried to solve the problem	Outcome
Problem A Difficulty in understanding the circuit	1) Talked to my partner 2) Talked to the other team 3) Talk to my instructor	Resolved
Problem B Difficulty in understanding mathematical formula	1) Talked to my partner 2) Talked to the other team 3) Talk to my instructor	Resolved
Part 2	Things we tried to solve the problem	Outcome
Problem A Could not measure current in the branch	1) Checked the connections 2) Changed the meter 3) Tested the circuit at different work station	Meter malfunctioning
Problem B Had difficulty in how to measure current in a branch	1) Talked to my partner 2) Talked to the other team 3) Talk to my instructor	Resolved

## APPENDIX II

### WEB SEARCH

You are asked to write a column in an electrical engineering magazine "Spectrum" on "Electric field strength". Include in your report the following but not limited:

- ❑ What is Electric field strength?
- ❑ History:
  - ❑ Who are these people?
    - Joseph Priestly
    - Charles Augustin De Coulomb
    - Michael Faraday
    - James Clark Maxwell
- ❑ Common equations:
- ❑ Units

## APPENDIX III

### MOCK PRESENTATION

The goal of this is to understand and to explain relationship between electricity and magnetism. These fundamentals are very important for individuals pursuing careers in electronics and electrical engineering.

Electricity and magnetism concepts were discussed in your Tuesday class. You are invited to give a 3-minute guest speaker lecture about "how the relay operates" to "Junior High" class at Lakota High School.

Your instructor provided the following circuit that you can use to prepare your lecture.

Your presentation should contain a brief explanation of the circuit.

