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Assessing Level of Laboratory Instruction to Engineering Technology Students

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Abstract

This study investigates what amount of assistance (text and hyperlinks) optimize student understanding of instructions in an engineering technology lab. The target course is a 300-level electrical instrumentation class taken technology students. Historically, lab assignments have been lengthy documents that include supporting material and detailed step-by-step instructions. Based on questions received by the instructor, it is obvious that students are not coming to lab having read over the instructions and other supporting material. One possible reason for lack of student pre-reading is the length of the documents. By modifying the presentation of the lab assignments into 3 distinct variations, the authors attempted to determine which variation the students preferred to work through. The authors revised approximately two-thirds of the lab assignments, dividing the assignments into three categories of detail:

- High level instruction with extensive hyperlinks for details.
- Medium level instruction with a combination of text and hyperlinks for details.
- Low level instruction with detailed instructions all in one document (existing format).

Students were surveyed on their understanding of the assignments and lab report grades were compared to instruction level.
The study was truncated because of the COVID-19 pandemic, so only partial results are presented. These partial results indicate that students prefer a “medium” level of instruction: an assignment that contains all the steps, but with details in hyper-linked documents.

Introduction

To provide the highest quality laboratory instructions to engineering technology students, this research looked at how the presentation of assignment details effects the amount of assistance a student needs to complete the assignment and their perceived impression of how well they met learning objectives. In the past, the instructor has created lengthy documents giving detailed step-by-step instructions on how to complete each lab assignment. During lab time, some students will ask questions that are answered in the instructions, making the instructional team question if the students are reading the assignment before coming to lab.

This study investigates what amount of assistance (text and hyperlinks) optimize student understanding of instructions in an engineering technology lab. The target course is a 300-level electrical instrumentation course required to be taken by mechanical engineering technology students, typically in their final year of study. The course is an elective for electrical engineering technology and computer engineering technology students, typically taken during their last two years of study. To prepare for this study, the instructional team revised two-thirds of the course's laboratory assignments. The 12 assignments were equally divided into 3 categories, described below. Students were then asked to participate in a post-assignment survey to obtain their opinion on the assignment layout.

The study was truncated because of the COVID-19 pandemic, so only partial results are presented.

Low Level Instruction

The low-level instruction assignments were formatted to be resemble a traditional type of assignment. Very short assignment instructions were included in the Canvas assignment (Figure 1) along with a detailed lab instruction word document. Students were expected to download the instruction document and follow along with all the steps, images, and support links. Each step included all the knowledge and material to successfully complete the step, which generally made for a lengthy document.

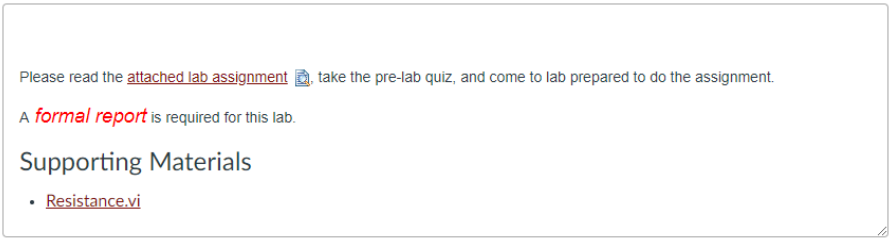

Figure 1: Low Level Instruction Canvas Assignment

Medium Level Instruction

The medium-level instruction assignments were designed to resemble the lengthy document from the low-level assignments, with the major difference being that all of the instructions were provided within a single Canvas page (Figure 2). All procedural steps and support images were laid out on the Canvas page and with links to support material provided as needed. Students were not expected to download any content or click on extra Canvas pages but could work through the assignment by scrolling down the assignment page. This created a single lengthy Canvas page

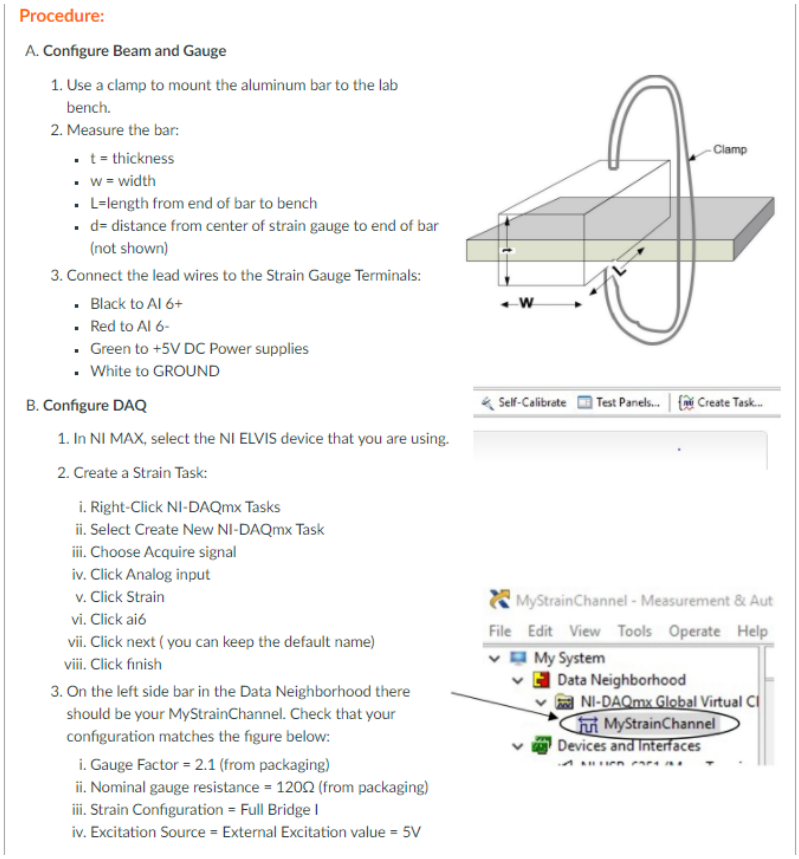

Figure 2: Medium Level Instruction Canvas Assignment

but did not require any download of material and minimal navigating to external sites for support. This type of assignment did require a significant amount of time to develop the Canvas page and did require some HTML experience to format the pages into a presentable assignment.

High Level Instruction

For the high-level instruction assignments, we altered the assignment to move the entire set of instructions into Canvas. The assignment page in Canvas was extensive (Figure 3), including the objectives, equipment, procedure, questions and submission information. Links were provided for any external information or for the individual procedural steps. All text instructions and support images for the procedural steps were placed into their own Canvas page (Figure 4) and

For this lab, you will need to be familiar with the Ideal Gas Law. The Ideal Gas Law states PV = nRT where:

- P = pressure
- V = volume
- n = Number of moles
- R = universal gas constant = 8.3145 J / (mol * K)
- T = Absolute Temperature (K)

If we have a closed system, the number of moles will remain constant. In this experiment, the temperature will remain constant as well. This means that PV will hold constant for this experiment. We will change the volume of our system, and that will change the air pressure inside the system.

Objectives of the lab: At the conclusion of this assignment, students will be able to:

1. Explain the difference between gauge and absolute pressure.
2. Observe the relationship between pressure and volume in a closed system.
3. Explain the effect of an offset voltage from a sensor.

Equipment: You will need the following equipment to complete the lab

1. Computer with NI LabVIEW Robotics 2017 w/ DAQ and ELVIS II software installed
2. Elvis II Unit
3. MPXV53GC7U pressure sensor – mounted on circuit board
4. Tubing
5. Syringe
6. Metric scale appropriate to measure tubing

Procedure: (For ease of navigation, open each step below in a new tab)

1. Assemble the syringe & pressure sensor system
2. Configure Sensor Circuit
3. Test Sensor Circuit
4. Calculations

Analysis Questions: Answer the following questions and include them in your lab submission.

1. Describe the relationship between volume of a closed system and pressure. Does your experimental data demonstrate this relationship?
2. Discuss the error between your measurements and theoretical calculations. What is the most probable source of significant error? Why would this be most significant?
3. The MPXV53GC7U uses what pressure as a reference? Describe the mechanics of the sensor.

You need to submit:

Figure 3: High Level Instruction Canvas Assignment

linked to the main assignments page. Students were expected to read through the main assignments Canvas page and navigate to the links for the procedural steps. This required no lengthy support document but did require a significant amount of time to create and develop all of the individual Canvas pages. Like the medium level instruction Canvas page, some HTML experience was required to format the page into a presentable assignment.

Lab 04 - Step 2: Configure Sensor Circuit

II. **Configure Sensor Circuit**

To prevent damage to the sensor, **DO NOT** exceed 5V on the source voltage.

1. Open NI MAX (type in MAX in the Start menu)
2. On the left side bar click the devices and interface tab
3. Then click NI ELVIS
4. Once on this page press the Test Panel button (top right)

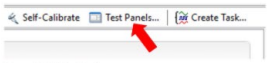

Figure 1 Test Panel button

5. Test panel should be set up as follows:

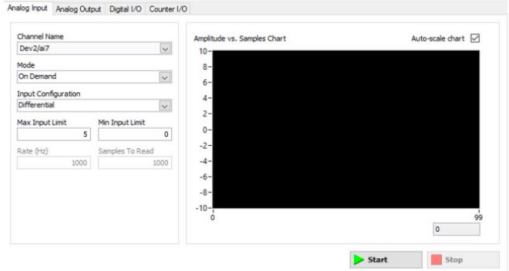

Figure 4: High Level Instruction Procedural Page

Method & Data

The labs were divided into 3 treatments described above: Low level of instruction (control) presented within the Canvas assignment page; Medium level of embedded instruction with some hyperlinks, and High level of instruction utilizing extensive hyperlinks. Table 1 lists the format of the eight lab assignments investigated.

Table 1: Distribution of Level of Instruction

Labs	Instructional Format
Lab 1: LabVIEW	Low level / as is
Lab 2: LabVIEW: DAQ	High
Lab 3: Strain Gauges	Medium
Lab 4: Pressure Measurements-Atmospheric	High
Lab 5: PH Measurements	Medium
Lab 6: Position Sensors	Low level / as is
Lab 7: Thermal Measurements	Low level / as is
Lab 8: Sensor Application Integration	Medium

The original experimental design also distributed amongst the categories the type of lab report (formal or in-formal) required; however, this part of the experiment had to be abandoned due the instructional changes caused by quarantine.

After each lab, students were invited to complete a brief survey about their experience with the lab instructions. (Figure 5) The survey was distributed within the Canvas learning management

ECET 351 students,

Following each of the 12* labs throughout this course, there will be a short 3 question survey. This survey is for research purposes only and will NOT be associated with your grade for the lab assignment or for the course.

We would like the information to be accurate and correctly reflect your experience within the lab environment, so the surveys will be 100% anonymous. The instructors will not know who completed/did not complete the survey nor will the instructors know how a particular student answered the questions.

The surveys may be completed on a voluntary basis, but we hope that you will take the time to provide feedback for our research.

Thank you in advance for assisting with our research!

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* Number of labs included in study was reduced due to COVID-19 instructional changes.

Figure 5: Invitation to students to complete survey.

system as an anonymous ungraded survey. To maximize response, the survey was brief and an attempt was made at humor.

The three questions were:

1. How clear were the lab instructions?
   - Mud
   - Iced tea
   - Foggy window
   - Crystal clear
2. How much assistance did you need to complete the lab?
   - No assistance – we completed the whole thing on our own
   - Some assistance - we had to ask a question or two to complete the lab
   - A lot of assistance – we had to ask a lot of questions to do the lab
3. How confident are you that you met the lab objectives?
   - Not Confident
   - Somewhat Confident
   - Confident
   - Very Confident

The instructor who wrote the assignments were hoping students found the instructions Crystal clear, needed no assistance, and were very confident in meeting the objectives of the lab.

The same survey was shared with the students after each lab, and the results retrieved from Canvas. Data were combined from the three low level instruction labs, the three medium level instruction labs, and both the high-level labs.

Analysis

The first analysis of the data is presented in Figures 6-8. Survey data from all the "high-level", "medium-level" and "low-level" assignments were added together, and percentages of responses compared.

Figure 6 presents the aggregate data from the survey question regarding clarity of instructions. Recall that the desired response was "Crystal Clear" and is identified by the blue section of each bar. The medium-level of instruction has the highest percentage of the desired response, and the high-level of instruction has the largest percentage of the less desirable response of "Iced tea" (shown in grey). It was a relief to the instructors that no students claimed the instructions were "as clear as mud."

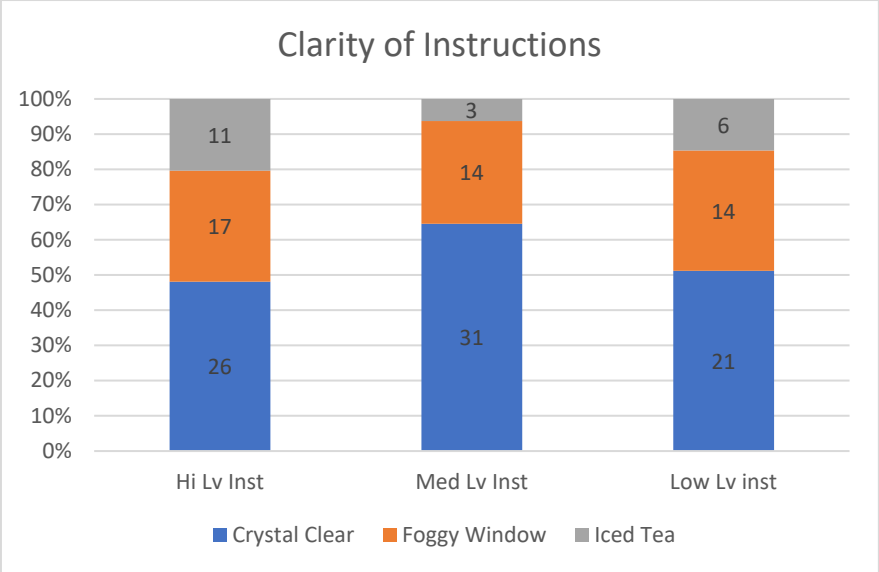

Figure 6: Student responses to the question "How clear were the lab instructions?"

Figure 7 presents the results of the survey question regarding amount of assistance required to complete the lab. The desired response was that the students needed no assistance which would indicate that all the necessary information to complete the assignment was presented in a logical way within the instructions. Again, the medium-level of instruction had the highest percentage of students giving the most desirable response (shown in blue). The

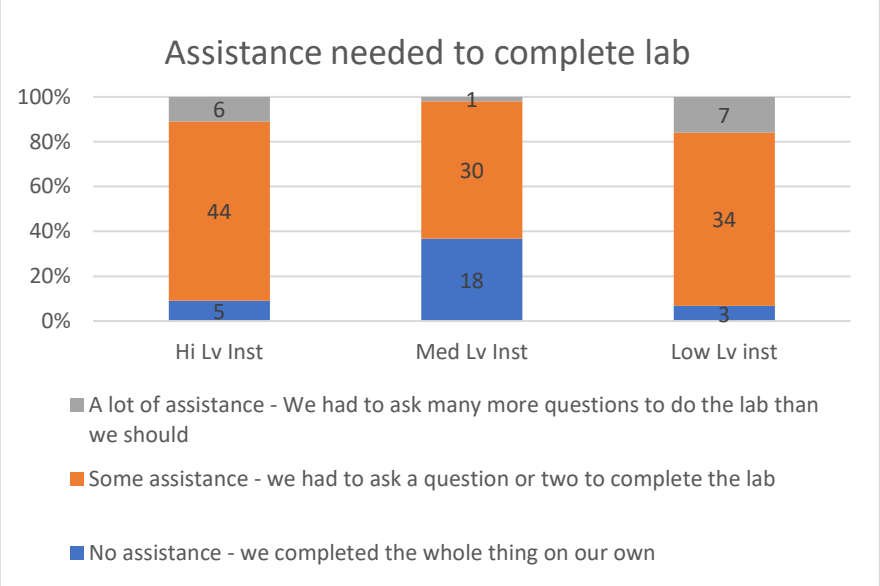

Figure 7: Student responses to the question" How much assistance did you need to complete the lab?"

responses regarding the assistance required for the high-level and low-level instructions were similar in distribution.

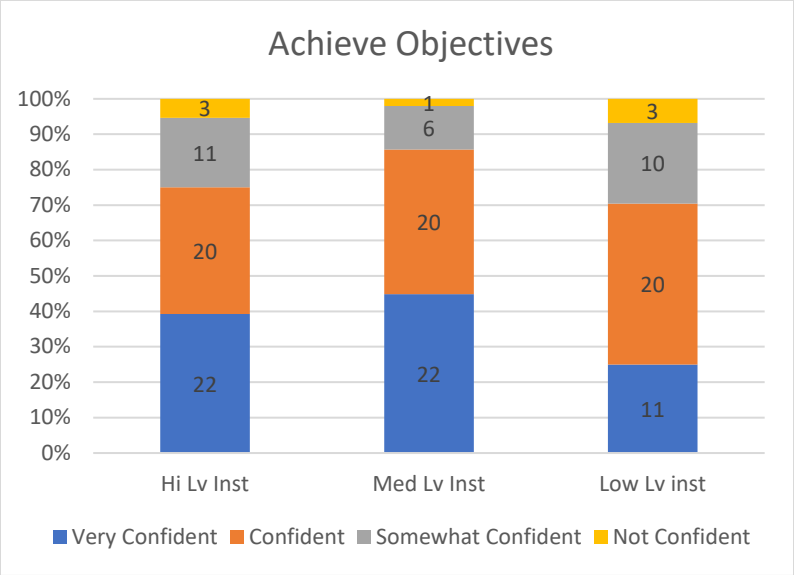

Figure 8: Student responses to the question "How confident are you that you met the lab objectives?"

Figure 8 displays the survey results regarding the students' confidence in achieving the objective of the lab. The desired response was "Very Confident." The medium-level instructions generated a slightly higher level of confidence than the high-level instructions. The low-level instructions yielded approximately 30% of the students being only "Somewhat Confident" or "Not Confident" that they had met the objectives of the assignment.

These initial analyses lead the instructors to believe that the medium-level of instruction was the best option for student success in the laboratory. To further evaluate this hypothesis, a Chi-Square test was applied to the data for each question. For the question "How clear were the lab instructions?" there is no level of association between treatments (level of instruction) at the 95% confidence level. The same lack of association was found regarding the responses to "How confident are you that you met the lab objectives?"

The Chi-Square test regarding the question "How much assistance did you need to complete the lab?" shows **there is** association between student's responses and the level of instruction presented at the 95% confidence level.

Conclusions and Recommendations

Although the Chi-Squared tests did not prove that the medium level of instruction produces the highest clarity and confidence, there is some evidence of a trend for students to prefer this format. Based on observations of students working in the lab, this may be because the students are required to do less "clicks" since most instructions are on one page within Canvas. Additional work is required to analyze the impact of the level of instruction on students' conclusions and lab reports.

Another important finding is that faculty should not do research in a class full of graduating seniors. The data shows a drop off of participation from week to week throughout the semester. We believe that this trend can be attributed to students focusing on higher priority items, such as capstone projects, internships, and preparing for job interviews. If further research is to be conducted in the future, we would target a class that is not taken by a majority of senior students.

As mentioned above, the semester was cut drastically short due to the COVID 19 pandemic. Students were sent home to quarantine and the remaining weeks of the course had to be altered to fit into the required virtual classroom environment. Due to these constraints, the instructional team was not able to fully complete all desired objectives of the research.

Appendix

Table 2 - Survey Data

	Lab 1	Lab 2	Lab 3	Lab 4	Lab 5	Lab 6	Lab 7	Lab 8
Crystal Clear	15	11	14	10	11	6	5	6
Foggy Window	8	9	9	5	2	4	5	3
Iced Tea	4	4	1	2	1	3	4	1
No assistance - we completed the whole thing on our own	2	1	5	2	8	1	2	5
Some assistance - we had to ask a question or two to complete the lab	24	20	19	14	6	12	8	5
A lot of assistance - We had to ask many more questions to do the lab than we should	1	5	1	2	0	0	5	0
Very Confident	13	5	10	6	8	5	4	4
Confident	11	13	11	7	5	4	5	4
Somewhat Confident	2	6	3	4	1	4	5	2
Not Confident	1	2	1	1	0	0	2	0
N	27	24	24	17	14	13	14	10
Instruction Level	low level / as is	High	Med-ium	High	Med-ium	low level / as is	low level / as is	Med-ium