IMPACT OF LANGUAGE AND STRUCTURE OF INSTRUCTIONS ON STUDENTS' CONFIDENCE TOWARDS COMPLETING ASSIGNMENTS

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Abstract – First-year engineering students usually spend more time on courses assignments and projects that they perceived to be more difficult, which increases students' workload and impacts their persistence in engineering programs. Students possess a higher level of confidence also tend to perform better on the tasks. Therefore, it is important to explore the impact of different aspects of assignment instructions on students' perceived confidence, and establish a comprehensive set of guidelines for first-year course instructors and curriculum designers in instruction writing.

This research builds on existing first-year engineering student workload survey to identify the students' confidence level on assignments in each first-year courses taught in University of Toronto. We compared assignment instructions in first-year engineering courses that students perceived to be difficult and easy, and conducted a focus group study to analyze students' confidence level towards the same assignments but two different instructions. Observations suggest that students perceived assignments involving new concepts and complex problem context appear to be more difficult. Qualitative responses from students suggest that short instructions with explanations of course connections using plain language could increase students' self-confidence towards completing these assignments.

Keywords: assignment instruction, project instruction, self-confidence, engineering education, instruction design, writing instructions

1. INTRODUCTION

1.1. Motivation and Problem Definition

For many engineering technical courses, assignments and projects are important parts of students' learning processes. They are aimed to provide students opportunities to get a better understanding of the course materials, obtain more practical experiences and enhance theory-practice integration in the learning process [1]. The lecturers usually design assignments and projects instructions to provide problem-solving questions with guidelines for students to complete the required tasks, while incorporating both course concepts and practical

cases to enhance students' learning experiences. Although these have been recognized as an effective approach of teaching in the undergraduate curriculum, several issues about student overload and lack of confidence towards completing the tasks have been discovered [2]. Based on previous discovered results by Darlee et.al [3], the time first-year engineering students spent on completing assignments increased with the conceptual difficulty of the tasks, which directly increased students' perceived workload in their first-year study. High perceived workload has been recognized as a major factor that influences the quality of learning in engineering, and also could mentally cause frustration on the students [4]. Several studies in social science have identified perceived difficulty has a direct influence on the students' confidence and the performance on the tasks (Bressan et al. 1982; Montcalm 1999; Hutchison et al. 2006) [5] [6] [7].

In most of the literature, the form of engineering assignments has been changed to improve students' motivation and performance such as utilizing technology-based environments [8] [9], case studies [10], and open-ended assignments [11]. Although, it is important to diversify the form of assignments to enhance students' interest and critical thinking skills, some structural and literal aspects of the assignment instructions also have direct influences on students' perceived difficulties and confidence towards the assignment, which have a significant impact on their task performance [6]. A previous discovery in social science field by Emily et al. suggests that students subjected to plain-English instruction improve student ability to analyze and apply knowledge [12]. However, few studies in engineering disciplines have explored the relationship between students' self-confidence and provided instructions. With an increasing number of practical laboratories and communication courses in engineering curriculums that require details instructions for students, it is beneficial to conduct an exploratory study on students' perceptions on the overall structure and the effectiveness of language used in the instructions to increase students perceived confidence. This could further reduce first-year engineering students' workload and enhance the persistence of students in engineering programs [13].

This paper examines students' perceptions of assignment difficulty and instruction structures and

languages (plain or jargon), by combining an online survey and focus group study. This research builds on existing first-year engineering student workload survey conducted in the University of Toronto, to identify the students' confidence level on two different styles of instructions from first-year engineering math course. The comparative study could provide great understanding of factors that influence students' self-confidence towards assignments. The primary research questions in this study are:

- How do current first-year students describe their self-confidence towards course assignments?
- What aspects of assignment instructions affect students' confidence in completing the tasks?

1.2. Selected Methodology

Two different approaches were designed to address research questions: 1) Online survey, and 2) Interview and focus groups. Online survey is more organized to gather students' general perceptions on assignments in different courses, and is more accessible for engineering students during their busy first-year study. Focus group can provide more qualitative responses from students' personal thoughts and experiences. All of the questionnaires and research approaches were reviewed and approved by the ethics review committee at University of Toronto.

From September 2017 to April 2019, around 30 first-year students from each engineering program in the University of Toronto responded to an online workload survey each week which includes both quantitative (scale) and qualitative questions. The results for questions about the overall course assignment conceptual difficulty is used as an indicator of students perceived confidence towards assignments. Initial analysis of this research focuses on understanding students' conceptual difficulty and confidence on assignments in different courses.

Students' focus group sessions are held twice during the semester to qualitatively analyze students' confidence level towards the same assignments but with two sets of instructions. We interview a few course instructors to obtain the expected results of the assignments. A backward design process is used to construct 'fake' instructions focusing on student understanding and desired results. During the session, students read the instructions and then answer a questionnaire regarding the following aspects:

- How you rate your self-confidence level against different desired results of the instruction
- Which and how different aspects of the instruction helps/deteriorates your self-confidence
- List and describe good/bad assignment experiences in your first year

2. METHODOLOGY

2.1. Online Quantitative Survey

Quantitative method is used to better understand the self-confidence of first-year students toward assignments in

each course. An ethics board-approved online workload survey was sent to 20 first-year students weekly from 2017 to 2019, which includes a question about perceived conceptual difficulties of assignments for each core course that every first-year student takes: *How difficult were these assignments Conceptually? (didn't know where to start, but once started it was easy to finish)*. Students rate their perceptions on the 5-point Likert scale rating (5 - *very difficult*, 4 - *somewhat difficult*, 3- *neither difficult nor easy*, 2 - *somewhat easy*, and 1 - *very easy*). Around twenty students responded the survey from each engineering disciplines each week. Students' rating of conceptual difficulties is used as an indicator of their self-confidence towards completing the assignments. From this survey, we assessed qualitative data by interpreting the results of this specific question and identifying the course assignments that students have the most and least confidence with. We compared the results of four technical courses in first-year engineering program: MAT186 (Calculus), MAT188 (Linear Algebra), CHE112 (Physical Chemistry), and CIV100 (Mechanics).

2.2. Instruction Design

MAT188 is a first-year mathematics course in linear algebra, which introduces the basic concepts and operations of linear algebra focusing on vectors, determinants and matrices, and numerical methods using MATLAB. The major assignment with instructions is MATLAB assignment, which is the focus of this study. As part of the research, the course instructors from MAT188 were interviewed to understand the expected results and goals of the assignment for the purpose of constructing 'fake' instructions for focus group study. One major question was asked during the interview: *What is the expected outcome of this assignment instruction?*

A three-step backward design process was used to reconstruct the content and structure of MATLAB assignment based on the desired results obtained from course instructors. Firstly, expected results and goals of the assignment are collected from instructors. Then based on the expected outcomes, we plan the learning activities in the 'fake' instruction to facilitate students' understanding of MATLAB operations and Engineering Problem Solving Process, which are the two main purpose of the lab. To compare students' preference of various aspects of instruction, we also construct a short version that has little examples and explanations around the learned techniques and procedures.

Besides the content and structure, languages used in the long version of instruction was modified to compare the addition of explaining scientific vocabularies using plain languages on students' self-confidence. In the long version of instructions, some concepts in linear algebra and science such as *Augmented Matrix*, *Gaussian Elimination* and *Elementary Row Operations* are essential for students to build a general understanding of linear algebra, but

knowing those concepts are not the main goal and requirements of this assignment. Those words are clarified and explained at the beginning of the instruction using plain languages to help students review or recall the concepts that will be used in the assignment. Other scientific vocabularies such as *Unbalanced Chemical Equations* and *Elongations* are unnecessary for students to gain an understanding of linear algebra, therefore these terms were translated into plain languages. Table 1 summarizes core sections in each set of instruction.

Table 1: Core sections in long version and short version instructions of the MAT188 MATLAB assignment

Long Version	Short Version
Introduction paragraph and learning outcomes	-
Average time taken for this lab and the preparation section	-
Preparation before lab	Preparation before lab
Glossary of Terminologies and concepts appear in this assignment	-
Course/Lecture Connection	-
Techniques in MATLAB with examples	Techniques in MATLAB
MATLAB exercise	-
Engineering Application Problems with suggested solving procedures	Engineering Application Problems
Engineering Problem Solving Process Explanation	-
A problem that requires to use Engineering Problem Solving Process with solution setup	A problem that requires to use Engineering Problem Solving Process
Submission Requirements	Submission Requirements

2.3. Focus Group Study

Focus groups were held to compare students' perceived self-confidence towards two different sets of MATLAB assignment instructions. Six students were split into two groups, where one group read a detail-designed instruction constructed and another group was given an unstructured instruction for the same assignment. A 3-section questionnaire was used to evaluate students' self-evaluation as a student's sense of his or her own competence or skill and perceive capability to achieve various goals. The first section asks students to rate their self-confidence against the desired learning outcomes obtained from the course instructor. *1 represents not at all confident, and 5 represents totally confident.* The second section requires students to comment on the aspects they like or dislike which contains: *length of the instruction, connection with classes, structure and layout, language used, and others.* The third section asks students to describe their good or bad experiences related to assignment instructions in their first-year study, in order to understand

what other aspects are under students' concern. Another repeated session is held with different students to ensure the consistency of the preliminary results. The sample questionnaire is illustrated in Appendix A.

3. RESULTS AND DISCUSSIONS

This section shows a compilation of data acquired from the Workload Survey and focus group study. It includes survey results for conceptual difficulty for each course assignment, and the aspects of instructions that build up students' self-confidence from first-year engineering students' perspective.

3.1. Course Assignment Conceptual Difficulty

Figure 1 compares the mean conceptual difficulty scores that students rated to assignments of each course during their first-year study. We can conclude from the graphs of Figure 1 that first-year students generally perceive assignments of MAT186 to be easier than other courses. Assignments in MAT188 and CIV100 are more difficult for students in both years.

Figure 1: Mean perceived conceptual difficulty for assignments of each technical course in 2017 (top) and 2018 (bottom)

We gathered assignment instructions from MAT186 and MAT188 with instructors' permission to compare the difference with them. For MAT186 assignments, they are generally short in length (1-2 pages), and consist of only problem-solving calculus problems with mathematical equations and symbols, such as "*Find the equations for the tangent and normal lines to the curve $f(x) = \sqrt{x}$, at the point*

$(x,y) = (4,7)$ ". The problems on the assignments are usually short and concise, along with vocabularies that are commonly used in calculus. The structure of MAT186 assignments is simple where only mathematical problems and total marks are shown on the instructions.

For MAT188, the assignments focus on learning and practicing MATLAB to solve practical problems. The linear algebra MATLAB assignments are usually long and consist of several sections such as *Preparation, Techniques in MATLAB, Do the Following Exercise, Engineering Applications, and Engineering Problem Solving, and Solution Setup*. The problems are usually provided in the context of real-world cases, long paragraphs and scientific vocabularies from other courses or fields appear in the instructions comparing with MAT186. After the interview with instructors, we observe that the difference in the structure and language used in the instructions is due to the slight difference in the focus of two math courses' assignments. MAT186 assignments emphasize on familiarizing students with mathematical calculations in calculus taught in class, and applying methods of calculus to solve established physics problems. MAT188 lab assignments aim to teach students about MATLAB skill which is new to most first-year students, and apply Engineering Problem Solving Process to solve real-world cases. Those concepts have not been revealed to most students in class and prior to their university studies. This indicates that students perceive more difficulties in completing technical assignments which involves new techniques and problems with complex context.

From the assignment instruction itself, we observe that length, structure and languages used in the instructions are the primary differences between MAT186 (perceived to be easy) and MAT188 (perceived to be difficult). Since MAT188 lab assignments need to provide more guidance and information to students, we choose to use its instruction as a basic model in focus group study to compare the influence of aspects mentioned above on students' self-confidence.

3.2. Students' Self-Confidence

Based on the quantitative responses (self-confidence rating) from 6 students in the focus group study, we observe that students' confidence level slightly varies in reading two different versions of the assignment instruction. Students reading the long version are generally more confident in understanding the learning outcomes and all concepts introduced in the lab. Students reading the short version instructions think they are more capable of completing it within allowable time, and they feel they are clearer about what is required for submission and marking.

To explore the reasons behind the difference in students' perceived confidence, we analyze students' comments on different aspects of the instruction. Students' comments on the **structure and layout** of the instructions do not have emergent groupings. Some students feel that

more white space on the instruction (long version) would make them feel less pressured towards the assignment. Others think compacting and simplifying instructions (short version) make them more positive towards completing it. We could conclude that the mood and emotional feelings of students can be changed by the instructions, and it directly connects with self-confidence.

Connection with classes and language used in the long version of instruction increase students' self-confidence. Explanations around concepts and terminologies using plain languages help them review course materials and provide cues that the concepts and problems are familiar to them. Students feel less confident when they find new vocabularies with no explanations around. This is echoed in student comments regarding the *languages used*:

"It helped me understand it better – especially since there are problems and concepts I might know but I haven't looked at for a while...vocabulary is not complex" (long version)

"helped me recall tools I would need to complete the lab" (long version)

"I'd prefer defining terms from outside of the course before they were used" (short version)

"There were a few words from other subjects which I was unfamiliar with" (short version)

The **length** of the instructions has a significant impact on students' self-confidence. We find that the long instruction might be daunting and deteriorates students' self-confidence. Too many extra explanatory materials and text add more pressure to students psychologically, and reading a long instruction increases the perceived 'workload' of the assignment. In contrast, the shortened problem statement and reduction of detailed explanations make the question for grading more obvious and clearer for students to read. Students express this as:

"It's very intimidating. As I kept reading and saw more parts of the assignment, I felt less and less confident in completing it in 3 hours." (long version)

"length of instructions made it a task to read over." (long version)

"I like the instruction gets straight to the problem and what needs to be solved." (short version)

In addition to the aspects mentioned in previous discussions, all students who read long version instruction indicate that the information about **assignment and preparation time estimates** strongly increase their confidence in completing this lab:

"Time estimates are extremely beneficial for scheduling. Even though it's different from person to person, at least I know to plan more than 1 hour and less than 8 hours for this task."

This suggests that students could establish their expectation from observing someone else engaged in

the same or similar activity before, and simultaneously become more confident if they know most of the peers could complete the assignment in the allowable time period. This time estimates also provide them with more controls in scheduling and relieve their mental stress towards completing the assignments, especially during periods where many major projects are scheduled around the same time. Similar to our observation from structure and layout, a positive attitude towards the task could increase students' self-confidence in their abilities.

To fully extend our exploratory analysis on different aspects of the instructions to a general approach to develop assignment instructions, we investigated the collected responses to a final open-ended question: *In all the first-year courses you have taken, do you have any good/bad experiences on the assignment instructions you have followed? Briefly describe what you like/dislike?* The aspects around assignments that students think are important to increase their self-confidence can be summarized into the following categories:

1. **Rubric and marking Scheme:** guidelines for students to what graders are looking for and what students should focus on in the assignment
2. **Explicit wording:** references to short and concise introduction and problem statements
3. **Close connection with lectures:** explanations of concepts and background necessary for completing the assignment; cross-reference with textbook or lecture materials
4. **Centralization of assignment resources:** centralizing mandatory and supporting materials of the assignment into a few locations that students are familiar with; reducing the number of different documents students need to reference for the assignment
5. **Explanations with examples:** examples provided while introducing a new concept, process or technique
6. **Structured format:** using short paragraphs; making problems for grading standout or placing them at the beginning of the instruction; highlight the points that require extra attention

4. LIMITATIONS

This exploratory research is a first step towards better understanding the first-year engineering students' perceptions on assignments and projects, from the perspectives of self-confidence. The indicator we use for self-confidence is "conceptual difficulty" of assignments, which is the only measure we have from the previously established survey. More precise measures of self-confidence are needed in the future to better characterize students' perceptions. In addition, this research aims to

establish a general set of guidelines for instruction writing, which does not consider students' individual differences in their educational background and learning styles. The individual differences might cause variations in the students' rating and responses. For example, in the focus group study, one student feels that the examples for MATLAB are not necessary, because he/she is very proficient with it. Furthermore, this preliminary result is derived based on a focus group of 6 students. More students will be recruited for the focus group study to monitor the consistency of preliminary conclusions and derive more comprehensive guidelines for assignment instruction writing.

5. CONCLUSION

Exploring students' self-confidence on assignments and projects instructions provides a novel perspective for investigating the effect of assignments on first-year students' perceived workload, which yields in interesting information for course instructors and first-year curriculum design. Students perceive assignments that introduce new techniques and complex problems to be more difficult. Designing against expected outcomes is necessary to increase students' self-confidence towards this type of assignments.

Connection with classes, language used, and length of the instruction have a significant impact on students' self-confidence. Providing explanations using plain language on concepts involved and how the assignment is related to lecture materials increases their self-confidence. Short and concise instructions build students confidence in completing the assignment before the deadline. In addition, students consider detailed rubric and structured format as essential factors that clarify the desired outcome of the assignments. Making assignment instructions and supporting materials more accessible could reduce the uncertainty in students' mind and improve their self-confidence. Students' confidence changes with their emotional states, and obtaining information about the performance of previous students also enhance students' faith in their capabilities. The results of this exploratory study

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8. APPENDIX

A.1 Sample of Focus Group Questionnaire

First-year Engineering Education Research Focus Study Session Questionnaire February 25, 2019

You are allowed to work on this lab assignment in **3-hour period**. Please read through the instruction document, answer the all the questions and express your real thoughts (this will be very helpful!).

**No personal information will be collected in this questionnaire. All answers will be used for research purpose only. Participants have the right to withdraw from the study if feel uncomfortable.*

Section 1: Rate your self-confidence towards this assignment Please provide a response for each item presented.

Self-Confidence Scale:

1 = not at all confident; 2 = somewhat confident; 3 = equally confident and not confident; 4 = mostly confident; 5 = totally confident.

Think about this statement as you read each item: "I am _____ in my ability to:"

Read Each Item Carefully	Circle the Number Best Identifying your Self-Confidence Level				
Determine the expected learning outcomes of this lab	1	2	3	4	5
Finish the lab in allowable time period	1	2	3	4	5
Identify the concepts used to complete the lab	1	2	3	4	5
Understand all the concepts and vocabularies mentioned in the document	1	2	3	4	5
Understand the concepts needed to complete the lab	1	2	3	4	5
Understand the descriptions of the problems to be solved	1	2	3	4	5
Have a clear sense of what is required for submission/marking	1	2	3	4	5
Understand Engineering Problem Solving Process	1	2	3	4	5
Apply Engineering Problem Solving Process to solve the problem required	1	2	3	4	5

Section 2: Comments regarding this assignment instruction

1. **Circle** the aspects of the **instruction itself** that you think help to build your confidence towards completing it and briefly describe the reasons

Aspects of Instructions:	Comments
Length of the instruction	
Connection with classes	
Structure and Layout	
Language used (vocabularies and terminologies, easy to understand? Well-explained?)	
Others	Specify:
None	Reasons:

2. **Circle** the aspects that you think makes you unconfident in doing this assignment and briefly describe the reasons

Aspects of Instructions:	Comments
Length of the instruction	
Connection with classes	
Structure and Layout	
Language used (vocabularies and terminologies, hard to understand? confused? Need more clarifications? Too many jargon words?)	
Others	Specify:
None	Reasons:

Section 3: Describe your experiences

In all the first-year courses you have taken, do you have any good/bad experiences on the assignment/project instructions you have followed? Briefly describe what you like/dislike.