# Enhancing student learning in mechanics through the development and implementation of a concept guide

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## Introduction

Introduction to Solid Mechanics (ME211) is one of the first introductory classes taken by students who intend to major in Mechanical Engineering. A considerable number of students have difficulties grasping the fundamental concepts presented in this course. This stems from a number of reasons:
i) Insufficient former academic preparation
ii) Reliance of formula sheet and 'plug-and-chug' strategies
iii) Challenges in understanding and visualizing how core mechanics concepts are applied in problems

This study aimed to develop a teaching approach to target specific gaps in students' analysis process and assist in retaining the fundamental concepts in this course.

### Research Question

To what extent would student learning in mechanics be improved through the reinforcement of a concept guide and hands on tools?

## Methods

### Participants
Nineteen students in an Introduction to Solid Mechanics (ME211) class participated in this study during Fall 2016.

### Study interventions
Concept guide listed out the most important concepts paired with a visual diagram.
e.g. When a cut is made in a non-two force member, three internal forces are present at any cut: normal force, shear force, and bending moment.

Visual hands on models composed of modular components that allowed students to visualize and apply forces.
e.g.
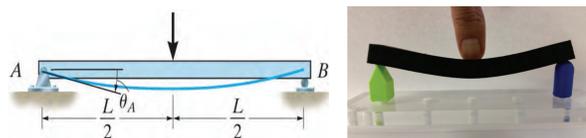
### Study measurements
Survey questions regarding the concept guide and visual tools were given to them after midterm 1 and 2. Exam scores were compared between other ME211 sections and the final scores of previous ME211 (Winter 2015) taught by the same instructor.

## Survey results

### Survey questions after midterm 1 (1-7 Likert Scale)
Q1. Did the concept guide help you better understand the materials in this course?
Q2. Did the visual tools help you better understand the materials in this course?
Q3. Will the concept guide help you remember the key points of this course in the long term?

### Survey questions after midterm 2 (1-7 Likert Scale)
Q4. Was the concept guide helpful in preparing for your exams?
Q5. Were the visual hands on models helpful in preparing for your exams?
Q6. Would you like to use the method of concept guide in other engineering classes?
Q7. Would you like to use the hands on visual models in other engineering classes?

| | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 |
|---|---|---|---|---|---|---|---|
| Average | 5.3 | 4.6 | 5.1 | 5.8 | 4.5 | 6.3 | 5.6 |
| Std | 1.1 | 1 | 1.45 | 1.43 | 1.1 | 0.9 | 1 |
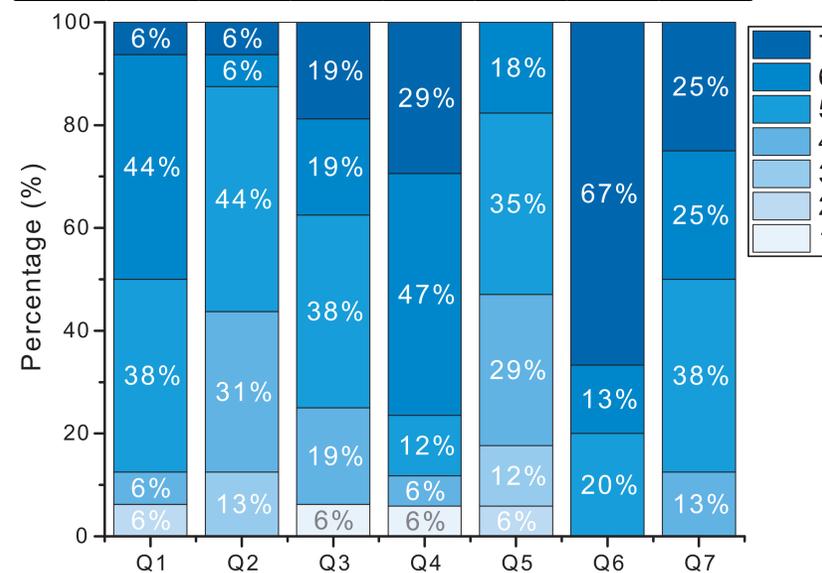


## Students' Responses

### Concept guide feedback
"Helped organize the topics and important concepts in my head."
"It's a good way to test your knowledge and look back on what you need more practice on."

### Concept guide suggestions
"Add more example."
"Make it more visual."

### Hands on tools feedback
"I like this idea, and it's helping a little... More parts would also help with this."
"I didn't use them a lot but for main concepts they were helpful."

### Hands on tools suggestions
"There could be more visual tools; so that some of the more complex concepts could be demonstrated."

## Comparisons of exam scores

### Midterm 1 scores
All three sections of ME211 students had the same midterm 1. Test scores were compared.
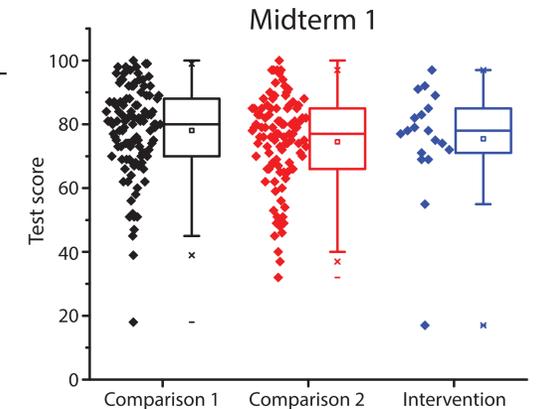


### Midterm 2 scores
All three sections of ME211 students had the same midterm 2.
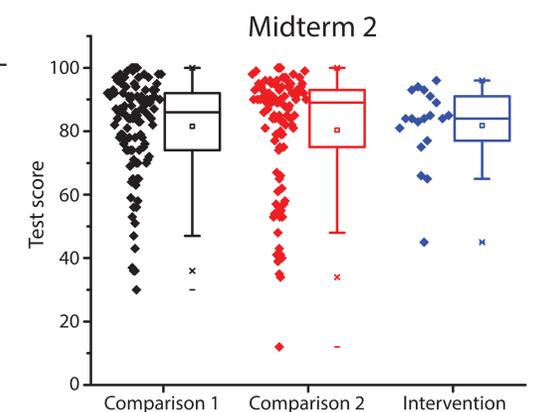


### Final exam scores
Same final exam from Winter 2015 was given to compare their exam scores.
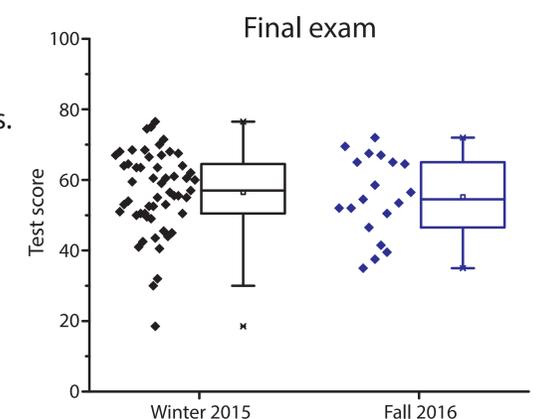


## Implications for Teaching

Although the using the concept guide and hands on models did not directly translate to better grades, the students' feedback were positive. The concept guide helped them organize important concepts and test their knowledge. The visual hands on tools helped them with some main concepts but they need to be further expanded to cover complex ideas.

## Acknowledgement