Mar 6th, 10:15 AM - 11:00 AM

Cross Disciplinary Perceptions of the Computational Thinking among Freshmen Engineering Students

Rami Haddad
Georgia Southern University, rhaddad@georgiasouthern.edu

Youakim Kalaani
Georgia Southern University, yalkalaani@georgiasouthern.edu

4th Annual Georgia Scholarship of STEM Teaching and Learning Conference

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Cross Disciplinary Perceptions of the Computational Thinking among Freshmen Engineering Students

Dr. Rami Haddad, Dr. Youakim Kalaani

Department of Electrical Engineering

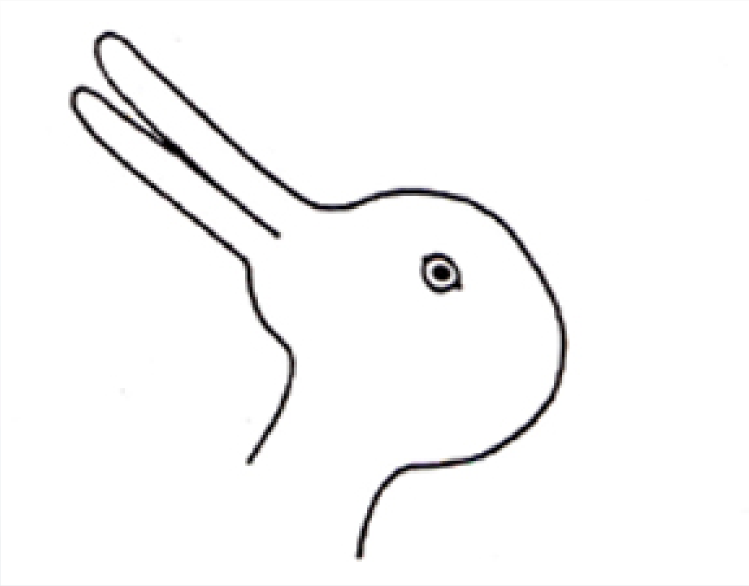
Georgia Southern University

Outline

- Motivation
- Computational Thinking Skills
- Hypothesis & Objective of Study
- Study and Results
- Conclusion

Motivation

What do you see looking at this pictures?



Is it a duck or a rabbit?!

There are two different ways to visually perceive this figure.

Motivation

Humans make decisions based on how they think the world works, if erroneous beliefs are held, it can result in behavior that looks distinctly irrational.

C. S. Green, C. Benson, D. Kersten, P. Schrater. Alterations in choice behavior by manipulations of world model. Proceedings of the National Academy of Sciences, 2010.

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Computational Thinking Skills

CT consists of four main skills:

- **Abstraction** is the skill that identifies the underlying laws and principles that governs the physical behavior of a model.
- **Decomposition** is the skill that involves breaking the problem into basic parts or components.
- **Recursion** is the skill that utilizes a repetitive solution of a simple instance of the problem to solve the more complex problem.
- **Algorithm design** is the process of combining the solutions of all the decomposed parts of the problem in logical order.

Hypothesis and Study Objective

- Computational Thinking (CT) is perceived differently among students from different engineering disciplines which affects the overall students' performance in CT.
- **<u>Study Objective</u>:** Improve the instruction of Computational Thinking through cognitive ergonomics.

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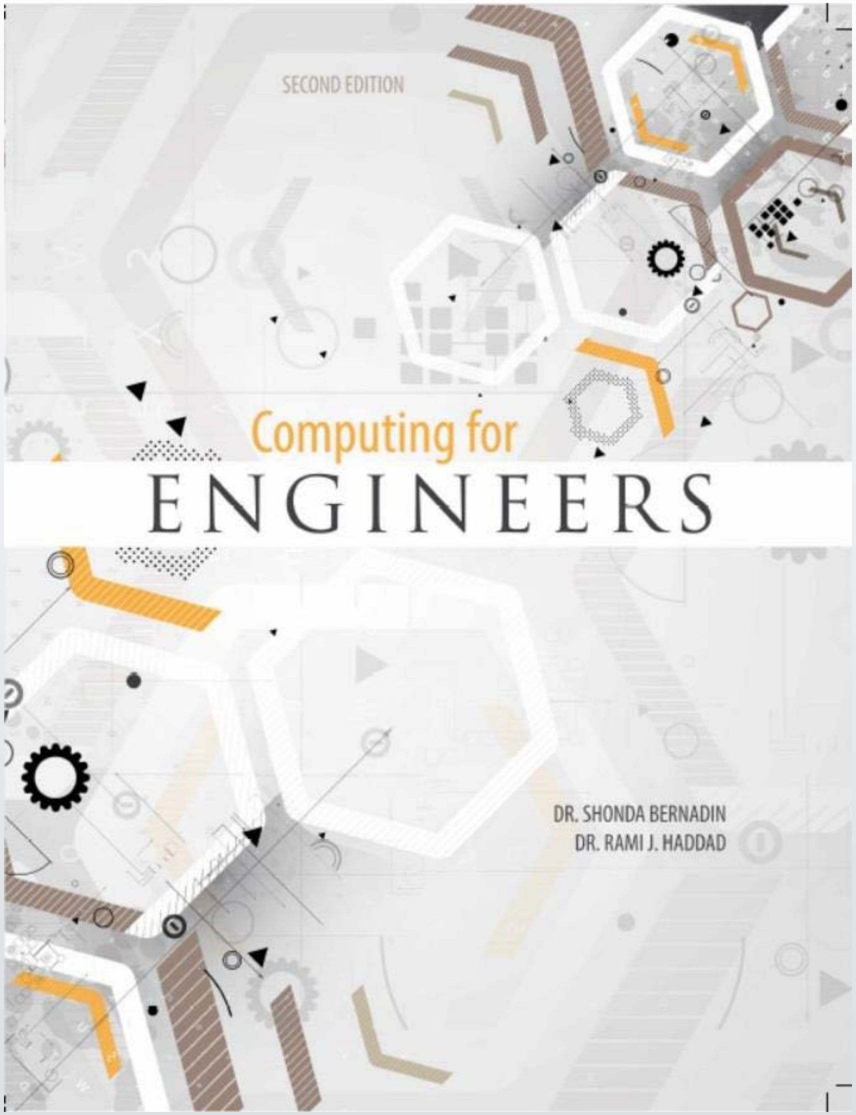
Study Details

To test our hypothesis,

- a quantitative analysis was conducted in over 40 different sections of this Computing for Engineers course offered between Fall 2012 and Spring 2014.
- Our sample consisted of 861 students (142 Civil, 484 Mechanical, and 235 Electrical)

Unified Curriculum/Instruction Material



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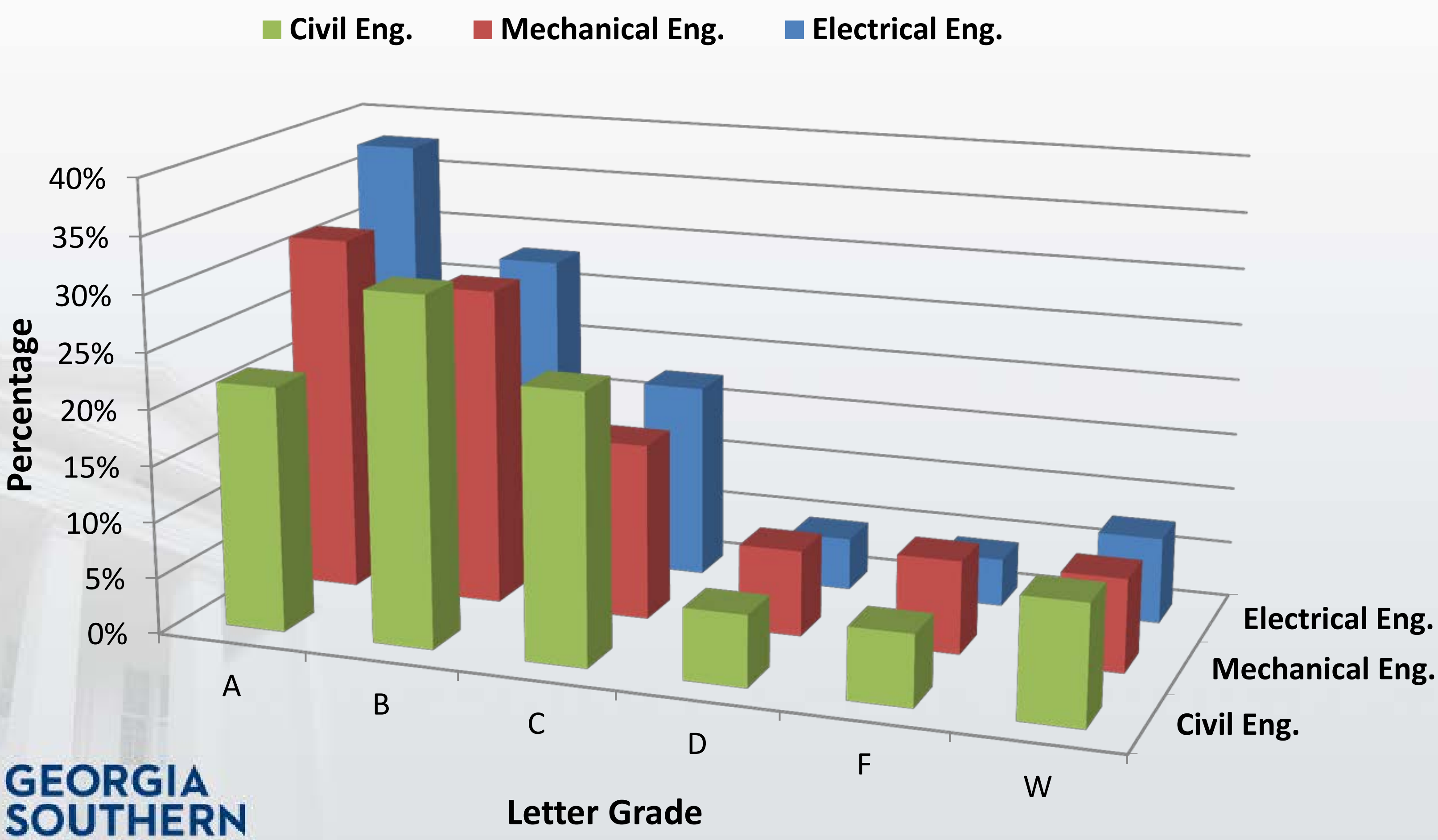
CT Students' Grades vs. Discipline



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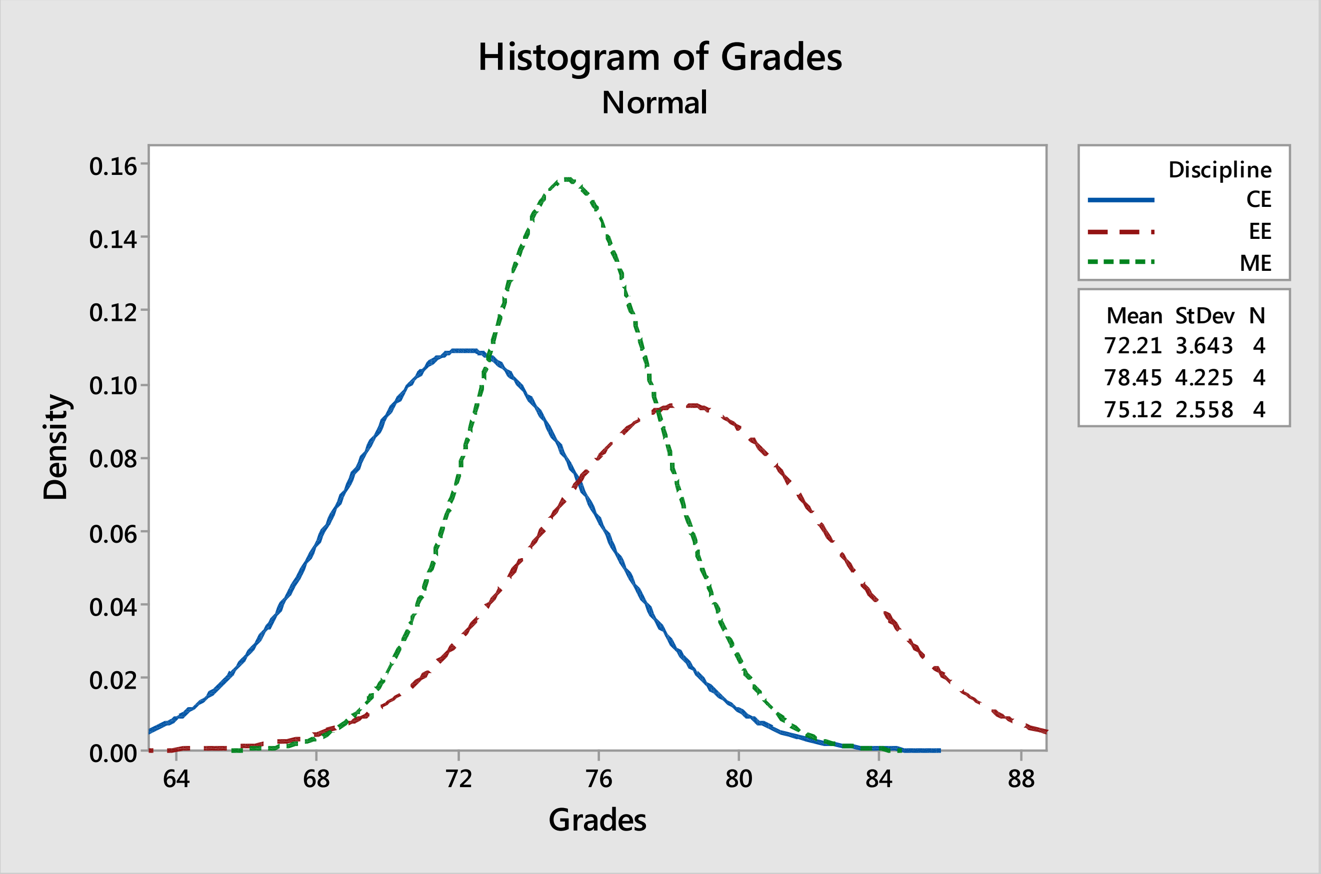
Observations

- EE students had the lowest D-grade, F-grade, and withdrawal (DFW) rates compared to ME and CE students.
- EE had the highest rate for A-grade followed by ME and CE, respectively.

Students from different engineering disciplines perceive CT differently when it is instructed by faculty with a specific engineering background

Normal Fit of Data



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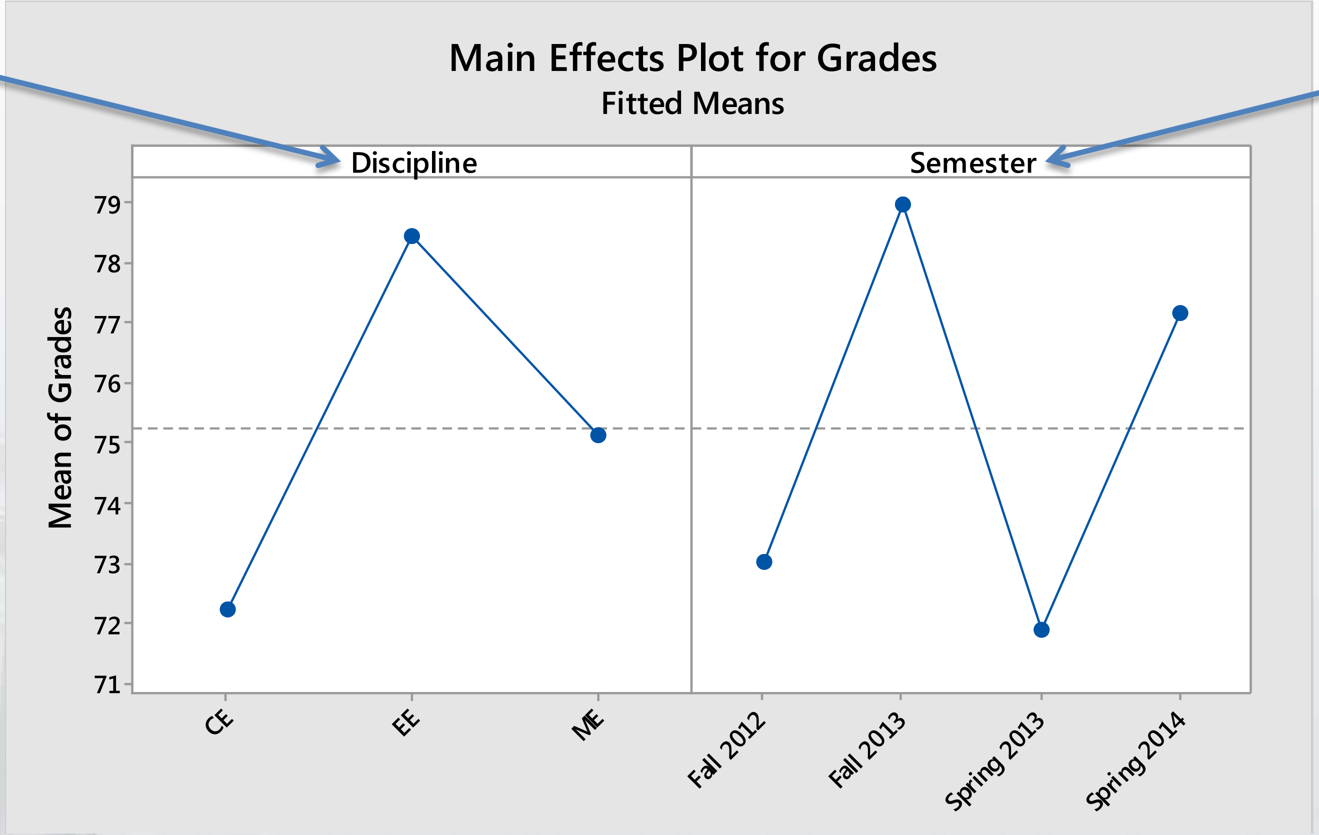
The mean of the students' CT grades are different based on their discipline

Main Factors Effects

Treatment Effect



Nuisance Effect

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Statistical Analysis Results

Statistical Analysis Model (General Linear Model: Grades versus Discipline, Semester)

Factor	Type	Levels	Values
Discipline	fixed	3	CE, EE, ME
Semester	random	4	Fall 2012, Fall 2013, Spring 2013, Spring 2014

Analysis of Variance for Grades, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Discipline	2	77.881	77.881	38.941	21.91	0.002
Semester	3	102.341	102.341	34.114	19.20	0.002
Error	6	10.663	10.663	1.777		
Total	11	190.885				

S = 1.33308   R-Sq = 94.41%   R-Sq(adj) = 89.76%

We achieved statistical significance with a confidence level of **99.8%**

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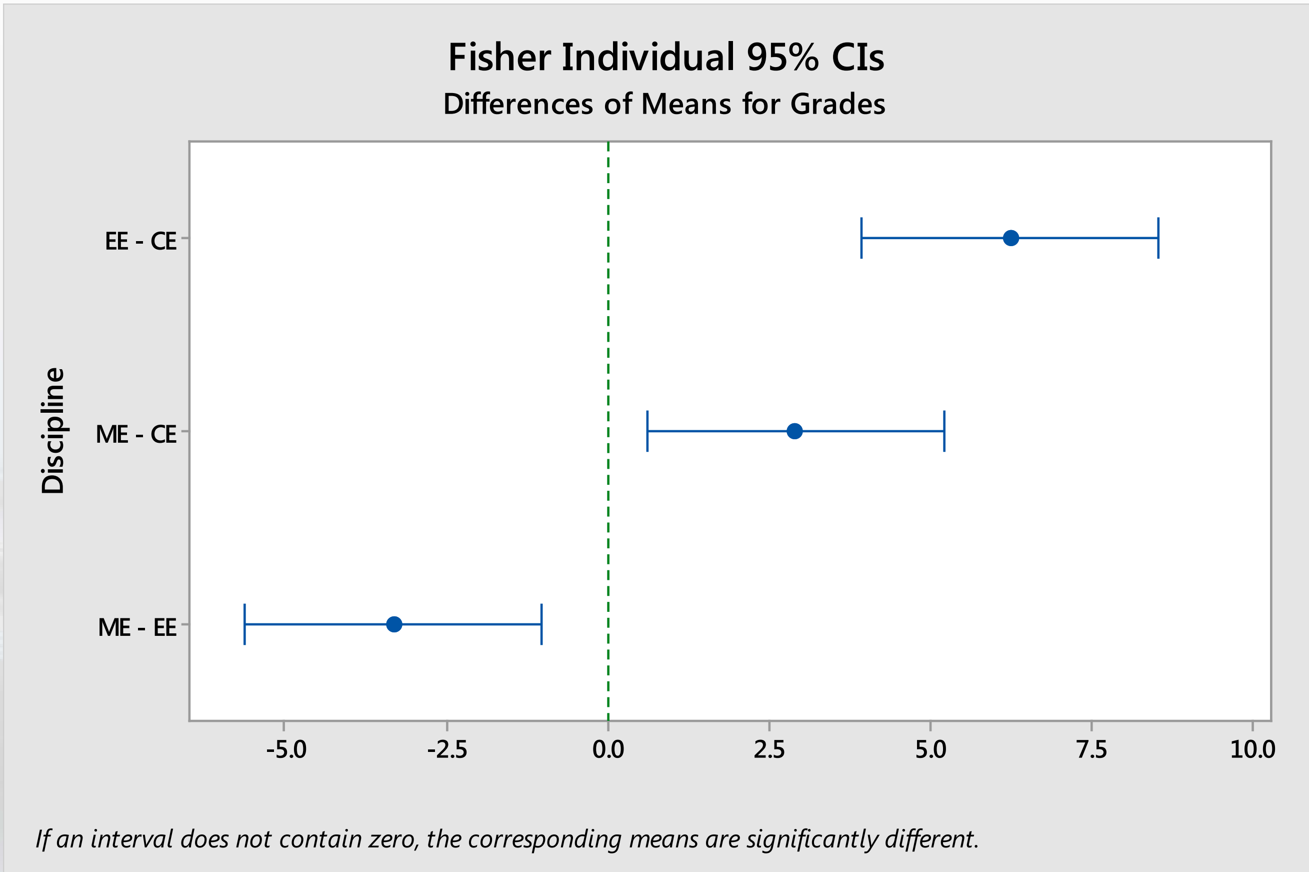
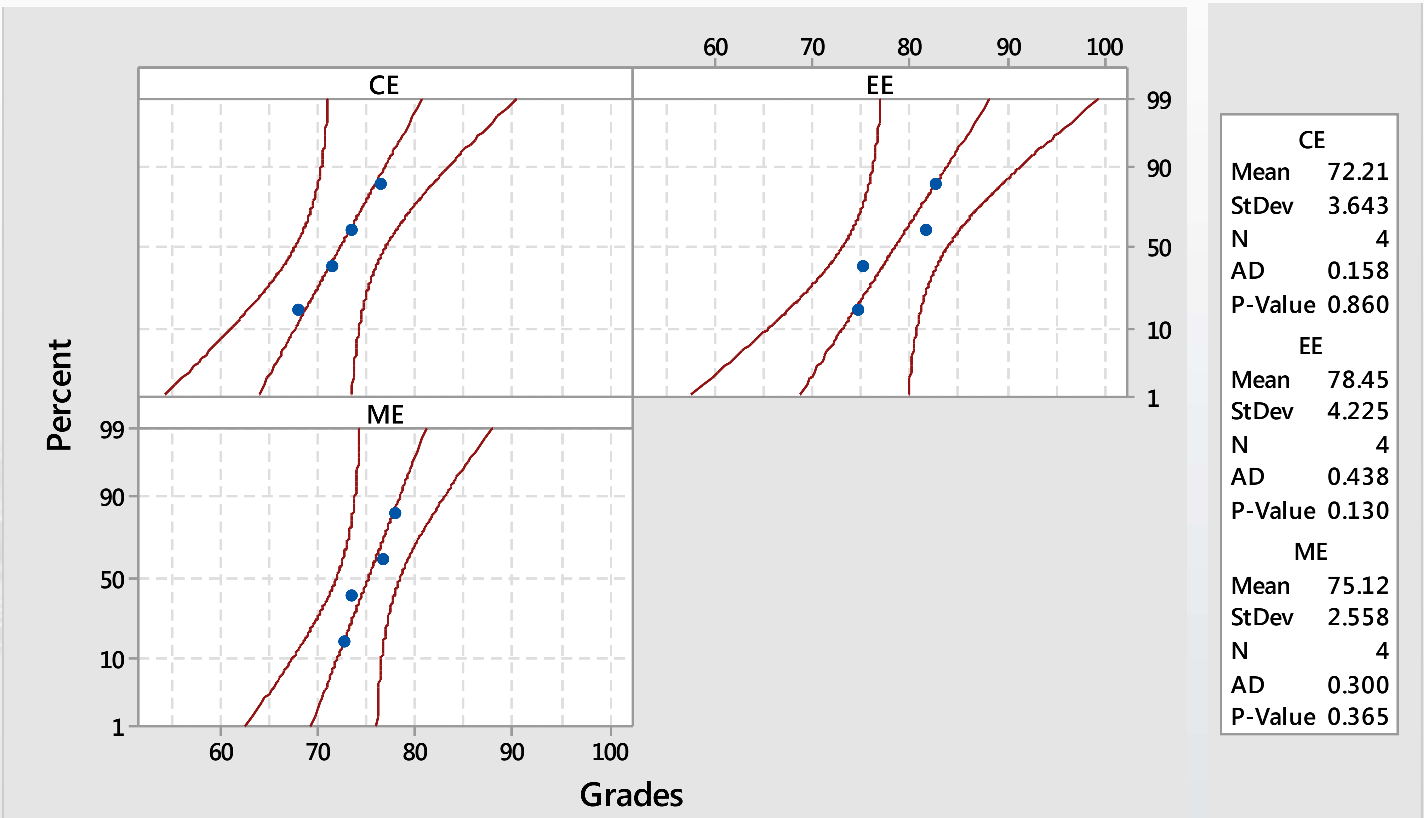
Pairwise Comparisons - Discipline



Discipline	N	Mean	Grouping
EE	4	78.45	A
ME	4	75.12	B
CE	4	72.21	C

Means that do not share a letter are significantly different.

Data Goodness-of-Fit



Conclusion

- Perception of Computational Thinking can differ among students depending on their discipline.
- We concluded that CT perception differ with 99.8% confidence level.
- To improve the teaching effectiveness, it is recommended that discipline-specific CT instruction to be implemented.
- Improving the students' perception of CT, improve their performance in other engineering courses, and ultimately will have a positive impact on the students' retention, progression, and graduation rates.

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Questions?

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