An Update Regarding the Pedagogical Efficiency of Continuous vs. Discrete User Interactions with Computer Simulations

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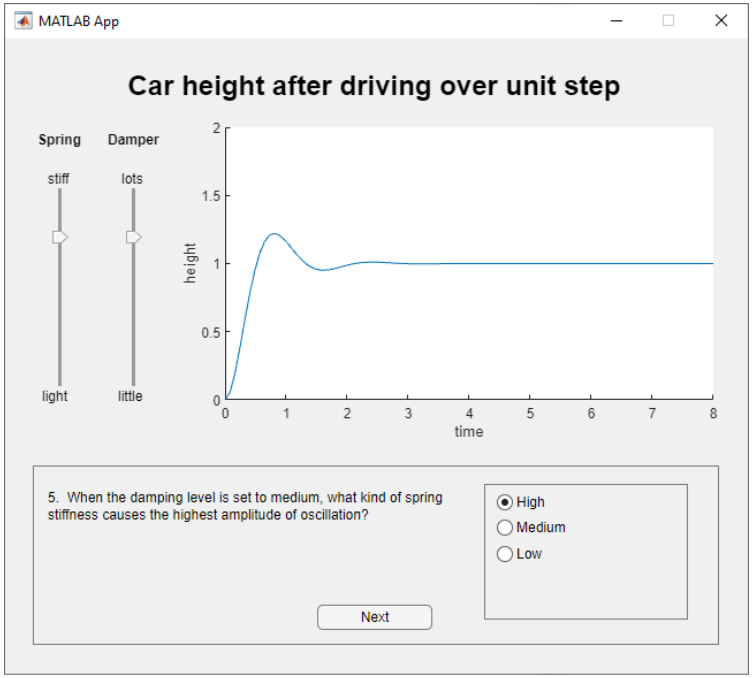
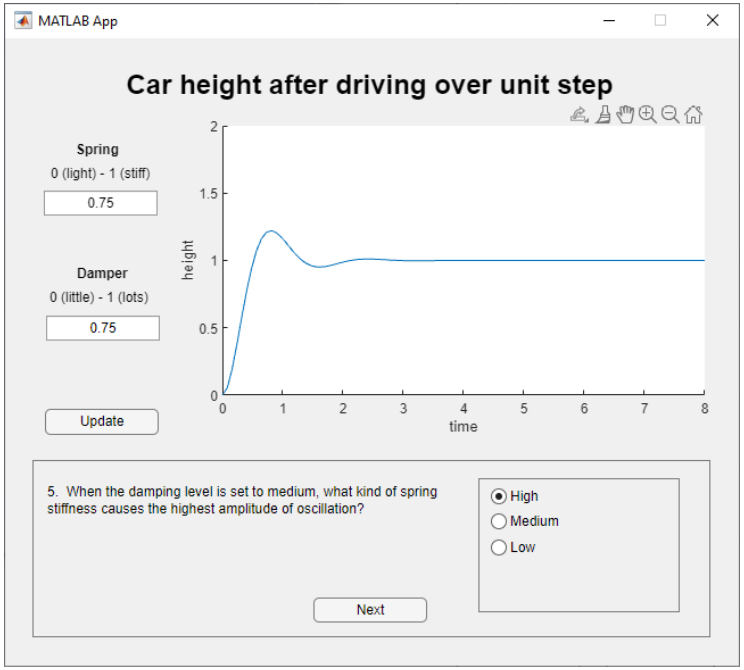
Overview

Did you use interactive simulations during your studies?

Should you have?

Which is Better?





Background Context

- Computer simulations important part of modern STEM pedagogies

- Many simulations may be categorized by:
  - ***Discrete User Interfaces***--- simulation parameters set by text or numerical input
  - ***Continuous User Interfaces***----simulation parameters set by virtual knobs, sliders and/or mouse-based selection from graphical operating curves

- Multiple interface modes identified as critical features for engaging students and boosting learning outcomes (Scalise)

- Simulations that include virtual knobs and sliders result in higher cognitive functioning than textbook-based courses, (Fang & Tjavadi)

Outline

- Purpose
  - Quantitative comparison of the pedagogical efficiency of simulations utilizing continuous user interfaces vs. discrete user interfaces
- Methods
- Results
- Conclusions

Methods

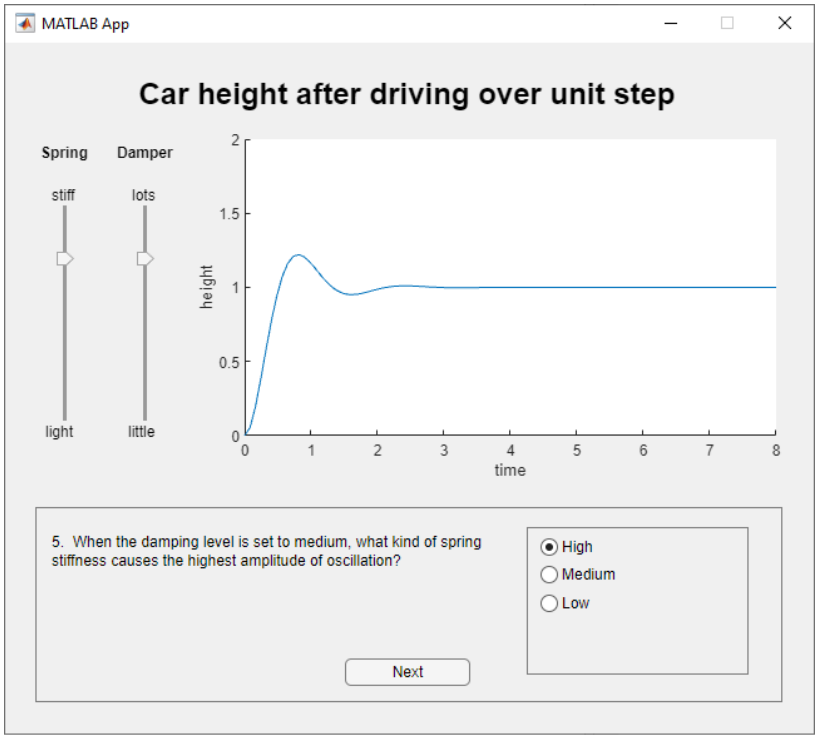
- Examine pedagogical efficacy of continuous and discrete user interfaces with a damped oscillator simulator
- Update to previous study conducted on phasors
- Address issue / question regarding time constraint

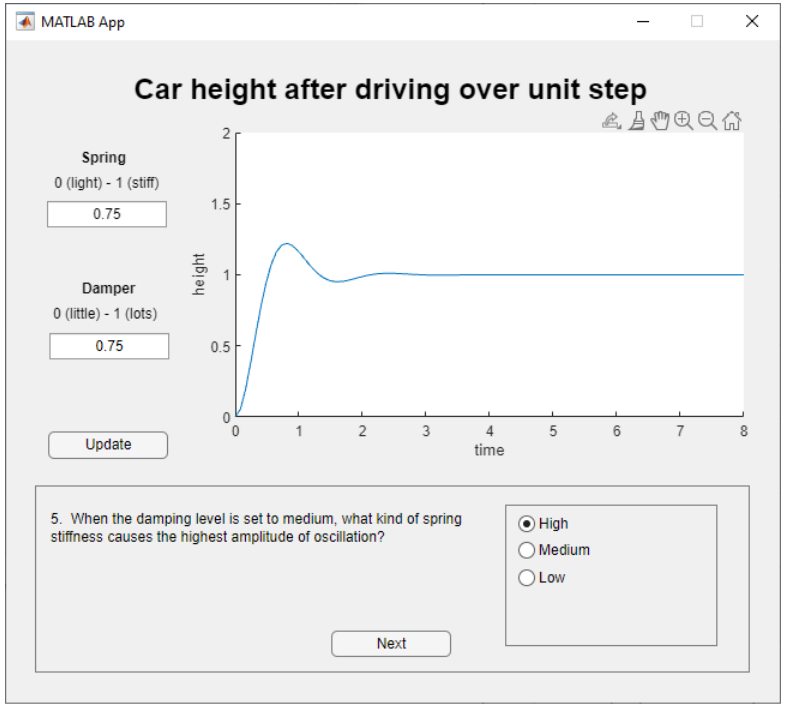
https://makeagif.com/gif/suspension-system-animation-Ityc70

Methods

- **Step I:** Distribute a tutorial
  - Covers basics of a car suspension modeled as a sprung damped mass
- **Step 2:** Randomly assign Continuous (C) or the Discrete user interface (D) simulation tool
- **Step 3:** Students explore scenarios, answer embedded comprehension questions.
- **Unlimited time, but it is tracked.**

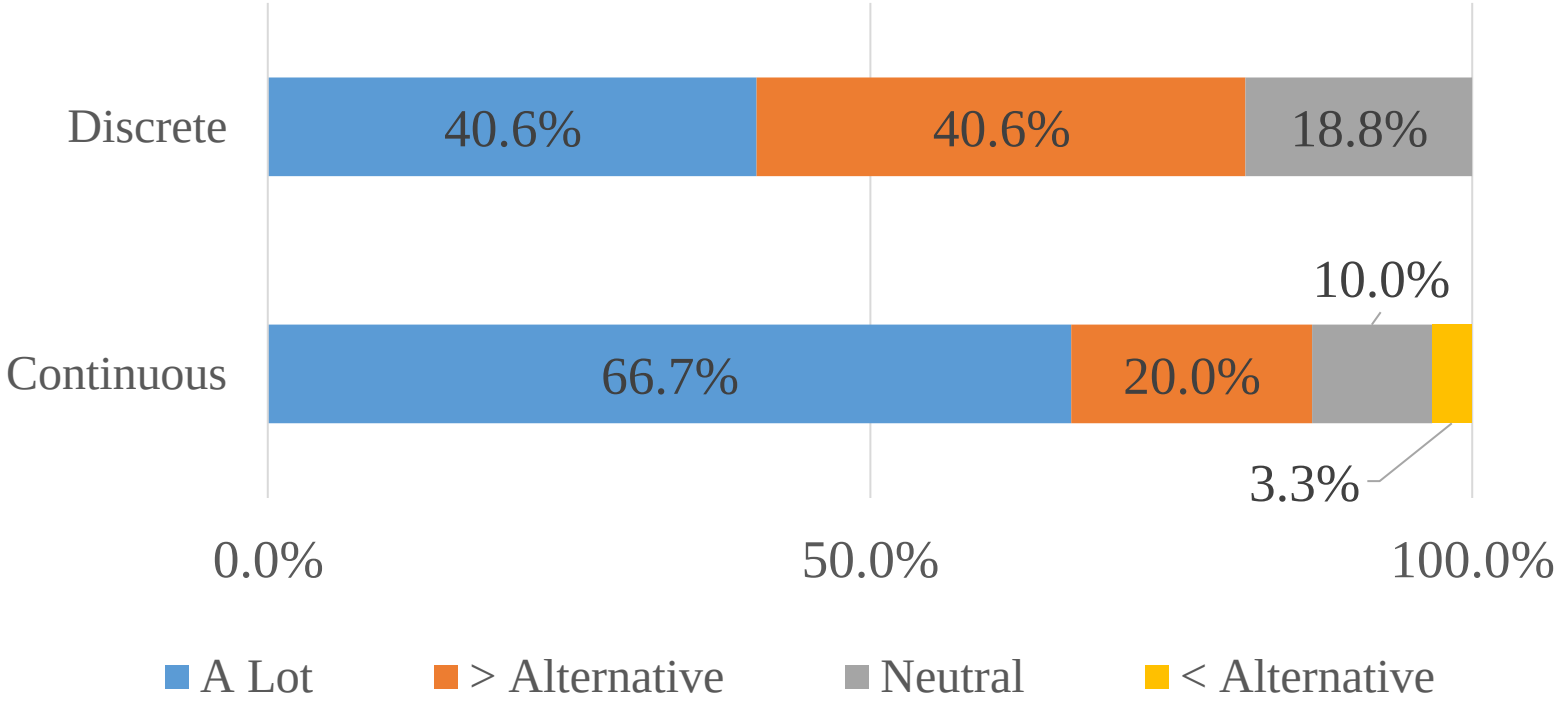
Interfaces


MATLAB App
Car height after driving over unit step
Spring
Damper
stiff
lots
light
little
height
time
5. When the damping level is set to medium, what kind of spring stiffness causes the highest amplitude of oscillation?
High
Medium
Low
Next


MATLAB App
Car height after driving over unit step
Spring
0 (light) - 1 (stiff)
0.75
Damper
0 (little) - 1 (lots)
0.75
Update
height
time
5. When the damping level is set to medium, what kind of spring stiffness causes the highest amplitude of oscillation?
High
Medium
Low
Next

Results – Self-Reported Enjoyment

- 30 users of Continuous Interface; 32 users of discrete interface
- All class years, predominantly freshman and senior
- Mix of ME and ECE students



Results – Self Efficacy Beliefs

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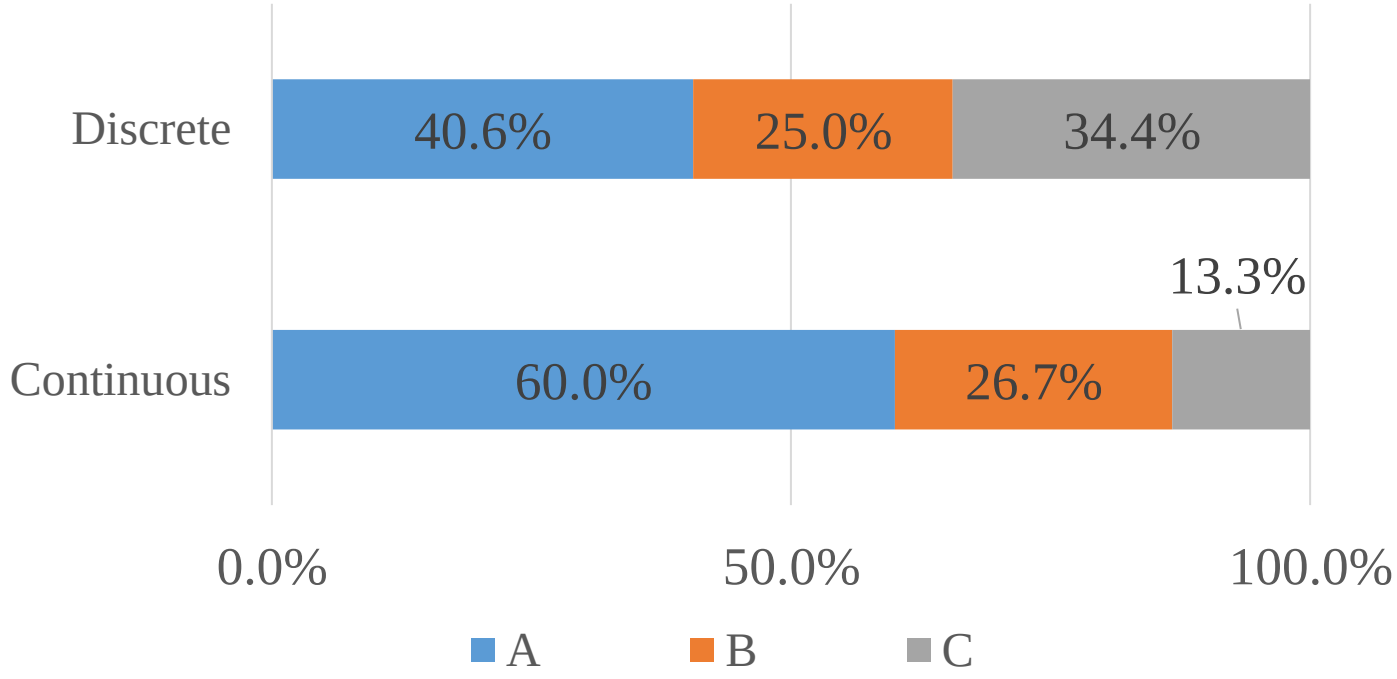
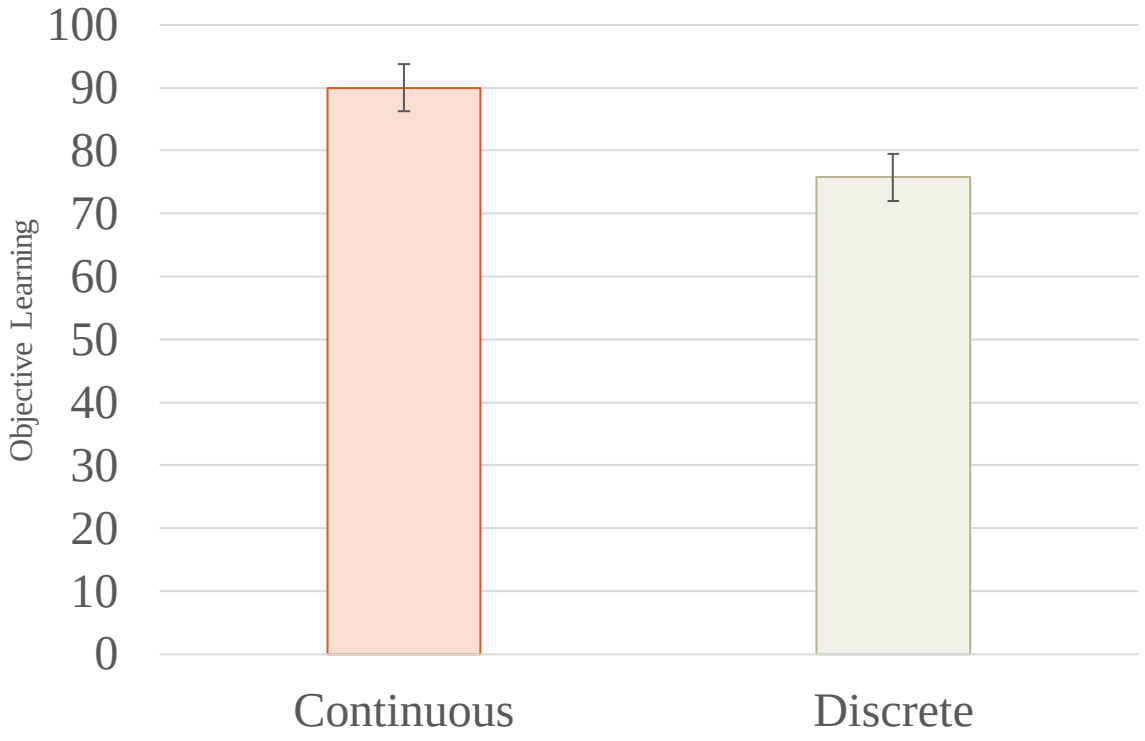


Results – Student Attainment

- 4 Questions to Check Understanding
  - Performance higher for continuous interface users all 4 questions
  - Higher by 30% for Q4 – the most complex
  - Discrete users spent more time exploring for Q's 1-3, less on Q4
  - Self reported confidence higher for continuous users all 4 questions with less variance

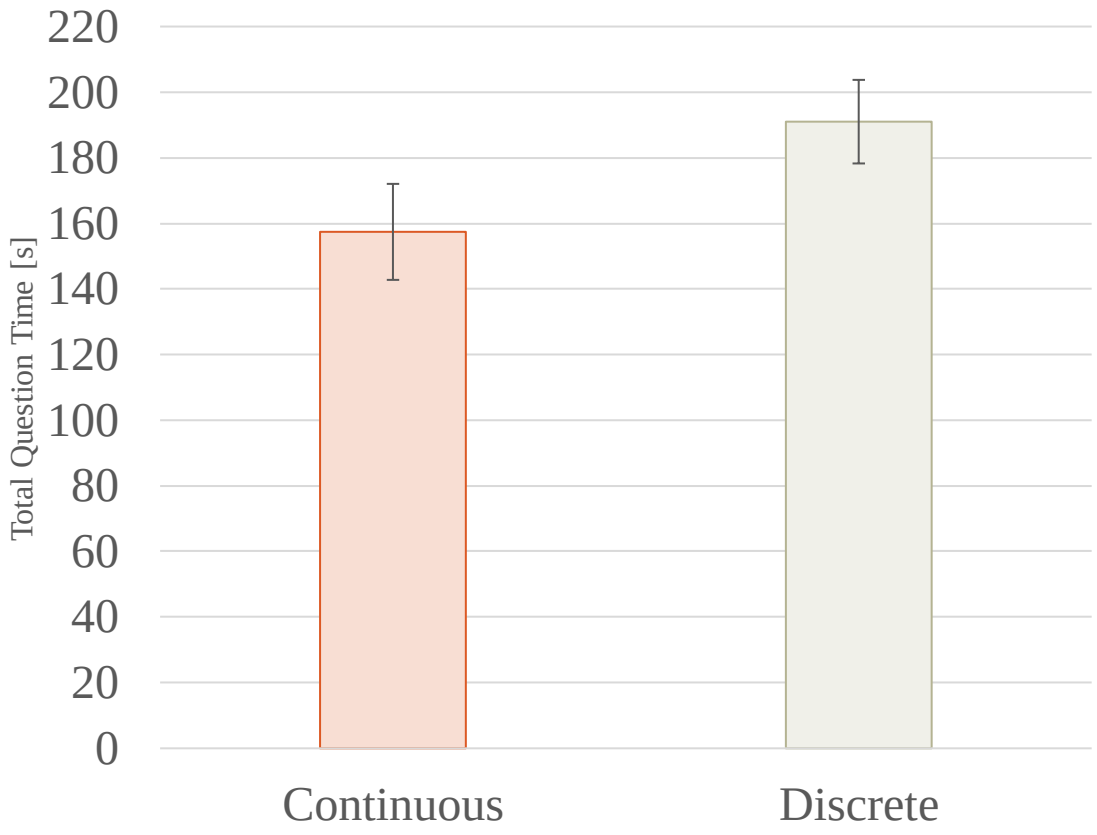
- Overall Attainment on 4 objective questions



$N_{continuous} = 30$
$N_{discrete} = 32$

P-value = 0.0087

- Overall Time Testing Scenarios



$N_{continuous} = 30$
$N_{discrete} = 32$

P-value = 0.0432

Conclusions

- **Comprehension was greater** when using **continuous** version (14% >)
- Users of the **continuous** version report **greater confidence**
- Users of the **continuous** version report **greater enjoyment**
- Users of the **continuous** interface spent less time exploring while also **performing** better

Future Work

- Explore how demographic dimensions impact results
- Explore relationships between performance and confidence in performance

Questions?

"…to produce educated, honorable men and women, prepared for the varied work of civil life, imbued with love of learning, confident in the functions and attitudes of leadership, possessing a high sense of public service, advocates of the American Democracy and free enterprise system, and ready as citizen-soldiers to defend their country in time of national peril."