Infusing Design: Impact of Engineering Design in Physics Labs on Student Engagement and Perception

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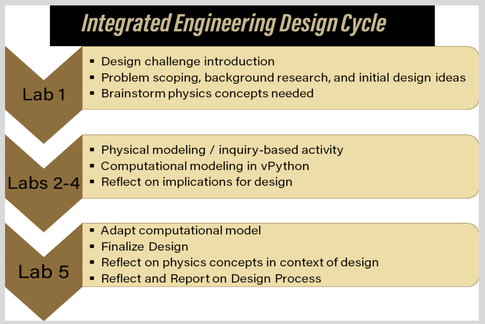
INTRODUCTION

- Interest, career relevance, and grades in introductory courses are strong predictors of persistence within STEM majors [1], [2].
- Introductory STEM courses typically involve well-structured problems with single-path solutions.
- In contrast, authentic engineering contexts involve integrated and complex problems.
- Engineering students often find it difficult to transfer scientific knowledge to solve ill-structured engineering design problems.
- The incorporation of engineering design in science classrooms also enables students to realize the relevance of science to everyday problems [3].
- Integrating design activities in STEM has been effective at improving student achievement and attitudes [4], motivation, interest, and self-efficacy [5], as well as learning, satisfaction, and retention in STEM [6].

METHODS

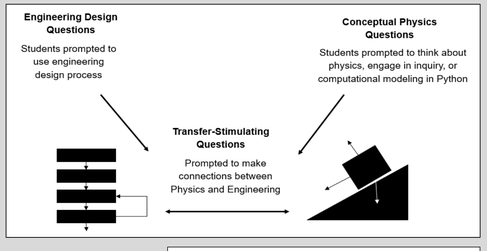
- Introductory Mechanics Labs for Engineering and Physics Majors.
- More than 2400 student annually.
- Three design challenges
  1) Autonomous Vehicles – Kinematics
  2) Food Delivery System – Energy and Momentum Principle
  3) Loading of Cylindrical Tanks – Linear and Rotational motion



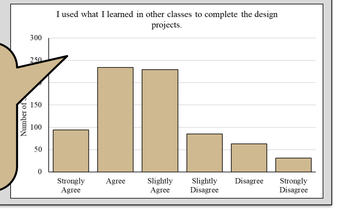
MEASURES

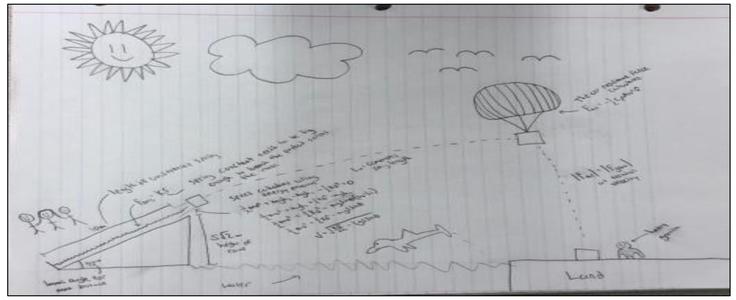
- Interest, Relevance, and Transfer Survey
- Interviews
- Case Study Observations
- Physics Concept Inventories
- Metacognition Awareness Index

FACILITATING TRANSFER



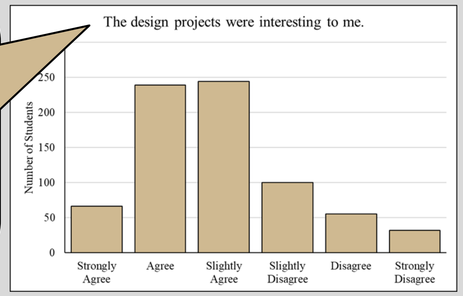
"It helped in my other courses such as ENGR 131"

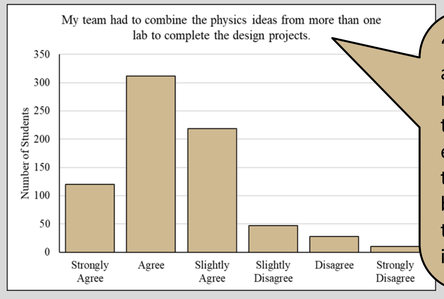




SELECTED SURVEY RESULTS

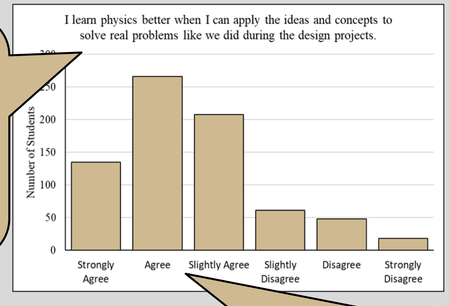
"They were very intriguing, being a real-world problem that requires a solution. It makes you feel like you're doing more than homework."





"We had to think critically and apply several different methods of brainstorming to develop a solution. I enjoyed having not only the PASCO and VPython, but also brainstorm and then combining all of the ideas together."

"Overall, I think they are an interesting way to learn about ways to apply physics. It was cool to see how physics principles can be applied to solve real-world problems."



"They challenged me to apply the things I was learning while thinking outside the box."

CONCLUSIONS

- Students overwhelming indicated that the design projects increased interest and motivation.
- Students made connections between the labs and their majors and future careers.
- Students demonstrated transfer between concepts covered in the physics course and transfer to their other courses.
- Most students indicated that the design problems were better for learning.
- However, there were epistemological conflicts for some students when considering how the design projects related to learning physics.
- Students need scaffolding to support coding and theoretical modeling of the physics concepts.
- There is a need for training physics TAs in engineering design and integrated STEM education methods.

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