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G-PhAsER

Laboratory Instruction Enhancement: Utilizing QR Codes and Digital Resources in Introductory STEM Courses

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REFERENCES & SUPPLEMENTAL INFO

ABSTRACT

Lab activities are integral to introductory STEM courses, including physics, yet time constraints often limit students' experiences. Instructors and teaching assistants spend considerable time explaining labs, leaving limited time for experimentation. This poster introduces a lab teaching intervention implemented in an introductory studio mechanics course for engineers at a large university. Instead of in-person lab introductions, the lab manual incorporates QR codes linking to TA-created videos, PhET simulations, and other resources. While data collection is ongoing, we hypothesize improved student engagement and understanding in comparison to traditional labs. Both intervention and control (traditional) sections' lab students will participate in pre- and post-lab surveys measuring engagement, perceived comprehension, interest, and self-efficacy during uniform circular motion (UCM) experiments. We anticipate that this intervention will enhance student performance by breaking down instruction into manageable, re-playable segments and integrating it into relevant sections of the lab manual. This has the potential to enhance introductory lab instruction, improve the student experience, and alleviate the instructional burden on TAs tasked with repetitive procedural explanations.

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INTRODUCTION

- **In many traditional physics labs, teaching assistants give a somewhat brief introductory lecture about course material and introduce the day's experiment**
- **This method has many limitations. Students may not remember important details, TAs spend considerable amount of time explaining and reexplaining material, and this method does not leave as much time for experimentation**
- **We have implemented a new approach to introductory labs aiming to address these issues**
- **Student lab manuals will contain Quick Response codes (QR Codes) throughout the lab manual linking to various resources, namely TA created videos explaining the material and experiment, PhET simulations, and other online resources**

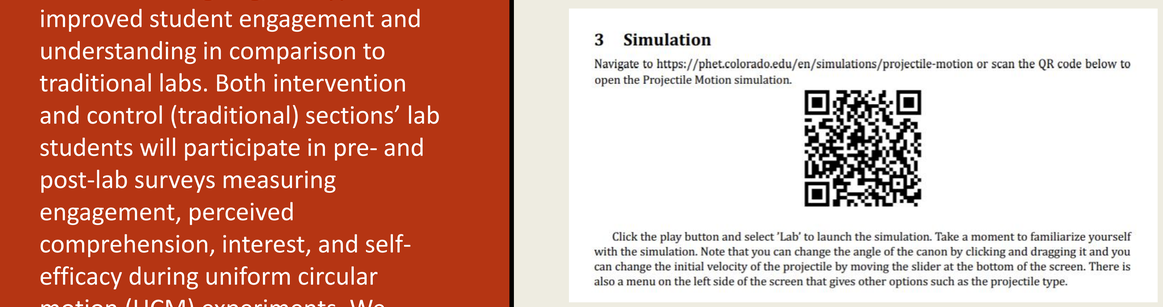

Fig 1: An example of an integrated QR code linking to a PhET simulation as a portion of the experiment on projectile motion.

METHODS

- **We are currently piloting a survey to measure the effectiveness of this intervention in a Uniform Circular Motion (UCM) Lab**
- **The survey has pre-lab and post-lab sections aiming to measure self-efficacy, expectations of enjoyment and understanding before the lab, and compare results to the same constructs measured after the lab.**
- **The survey was developed using questions from the E-CLASS (Zwickl et al., 2013) and individually created questions specific to this context.**
- **This pilot data is not currently available for presentation**

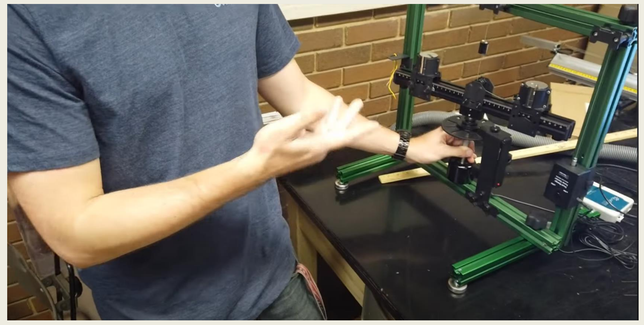

Fig 2: A screenshot of a video implemented in the lab manual for the UCM experiment showing a TA explaining the lab apparatus

SURVEY

The anonymous survey consists of 10 Likert items participants rate on a scale of 1-7 immediately before and after the experiment.

1. **I understand what I am supposed to do in this experiment (Uniform Circular Motion)**
2. **I understand the purpose of this lab**
3. **I understand the experimental procedure**
4. **I can understand the physics behind why this experiment works**
5. **I will enjoy this lab**
6. **I can successfully complete this lab even if it is difficult**
7. **This lab will help me understand the concepts explored in the experiment**
8. **This lab will be too hard**
9. **Time in lab today would be better spent with more lecture**
10. **Labs are an important part of learning physics**

The survey also collects demographic information

EXAMPLES

PROJECTILE LAB MANUAL

UCM VIDEO

Fig 3: [LEFT] A QR code linking to an example lab manual (projectile motion) with integrated QR codes [RIGHT] A QR code linking to an example TA created video showing experimental procedure and software use.

ADVANTAGES

Reduce time taken by introducing experiment at beginning of lab

Reduce TA instructional load of repeating procedural explanations for several lab sections and several times within each lab section

Instruction is provided at relevant times to sections of the lab manual, promoting student understanding and material retention

Students may replay instructional videos as often as needed

Improved accessibility for students with visual or auditory challenges

Aids in Lab Final preparation for students

Aids in TA professional development

Easily implementable and updatable

FUTURE WORK

- **To test the effectiveness of this method, we will ask students to volunteer in a survey throughout the Uniform Circular Motion (UCM) lab.**
- **This survey will be implemented in a calculus based introductory mechanics for engineers course, which will have the labs with the QR codes.**
- **This survey will also be implemented in traditional labs at the institution conducting the same experimental procedure with the same learning objectives, but with unchanged lab manuals.**
- **The survey consists of 10 Likert item questions in the pre-lab survey and the same 10 questions in the post-lab survey, as well as gathering course information, demographics, and how many prior physics classes the student has taken.**
- **We aim to collect more data in the Spring 2024 semester**