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# Visualizing Lenz's Law

## Physics Lesson Study '25-'26


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Facilitated By:
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# Our team

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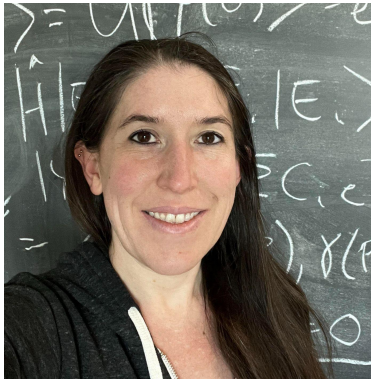

Alexandra Miller
Physics
Sonoma State

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# Choosing a Dimension

## Ourstories/Theirstories

Having the students connect the content to their own lives

## Body/Emotion

Invite our students to use their bodies as resources

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# Focal Student Interviews

Takeaway: Students did not have experience with electricity generation

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# Body and Emotion

“The body and senses matter for any real world problem.” Whether we realize it or not, we are constantly using our bodies to observe the world around us, thus our bodies serve us as an experimental tool.

In this dimension, we invite our students to use their bodies as resources to explore the content of the lesson.

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# Embodied Learning

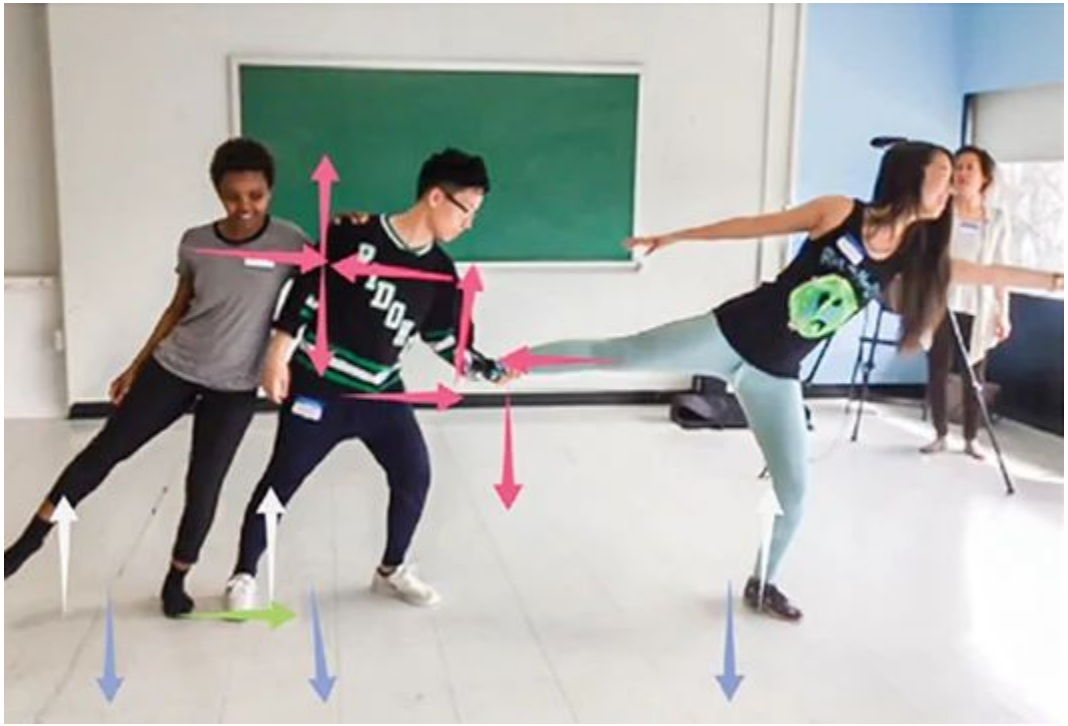

Photo: https://blog.terc.edu/embodied-learning-through-dance-and-physics
From the Embodied Physics Program"

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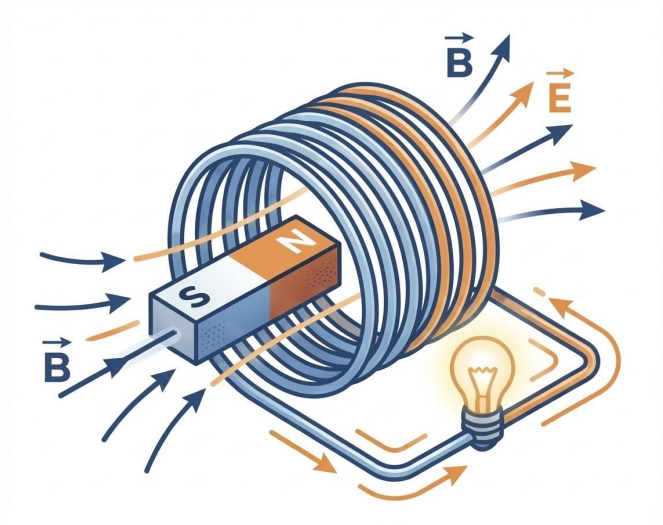
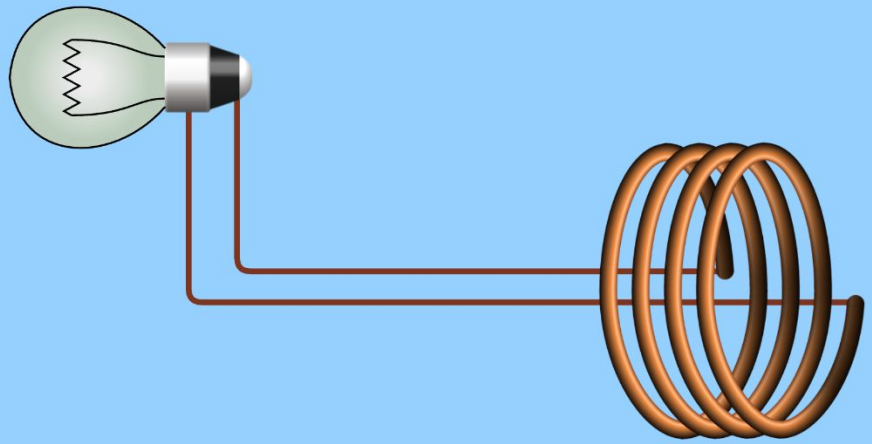
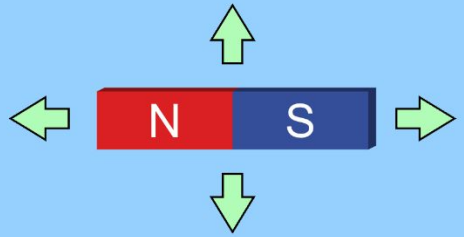
# Faraday's Law

A time-dependent magnetic field induces an electric field.

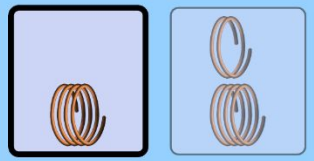


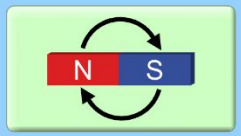





Voltmeter

Field Lines






Faraday's Law

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# Lenz's Law

A "helpful" rule to help determine the direction of a voltage induced via Faraday's Law

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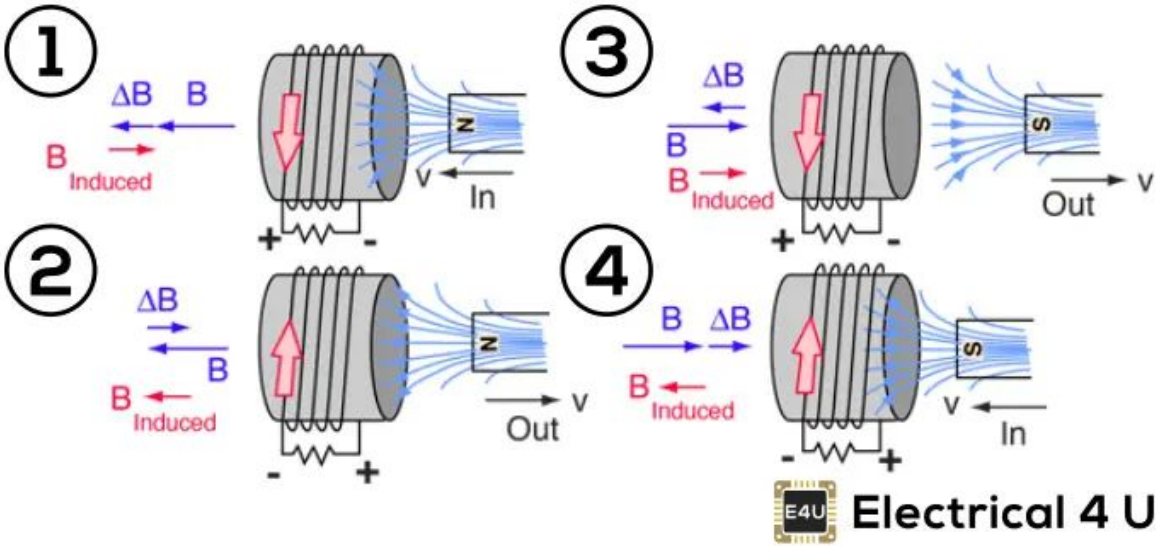
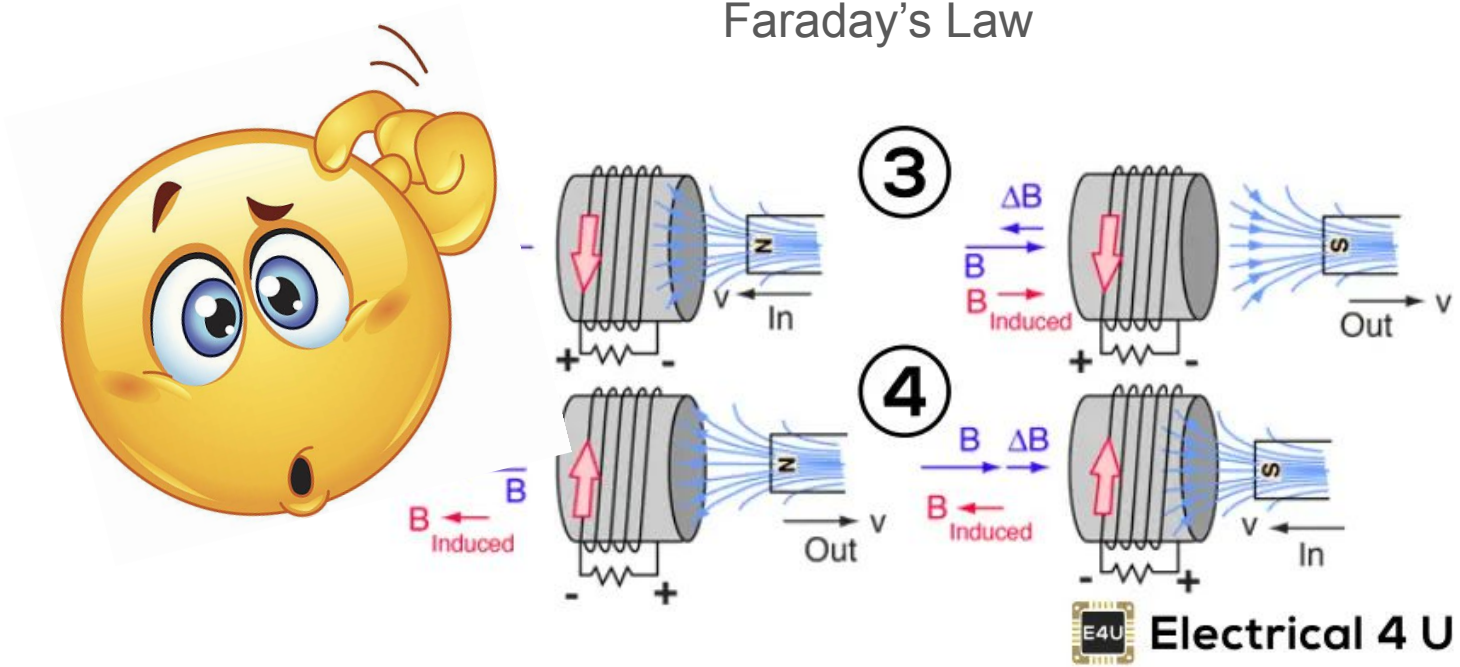
# Lenz's Law

A "helpful" rule to help determine the direction of a voltage induced via Faraday's Law



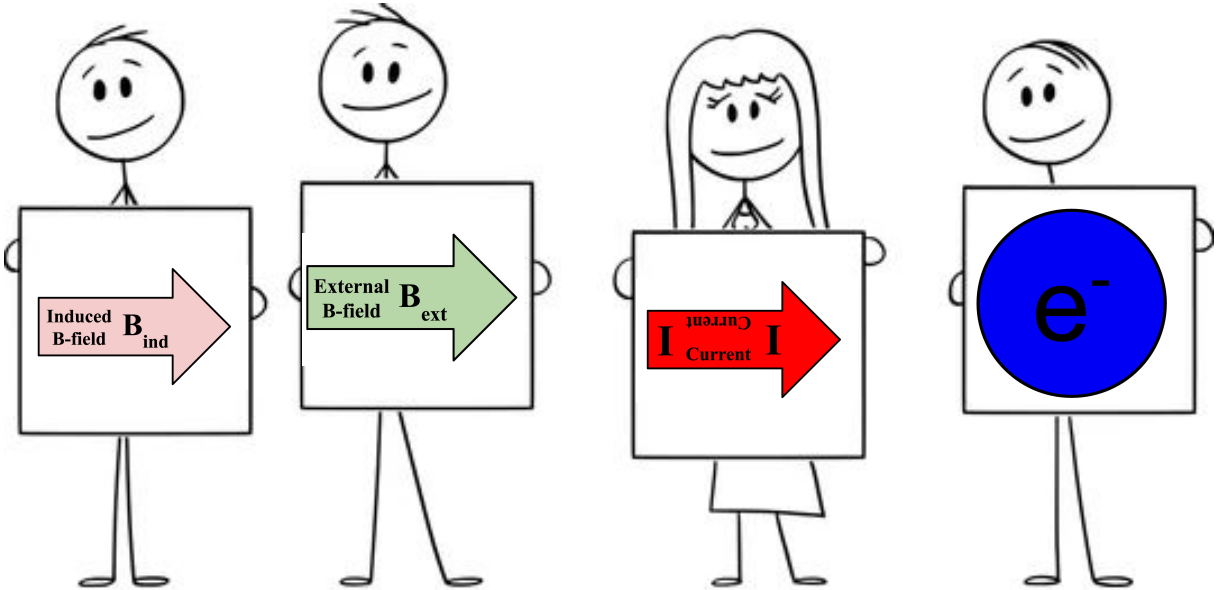
# Lenz's Law

A "helpful" rule to help determine the direction of a voltage induced via Faraday's Law



We had our students use their bodies to represent:

- The external magnetic field
- The electrons in a conducting wire
- The direction of the current in the wire
- The magnetic field sourced by the current in the wire



# Scenarios

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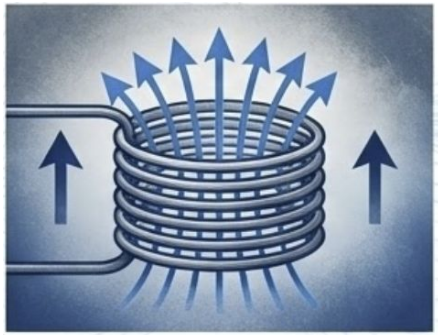
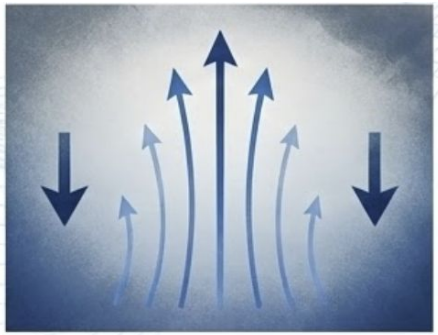
We considered various scenarios, such as:

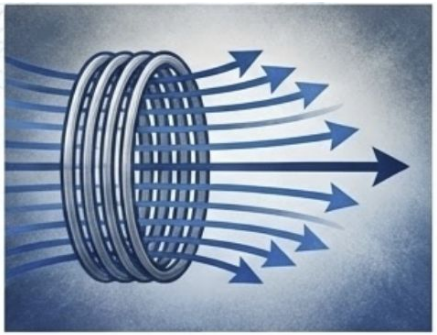
- A vertical increasing magnetic field
- A vertical decreasing magnetic field
- A horizontal increasing magnetic field
- A field with constant magnitude, but changing direction



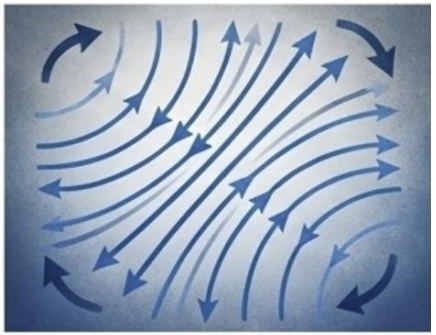
Vertical increasing magnetic field



Vertical decreasing magnetic field



Horizontal increasing magnetic field



A field with constant magnitude, but changing direction

# Sample Exercise

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# Focal Students speaking up!

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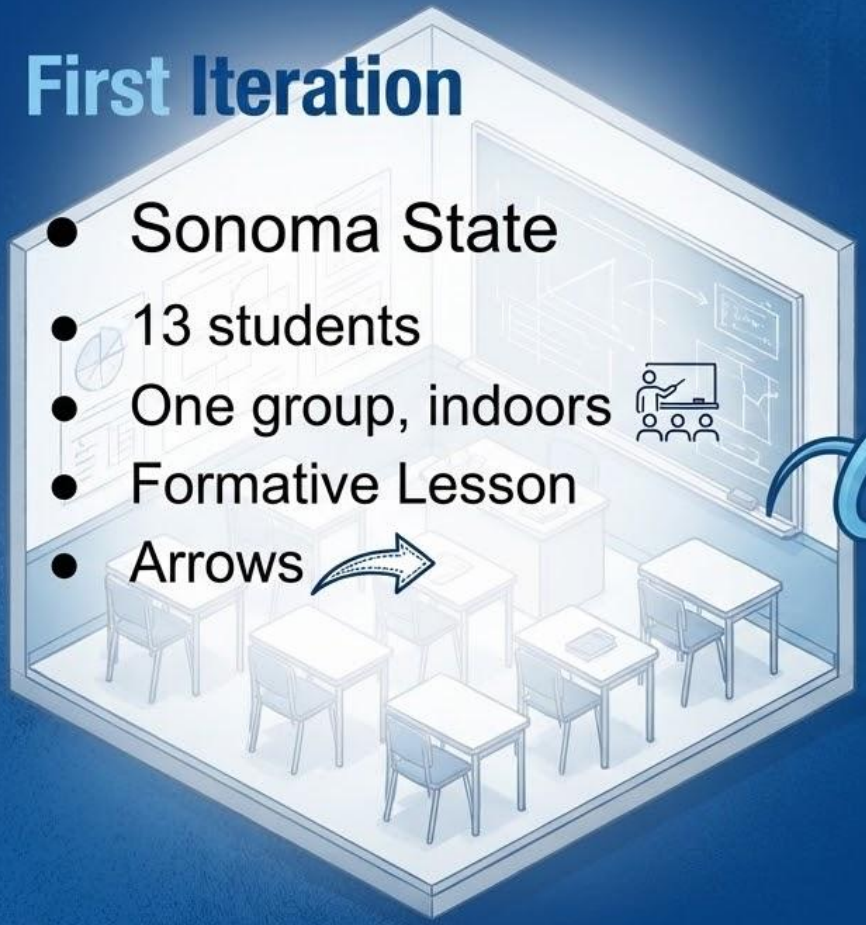
## First Iteration

- Sonoma State
- 13 students
- One group, indoors
- Formative Lesson
- Arrows



## Second Iteration

- Sac State
- **84 students!!!**
- Multiple groups, outdoors
- Competition at the end of unit
- Hats

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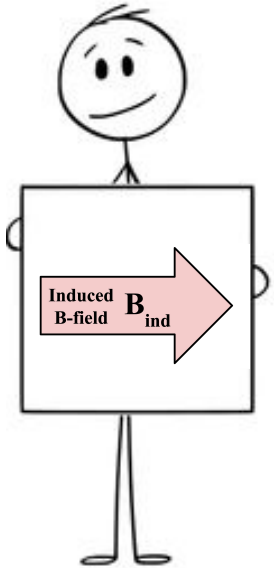
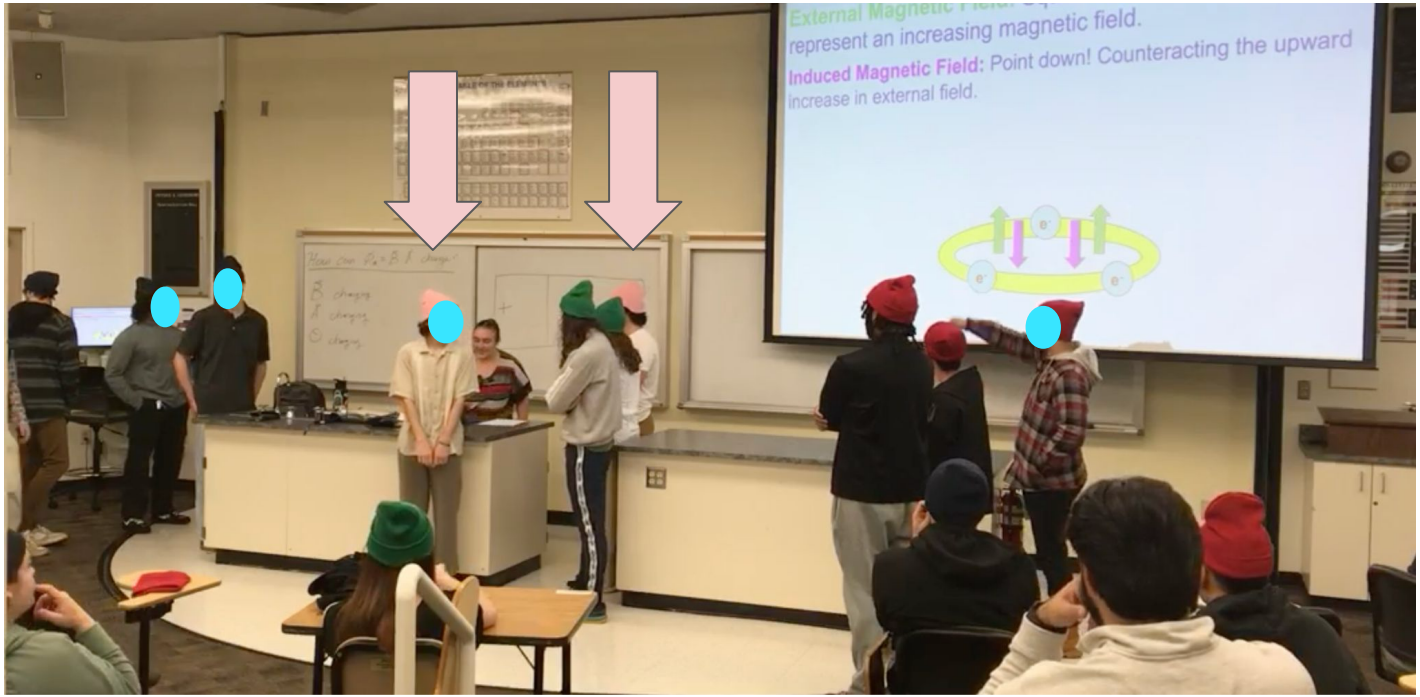
# Second Iteration



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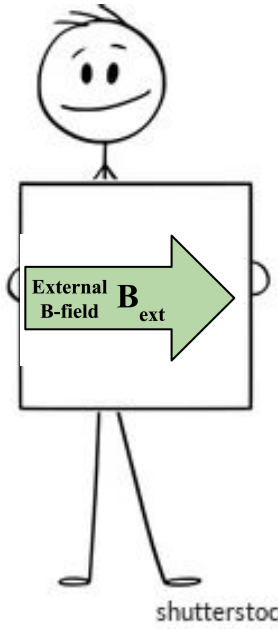
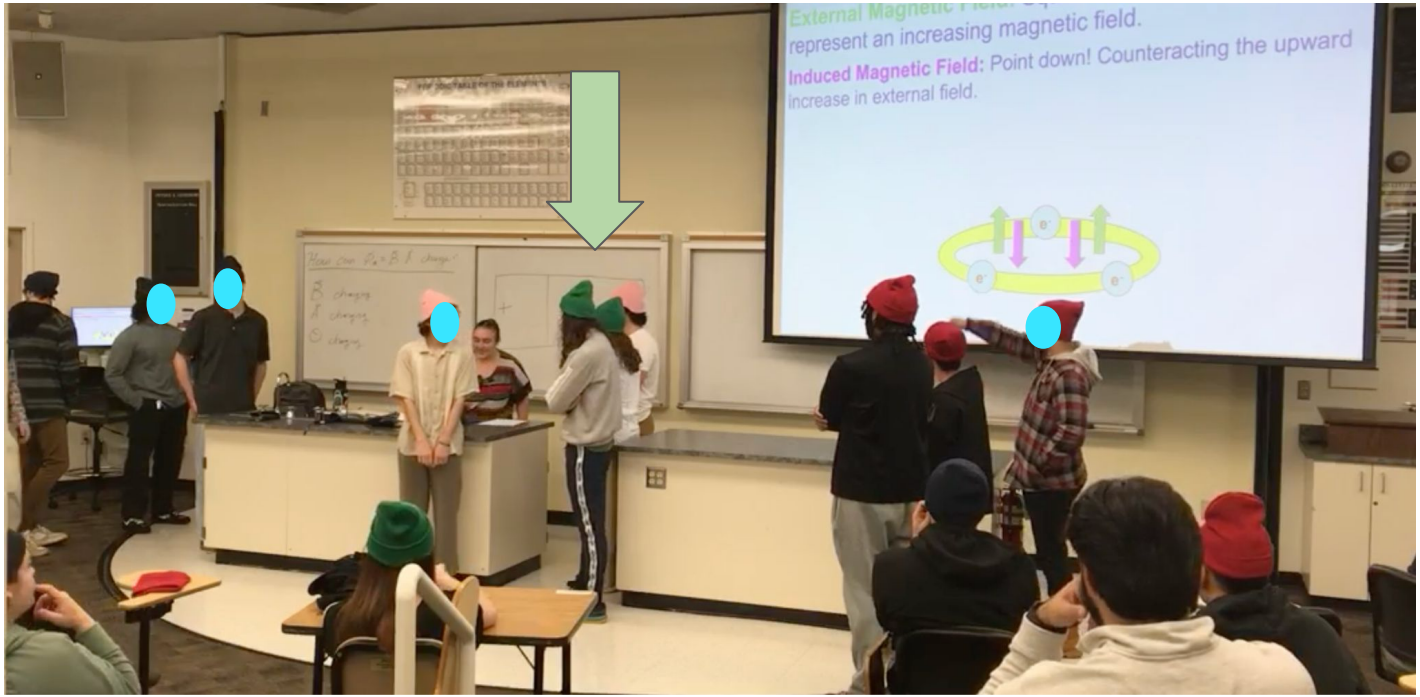
# Second Iteration



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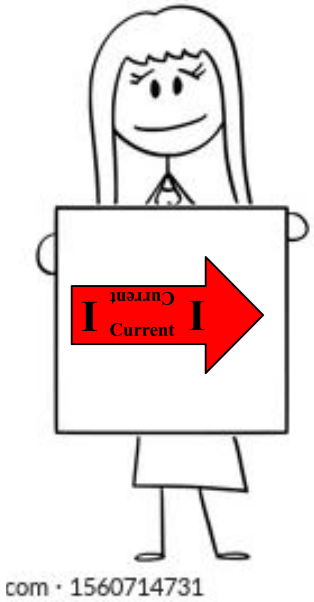


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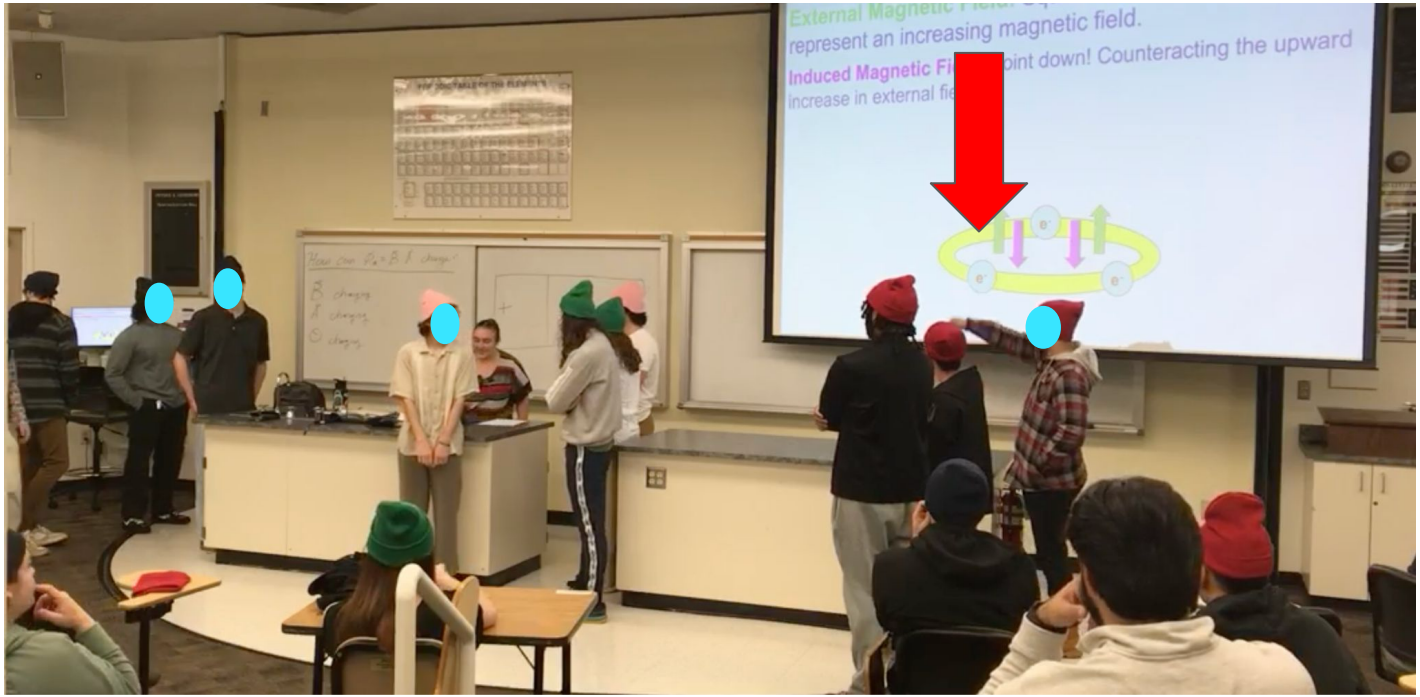

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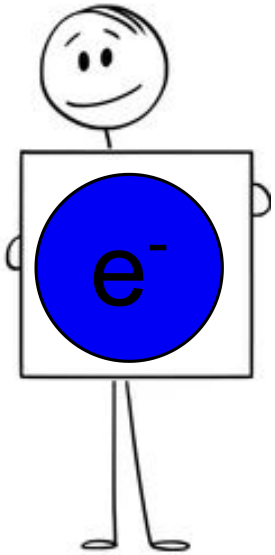
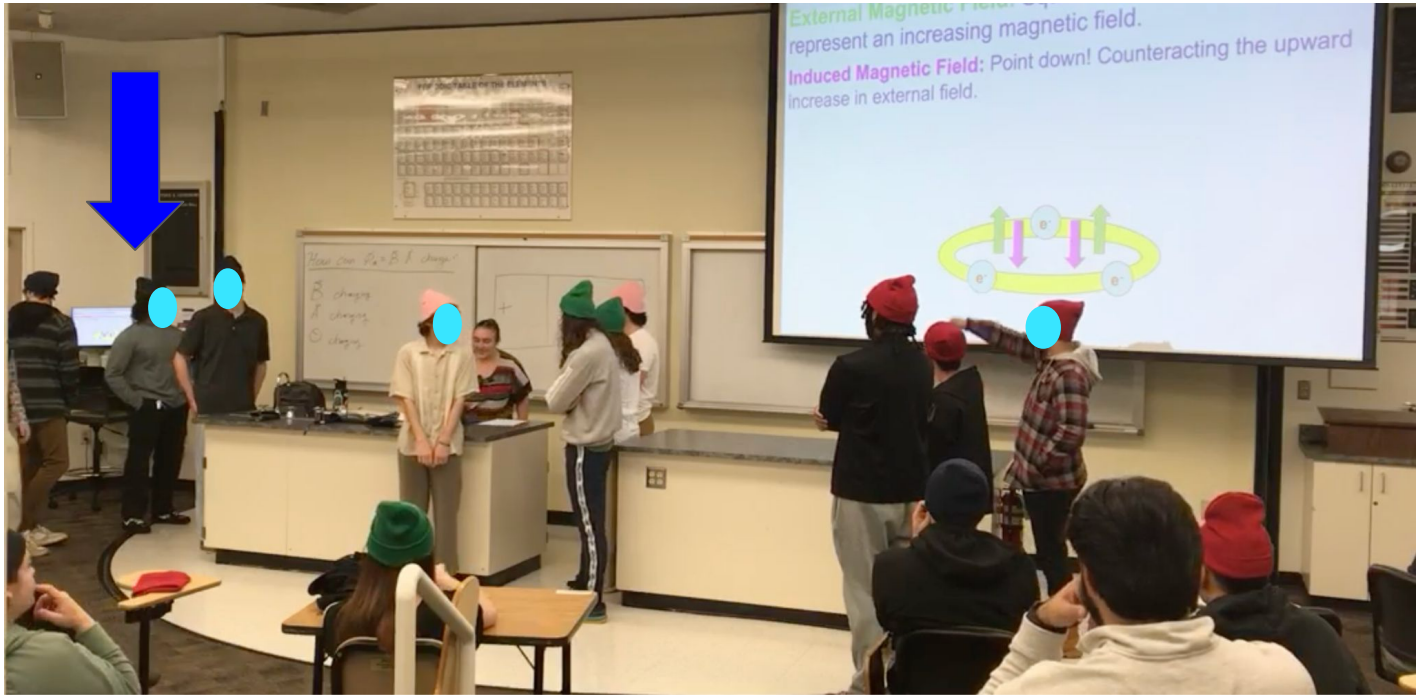
# Second Iteration



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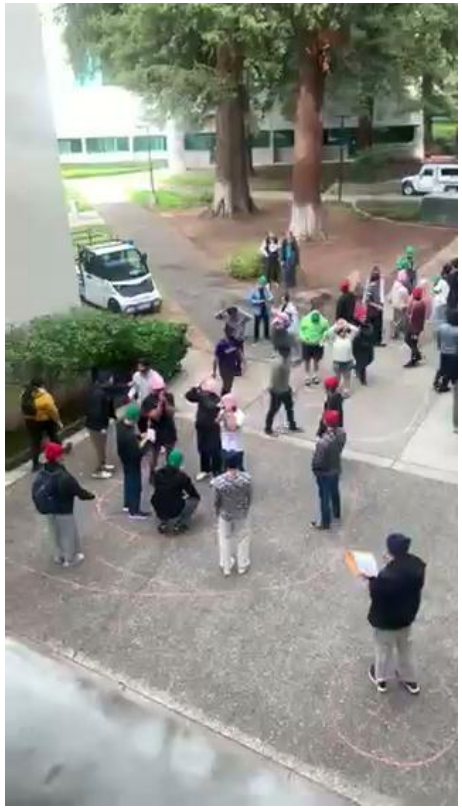
# Second Iteration



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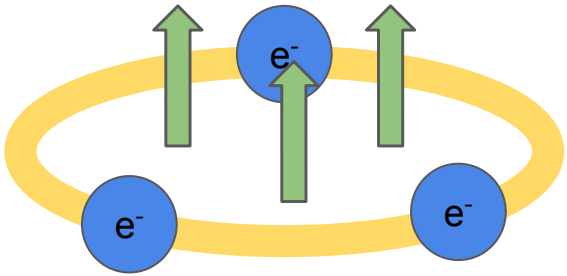
# Second Iteration - Discovering AC Current

External Magnetic Field: Point your arrows straight up, reaching your arm out. Then slowly lower your arm up all the way until it points downward. Then slowly lift your arm back so that it is pointing straight up. Repeat this motion continuously



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# Second Iteration - Discovering AC Current

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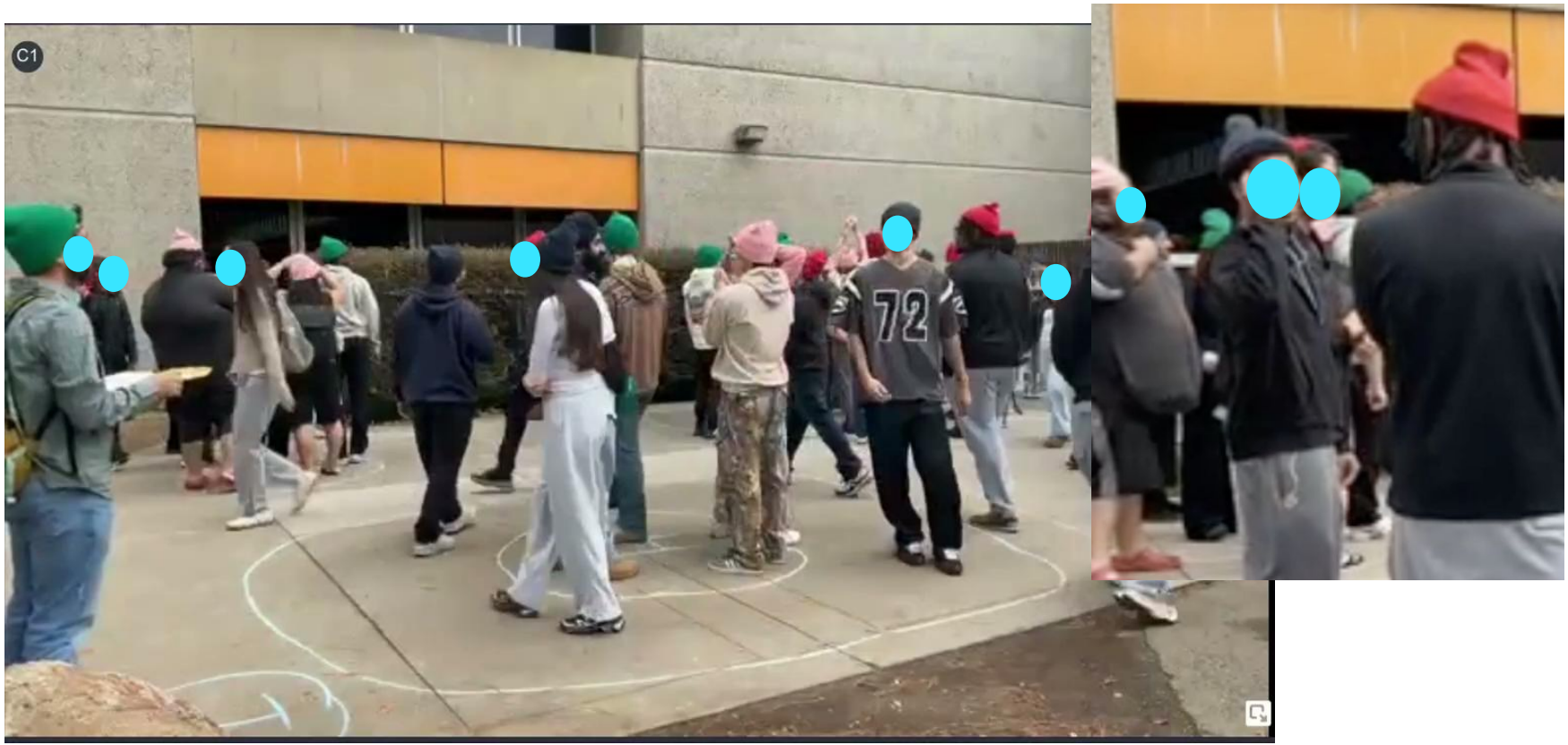

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# Our observations of how it went

## First Iteration

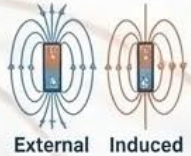
### Successes

- Focal Students spoke up!
- Helped students with the right hand rule

### Improvements

- Letters for groups were unnecessary.
- Instructor felt she was talking more than students

## Second Iteration




### Successes

- Students spoke up!
- Helped students differentiate between external and induced fields

### Improvements

- Without switching some students were less engaged
- Couldn’t complete the full set

# Engagement Survey

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During this activity: I felt happy.

- ✔ YES!
- ✔ yes
- ✘ no
- ✘ NO!

# Engagement Survey Results

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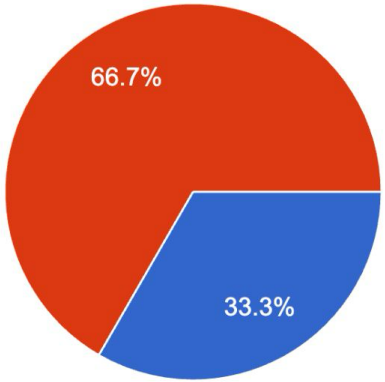
## 1st Iteration

During this activity: I felt happy.

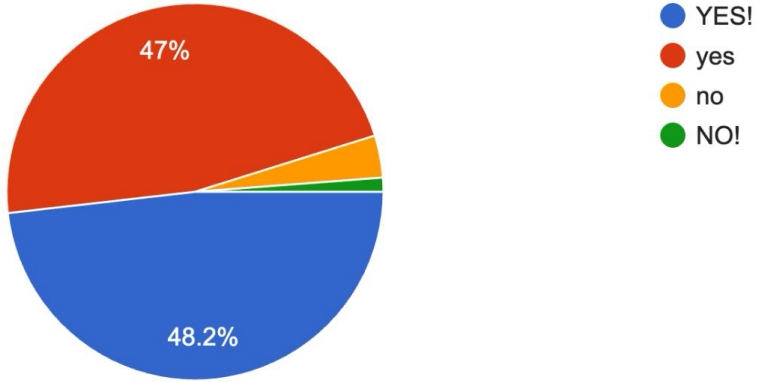
9 responses




## 2nd Iteration

During this activity: I felt happy.

83 responses



# Engagement Survey Results

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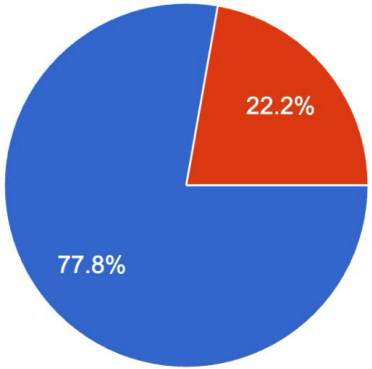
## 1st Iteration

During this activity: I felt intrigued and engaged.

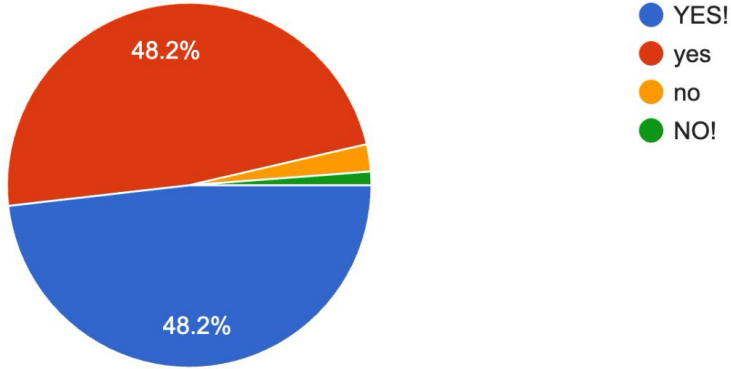
9 responses




## 2nd Iteration

During this activity: I felt intrigued and engaged.

83 responses



# Engagement Survey Results

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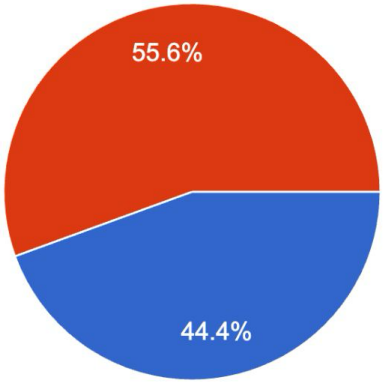
## 1st Iteration

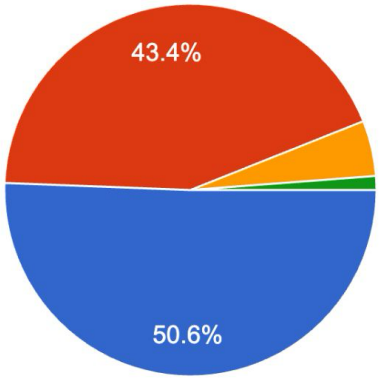
## 2nd Iteration

Physically engaging in the activity helped me to better visualize the scenario.

9 responses




83 responses




# Engagement Survey Results

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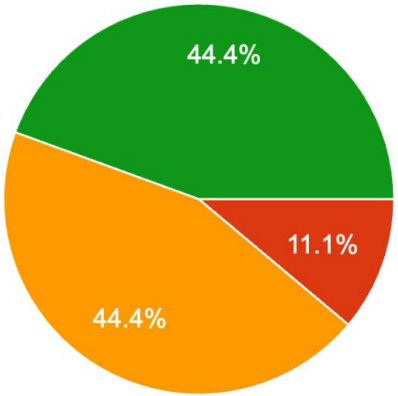
## 1st Iteration

I'm more confused than before the activity.

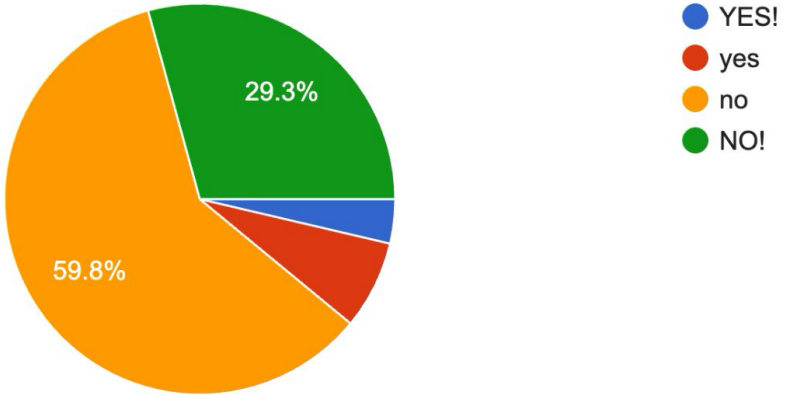
9 responses




## 2nd Iteration

I'm more confused than before the activity.

82 responses



# Engagement Survey Results

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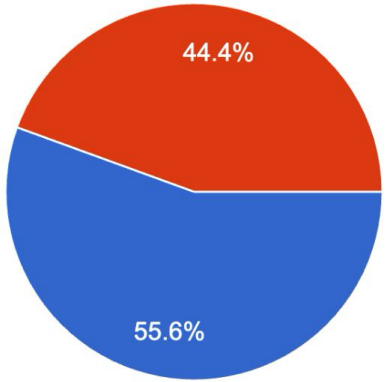
## 1st Iteration

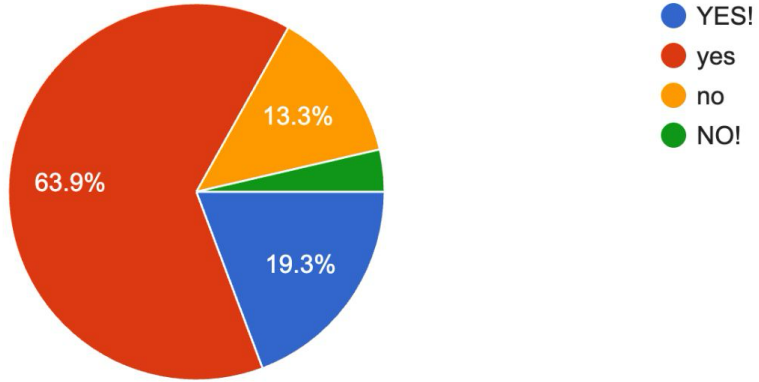
## 2nd Iteration

During the activity, I felt my voice was heard when I wanted to share.

9 responses




83 responses



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# Positive Feedback from Students

"This was notably helpful for visualizing the concepts involved"

"It was fun and entertaining. Honestly a nice change of pace from the usually class session."

"Loved every part of it and it helped me fully understand the concept"

"It was fun, a great physical representation of the Law in action."

"I would suggest doing more physical and outdoor lessons wherever possible. My favorite lesson of the semester!"

"This was the fastest I have learned information for this class, period. No other form of teaching has taught me a concept as fast"

"definitely more fun than clicker questions."

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# Constructive Feedback from Students

## Anxiety & Knowledge Gaps

The activity was very fun, but at times I would feel anxious as a result of my lack of knowledge and not being able to contribute as well as others did during the activity."

## Desire for More Time

I wish we could have done this during the lab so that we would have had more time to go through it. (Multiple comments like this in 2nd iteration)

## Need for Note-Taking

"I wish we were able to also take notes inbetween the senarios because i will forget"

## Role Inequality

I felt there was inequality in the engagement required for each of the roles and so people should have maybe switched roles part way through a couple times."

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# What went well

- Students were **engaged** and generally having fun!
- We saw an increase in focal student participation and **leadership**!

# Where we can improve

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## Changing Roles

Helped all students stay engaged

## Lab Setting & Time

Perhaps a lab setting or longer lecture class might be preferable for sufficient time

## Note-Taking

Students wanted to take notes during the activity

## Investigating Learning

Further investigate if students actually learned more

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# Thank you!

## For follow-up questions and comments please contact:


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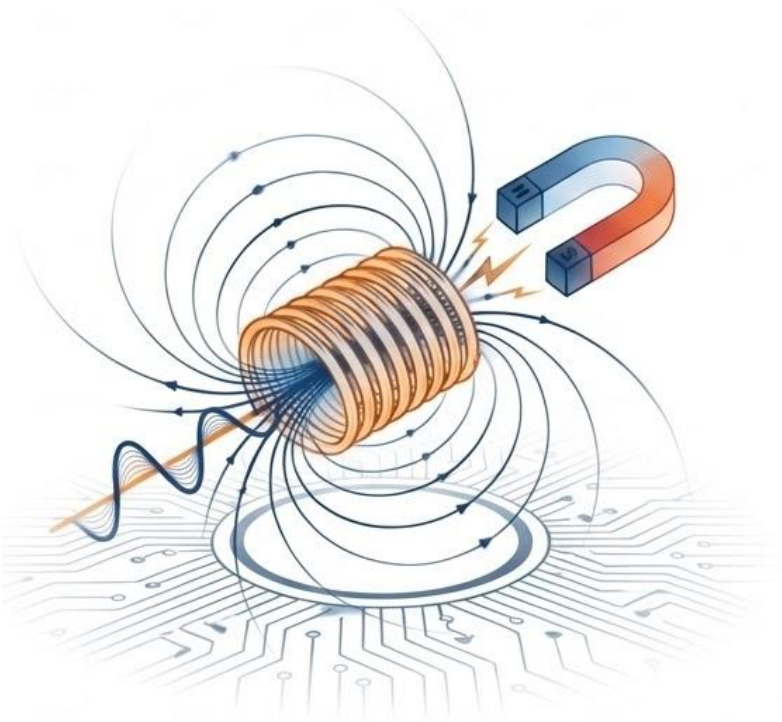


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