Learning Induction With Ease is Now An (Augmented) Reality!

By:Christian Montero, Nick Giordano, Shannon Sweet, Dr. Michele McColgan

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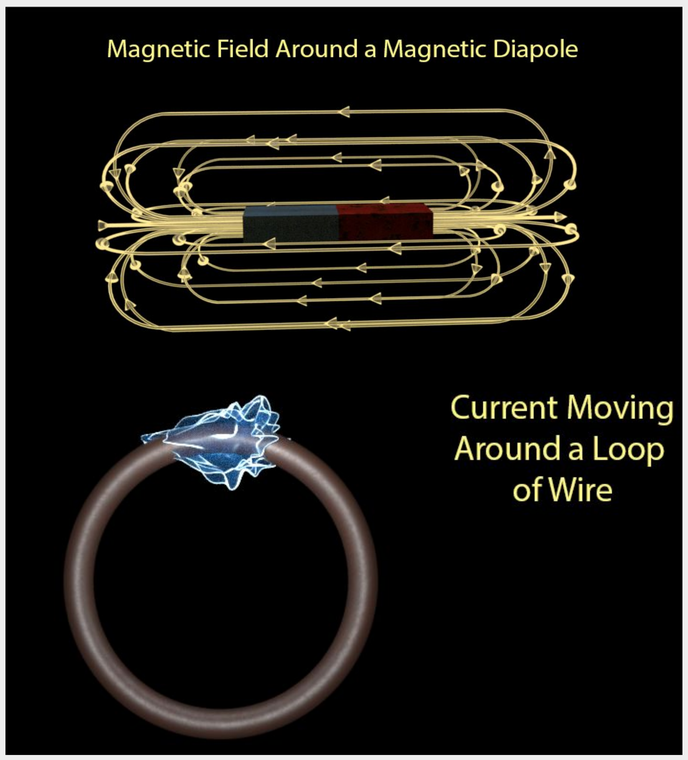
Introduction

Conceptualizing 3D interactions between electric charge and magnetic fields is difficult for students. In order to make this concept easier to understand an augmented reality app was designed to create a 3D visualization of induction. Augmented Reality (AR) makes objects that aren't physically there, viewable through a device, like a smartphone.

A lesson plan, and worksheets were created to accompany the app.

Software

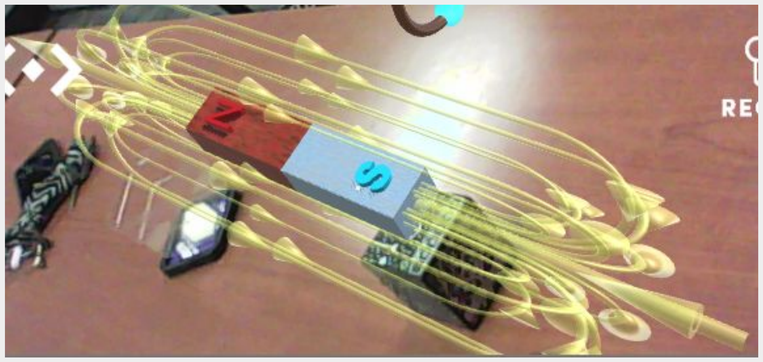
- Blender
  - Makes detailed objects, and allows for the application of detailed textures.
- Unity
  - Manipulate objects to demonstrate physics concepts
- Vuforia
  - Used to allow the virtual object to be tracked by an image or the merge cube



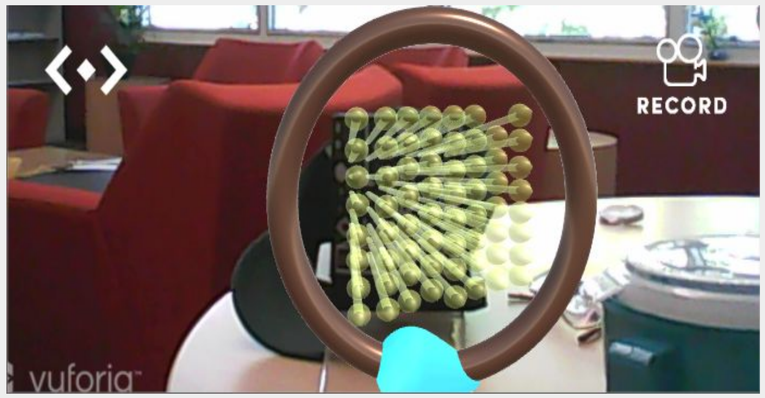
*Images created in Blender.

Procedure

Research was done to understand how Unity and Blender work. Then, a simple video of induction was created on Unity. After that, a more hands on visual was created where students could move an augmented reality image of a copper ring towards a magnetic field.



*Video visual



*Hands on version

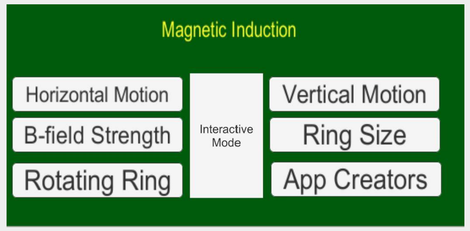
Induction

There are four types of electromagnetic induction taught in a physics classroom. The first two we show involve using a magnetic dipole and a ring of copper wire. The ring moves both horizontally near the north and south ends of the magnet, as well as moving vertically through the straightest portions of the field lines. In both cases a current is shown to move around the ring of wire either clockwise or counterclockwise. The other two methods of induction are increasing/decreasing the magnetic field strength and changing the size of the ring in a fixed magnetic field. These methods also induce a current in the wire that moves either clockwise or counter clockwise.

Merge Cube

- A foam cube with a different design on each side for the computer or phone to recognize.
- The cube can be used to track objects onto the cube.
- The Merge Cube is manufactured by Merge Virtual Reality

*To the left is the merge cube. Below is the home screen to the app we created.



Future Work

- Continue writing instructions for teachers.
- Improve small problems in our original app.
- Create a 3D visualization for harmonic motion on a spring.

References

Unity Technologies. (2018 September 7). "Unity3D". Retrieved September 8, 2018. from https://unity3d.com/

Unity Technologies (2018, September 7). "Get Unity - Download Archive". Retrieved September 8, 2018. from https://unity3d.com/get-unity/download/archive

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notes

Ideas:
There are 3 panels, have first as intro to ar, second to introduce apps(topic and ar) with merge cube, third have how it will be implemented into classroom
Change pictures in the middle to be for area vectors and Spherical induction

Learning Physics With Augmented Reality

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Introduction

Conceptualizing 3D physics concepts can be difficult for students. In order to make them easier to understand, augmented reality apps were designed to create a 3D visualization of induction, area vectors, and integration. Augmented Reality (AR) makes objects in a real world setting that aren't physically there, viewable through a device, like a smartphone.

A lesson plan and worksheets were created to accompany the app.

Link: https://bit.ly/2RyuZ6E

Software

- **Tinkercad**
  - Makes objects quickly for easy development.
- **Unity**
  - Manipulate, add texture, and program objects to demonstrate physics concepts
- **Vuforia**
  - Used to allow the virtual object to be tracked by an image or the merge cube

Topics

Induction

Magnetic dipoles produce fields that are depicted as field lines. When a copper ring enters or leaves the field depending on the direction of the field, a current can be produced. Either the current flows in a clockwise or counterclockwise direction.
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Area Vectors

Vectors that represent the different areas of figures which are perpendicular to those areas. Visuals in the app include different shapes (quarter cylinder, nested sphere, hollow sphere) with their labeled area vectors.

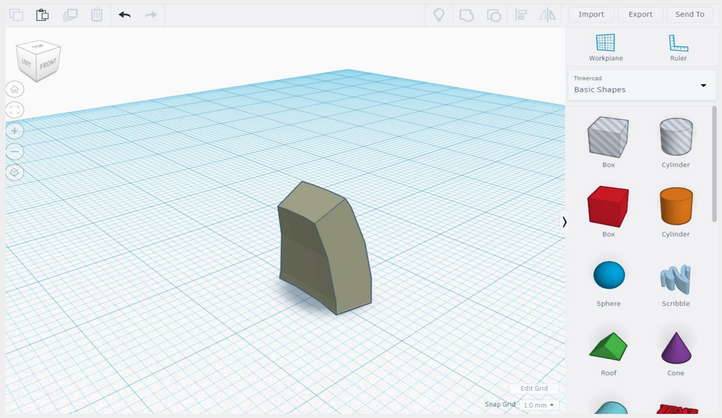
Integration

Visualizing and solving integrals in cartesian, cylindrical, and spherical coordinates. Visuals in the app include a cube for cartesian coordinates, a cylinder for cylindrical coordinates, and a sphere for spherical coordinates. Pieces of the cylinder and sphere (volume elements) were included to help visualize the axes of cylindrical and spherical coordinates.

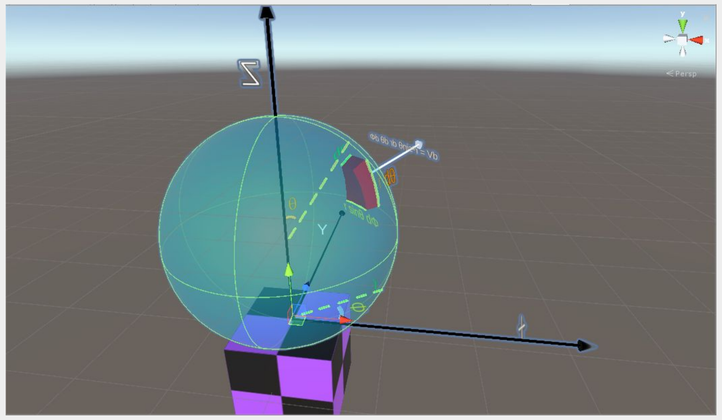
Procedure

Objects were made in tinkercad and imported over to unity where they were manipulated and animated. Scripts assisted in adding functionality to animations. Then a User Interface (UI) was then made to navigate through the apps and play the animations.

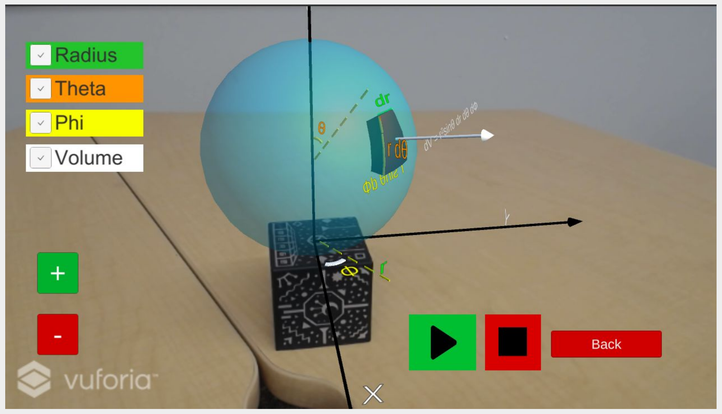
Tinkercad Editing Screen (making the sphere piece)



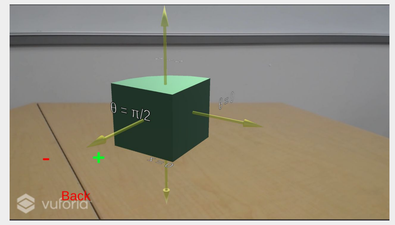
Unity Editing Screen (with imported sphere piece)



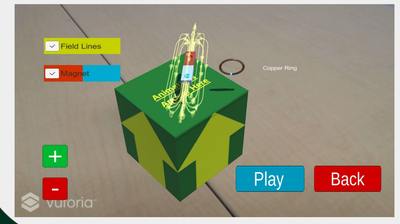
Final AR Image Screen (with user interface)



AR Screens



Area Vector App (Quarter Cylinder)



Induction App (Magnetic Dipole with Copper Ring)

Merge Cube

A foam cube with a different design on each side for the computer or phone to recognize. The cube can be used to track objects onto the cube. The Merge Cube is manufactured by Merge Virtual Reality.

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Future Work

- Continue writing lesson plans for teachers.
- Improve small problems in our original apps.
- Create 3D visualizations for other topics

References

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Software

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Topics

Torque

Being a vector quantity, we can use the right hand rule to determine the direction of the torque vector about an axis. Components of torque include applied forces, radii, angles, angular acceleration and moment of inertia.

Circular Motion

The movement of an object in a circular path or about the circumference of a circle. The object can be moving at a constant speed and acceleration in uniform circular motion or the object can also change the rate of acceleration in non-uniform circular motion.

Moment of Inertia

Dependant on the mass distribution of an object, moment of inertia is a scalar quantity that determines the torque needed for a certain angular acceleration about a chosen axis of rotation.

Procedure

Objects were made in tinkercad and imported over to Unity where they were manipulated and animated. Scripts assisted in adding functionality to animations. Then a User Interface (UI) was then made to navigate through the apps and play the animations.

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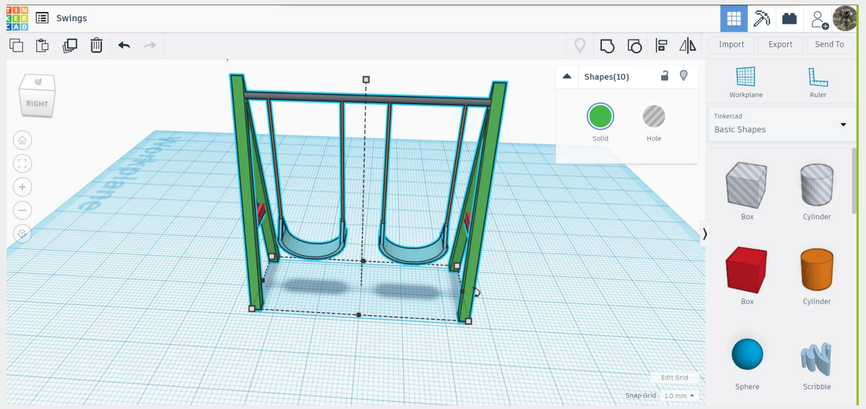
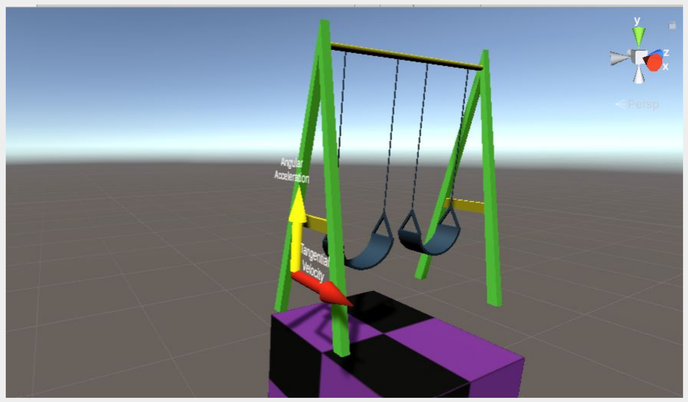


Unity Editing Screen (with imported Swings)



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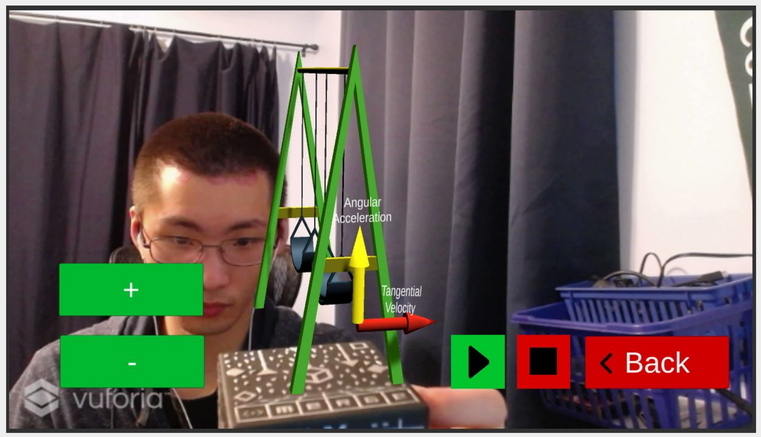
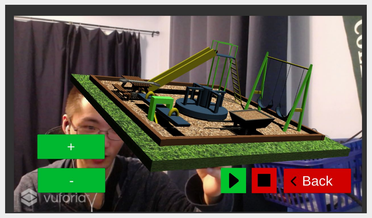
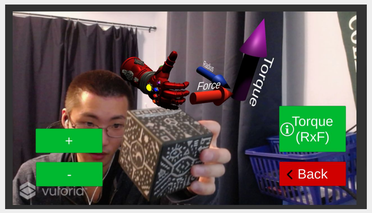


AR Screens



Physics Park



Right Hand Rule

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Future Work

- Further clarification of AR objects to concepts
- Develop curriculum materials for the app
- Push app to store
- Projectiles, forces, Electric/magnetic field, dot and cross product, right-hand-rule, relativity

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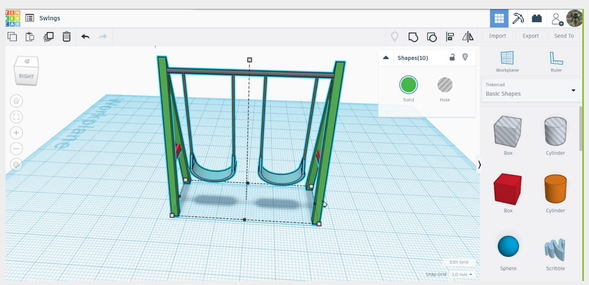

2. **Unity Editing Screen** (with imported Swings)
3. **Final AR Image Screen** (with user interface)

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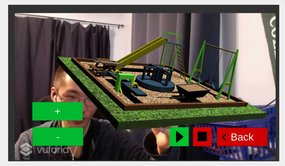

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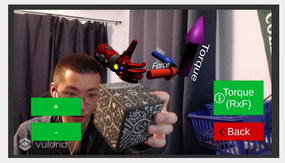

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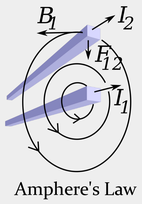
Topics

Ampere's Law

The relationship between magnetic fields and electric currents expressed as B. The electric field is dependent on whether the current carrying wire is inside or outside of the magnetic field.

Optical Lenses

The manipulation of light rays when hitting a surface of an object can be demonstrated with different optical properties. Magnification uses lenses and manipulates the light rays to be larger than the real object. Lenses can invert the object on an axis for use with other lenses.



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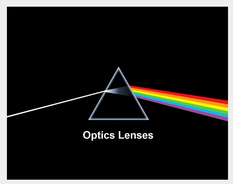

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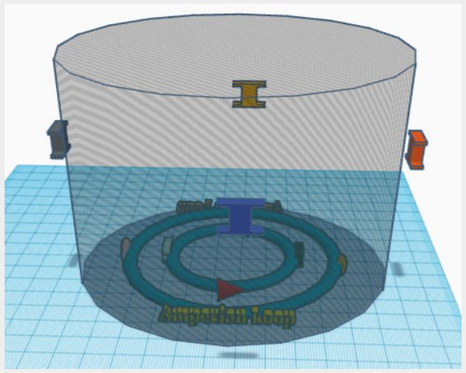
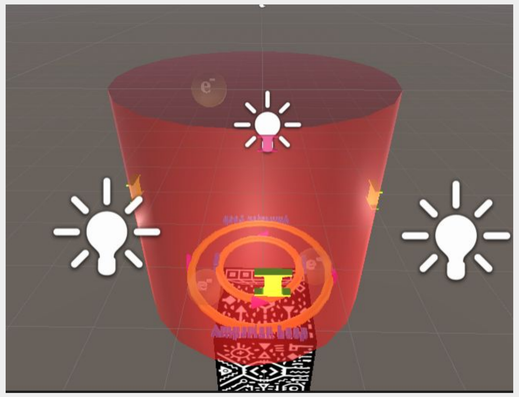
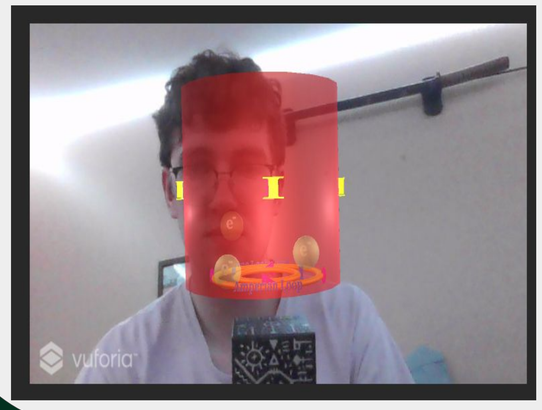


Unity Editing Screen (with imported Swings)



Final AR Image Screen (with user interface)



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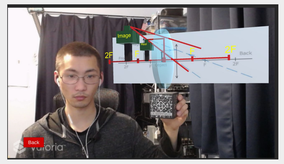
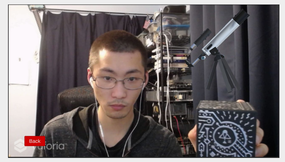


Magnification



Telescope

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Future Work

- Further clarification of AR objects to concepts
- Develop curriculum materials for the app
- More optic concepts or topics developed
- More interaction from user within app
- More developed graphics

References

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Learning Physics With Augmented Reality

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Introduction

Conceptualizing 3D physics concepts can be difficult for students. In order to make them easier to understand, augmented reality apps were designed to create a 3D visualization of torque, circular motion, and moment of inertia. Augmented Reality (AR) makes objects in a real-world settings that aren't physically there, viewable through a device, like a smartphone or laptop.

Software

- **Tinkercad**
  - Makes objects quickly for easy development.
- **Unity**
  - Manipulate, add texture, and program objects to demonstrate physics concepts
- **Vuforia**
  - Used to allow the virtual object to be tracked by an image or the merge cube

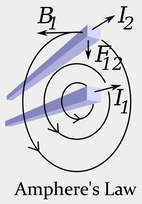
Topics

Ampere's Law

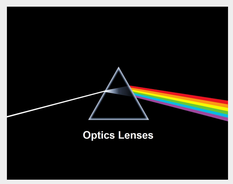
The relationship between magnetic fields and electric currents expressed as B. The electric field is dependent on whether the current carrying wire is inside or outside of the magnetic field.

Optical Lenses

The manipulation of light rays when hitting a surface of an object can be demonstrated with different optical properties. Magnification uses lenses and manipulates the light rays to be larger than the real object. Lenses can invert the object on an axis for use with other lenses.



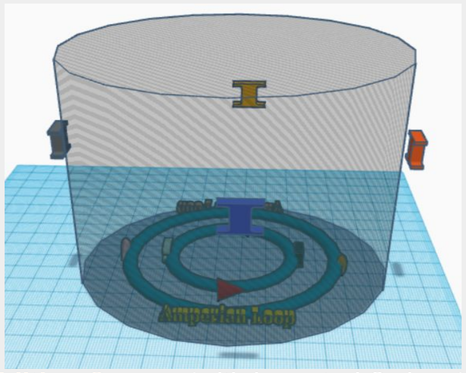
Amphere's Law



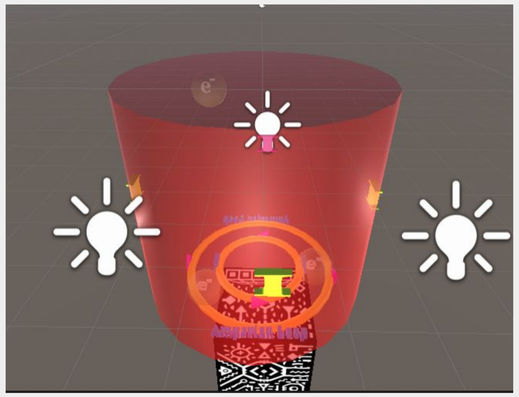
Procedure

Objects were made in tinkercad and imported over to Unity where they were manipulated and animated. Scripts assisted in adding functionality to animations. Then a User Interface (UI) was then made to navigate through the apps and play the animations.

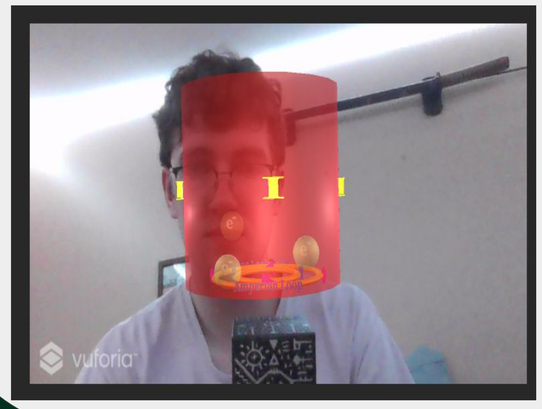
Tinkercad Editing Screen (making the Swings)



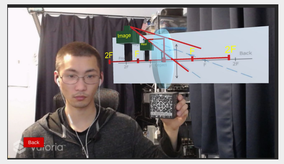
Unity Editing Screen (with imported Swings)



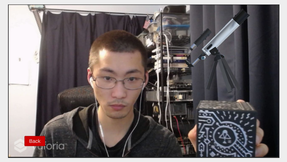
Final AR Image Screen (with user interface)



AR Screens



Magnification



Telescope

Merge Cube

A foam cube with a different design on each side for the computer or phone to recognize. The cube can be used to track objects onto the cube. The Merge Cube is manufactured by Merge Labs.

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Future Work

- Further clarification of AR objects to concepts
- Develop curriculum materials for the app
- More optic concepts or topics developed
- More interaction from user within app
- More developed graphics

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