Illuminating Apps for Fourth Grade

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Abstract:

Elementary science is chock-full of wonderful experiences for students. Do children see iPads as a tool for learning about science? Using Prensky (2010) as a guide, the researchers decided to see if *assessing students with their own* tools (p.178) using iPad apps would support learning discrete knowledge for electricity and light content. The intent of the study was to determine in what way(s) apps could adequately lead students to scientific understanding.

The population is two fourth grade classes set in a school that are 95% white, 50% free/ reduced lunch program, and scoring 65% proficient on state testing. Using both experiential and iPad app elements, the researchers analyzed student performance with Fourth Grade Kentucky Core Content (KCCT) and Next Generation Science Standards (NGSS) electricity and light content. Results with students taking both pre and post-tests (N=14) indicated the use of apps influenced student understanding of electricity and light.

Introduction

Do children see iPads as a tool for learning about science? Children use iPads for everything from learning their ABC's to practicing handwriting to exploring the stars. What can iPads lend from app manipulation to transfer of learning in real-world understanding? Apps can create self-assessment and demonstrate appropriate science concepts. Would use of iPad apps support learning discrete knowledge for electricity and light (Prensky, 2010, p. 178)? The intent of the study was to identify grade and content appropriate apps which would support learning for Next Generation Science Standards 4-PS3 Energy and 4-PS4 Waves and their Applications in Technologies for Information Transfer. Results with students taking both pre- and post-tests

(N=14) indicated by verbatim recitation and/or drawing of graphics that the use of apps assisted appropriate student understanding of electricity and light performance expectations.

Case Study Design

Our population was two typical fourth grade classes set in a school that was 95% white, 50% free/ reduced lunch program, and scoring 65% proficient on state testing. Both classes had the same teacher for science. Due to circumstances beyond the control of the researchers, separate control and experimental groups could not be established. iPads have been very lightly used in this school system for support of content. None of the students in this study had used iPads in a school setting. Students received iPads with a specific app in three class periods and science experiment stations in alternate weeks in three class periods for ten to twenty minutes during science class. Apps were always presented first to students.

Students explored electricity and light reflection/refraction through traditional hands-on experiment stations and iPad app exploration elements. The lessons utilized Fourth Grade Kentucky Core Content (KCCT) and Next Generation Science Standards (NGSS) electricity and light content as Kentucky was transitioning to NGSS. Of the apps tested, the following were found to best support the NGSS for Fourth Grade Curriculum: *Bobo Explores Light, Circuit GoGo, and Simple Circuits*.

There were ten non-district iPads available for class use. Few free apps for physical sciences applied to our instructional sequence. Cost being a factor, iCloud was a good option to accommodate multiple purchases. iCloud is an Apple service on which ten devices, iPad II and above, can simultaneously share apps. This greatly decreased costs while allowing all devices to have the same app. It is tied to a specific iTunes account with apps residing in the owner's cloud. There is a distinct advantage to using iCloud in that the teacher could present apps or upgrade easily.

The NGSS Standards addressed were:

Standards: [**4-PS3** Energy; **4-PS4** Waves and their Applications in Technologies for Information Transfer]

Performance Expectation: [**4-PS3-2**]: Make observations regarding evidence that factors such as water may affect perception of light waves

Science and Engineering Practices: Engineers improve existing technologies or develop new ones

[**Planning and conducting investigations**]

Disciplinary Core Ideas

[**PS3-B**: Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced; Light also transfers energy from place to place; Energy can also be transferred place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The current may have been produced to begin with by transforming the energy of motion into electrical energy; **PS3-C**: Collision with a force may affect the direction of the energy; **PS4-B**: An object can be seen when light reflected from its surface enters the eye.]

Crosscutting Concepts

[**Cause and effect: Cause and effect relationships are routinely identified**]

Apps and Experiments

Circuits

Prior to the lesson, students independently explored *Circuit GoGo* and *Simple Circuit*. *Circuit GoGo* is a game format in which students must complete circuits to build specific items. Students must drag the pieces of the circuit to the correct space to build an item such as a flashlight or a lamp. Robots help throughout the game, and the challenges get more difficult as students progress through the levels. This game helps students to see that circuits must be completely connected in order for electricity to flow.

Circuit GoGo was explored prior to circuit activity. Students were able to create both series and parallel circuits. Parallel circuits were the most difficult for students to comprehend. The app is free.

In *Simple Circuits*, students create a circuit using wires, switches, fans, light bulbs, etc. There are even toys that they can include in their circuit that will move if the circuit is correct. There is a free play mode in which students can build their own circuits. Students can also play a game in which there is a model circuit that they must complete. The bulbs glow at less intensity if there are more bulbs in the circuit, and students can see the flow of energy throughout the circuit. This app costs $1.99.

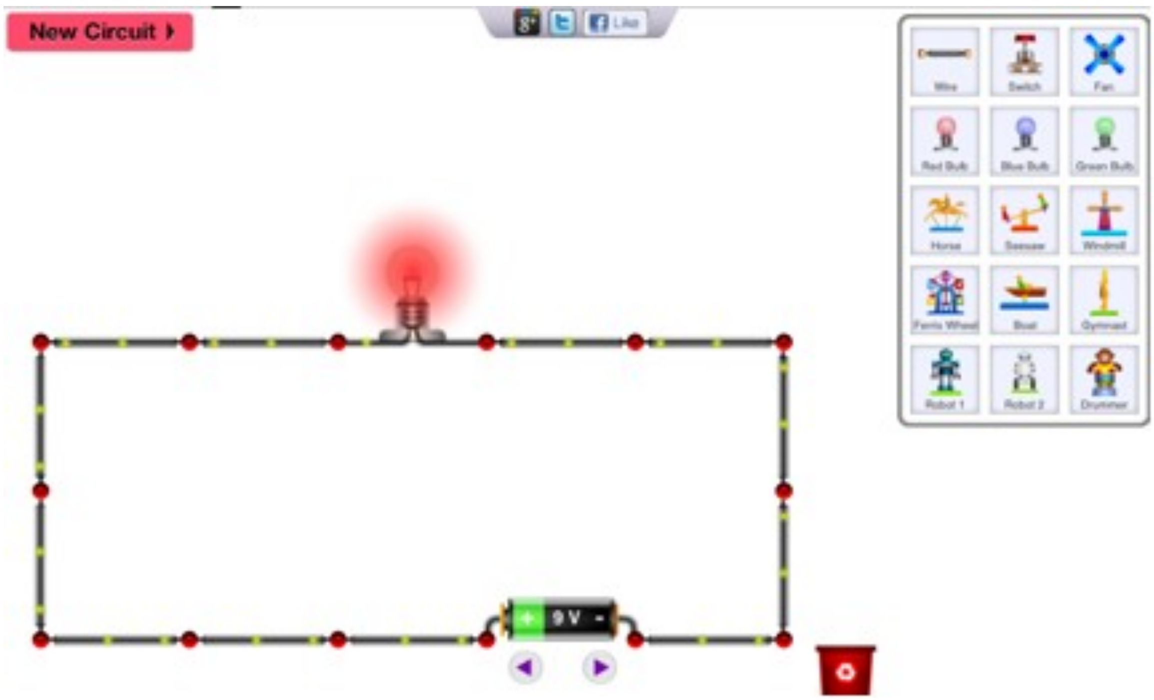

Figure 1: Screen Capture *Simple Circuits* serial circuit template is a product of IL & FS Education

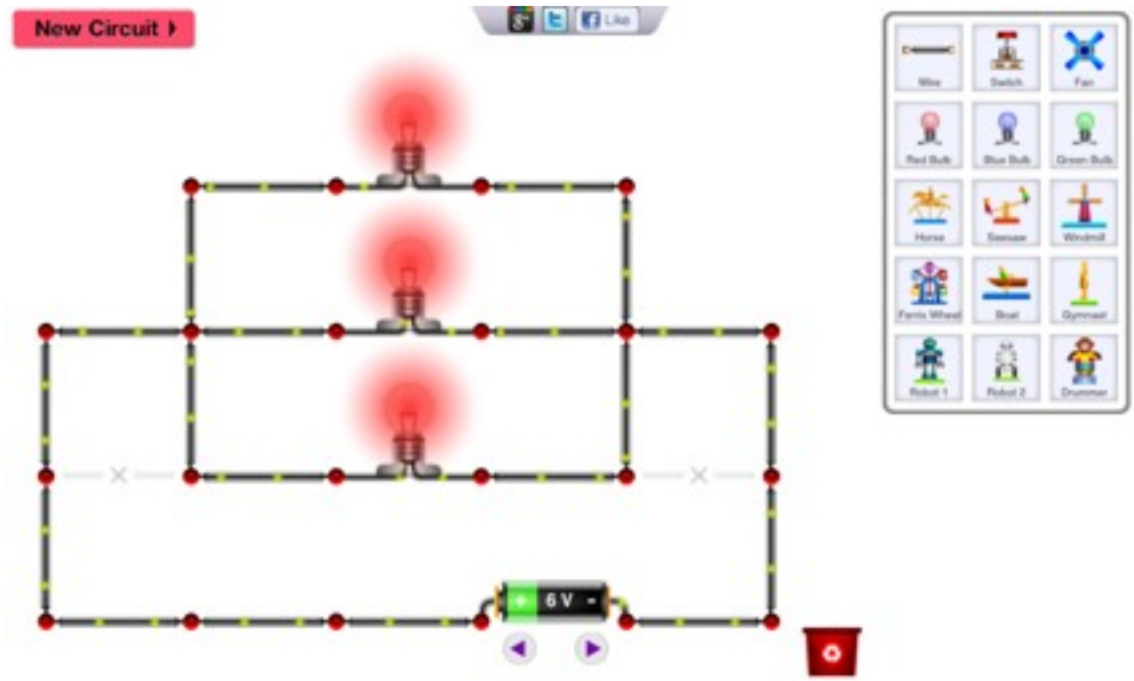

Figure 2: Screen Capture *Simple Circuits* parallel circuit template is a product of IL & FS Education

The first guided lesson in the sequence presented hands-on experience with electrical circuit construction. Students were paired as they entered the room. Each pair was given two bags: one bag contained the materials necessary to build a circuit (battery, battery holder, light bulb, light bulb holder, battery clips, 3 wires, and a switch) and the other contained various items that students were to test as either insulators or conductors. Photo 1 shows students testing a battery and threaded mini-bulb.

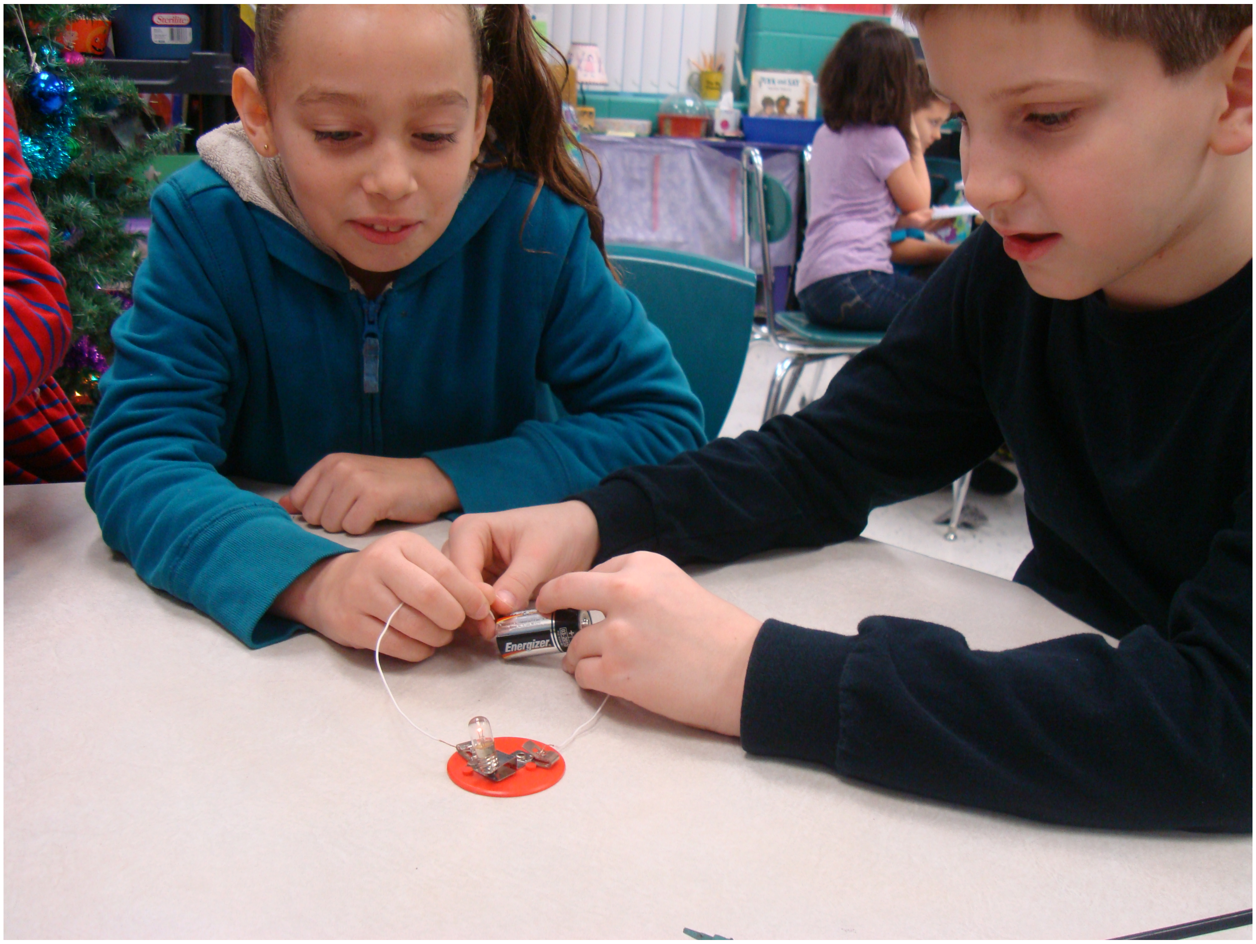

Photo 1: Students Testing a D-Size Battery and Standard Threaded Bulb

Each child was also given a recording sheet on which they wrote the name of the item, their prediction as to whether or not it would light the bulb, and the result of their test. Students were told to test their items by placing them on the metal pieces of their bulb (Photo 2).

Photo 2: Students Construct a Series Circuit Using Alligator Clips and Christmas Tree Bulb

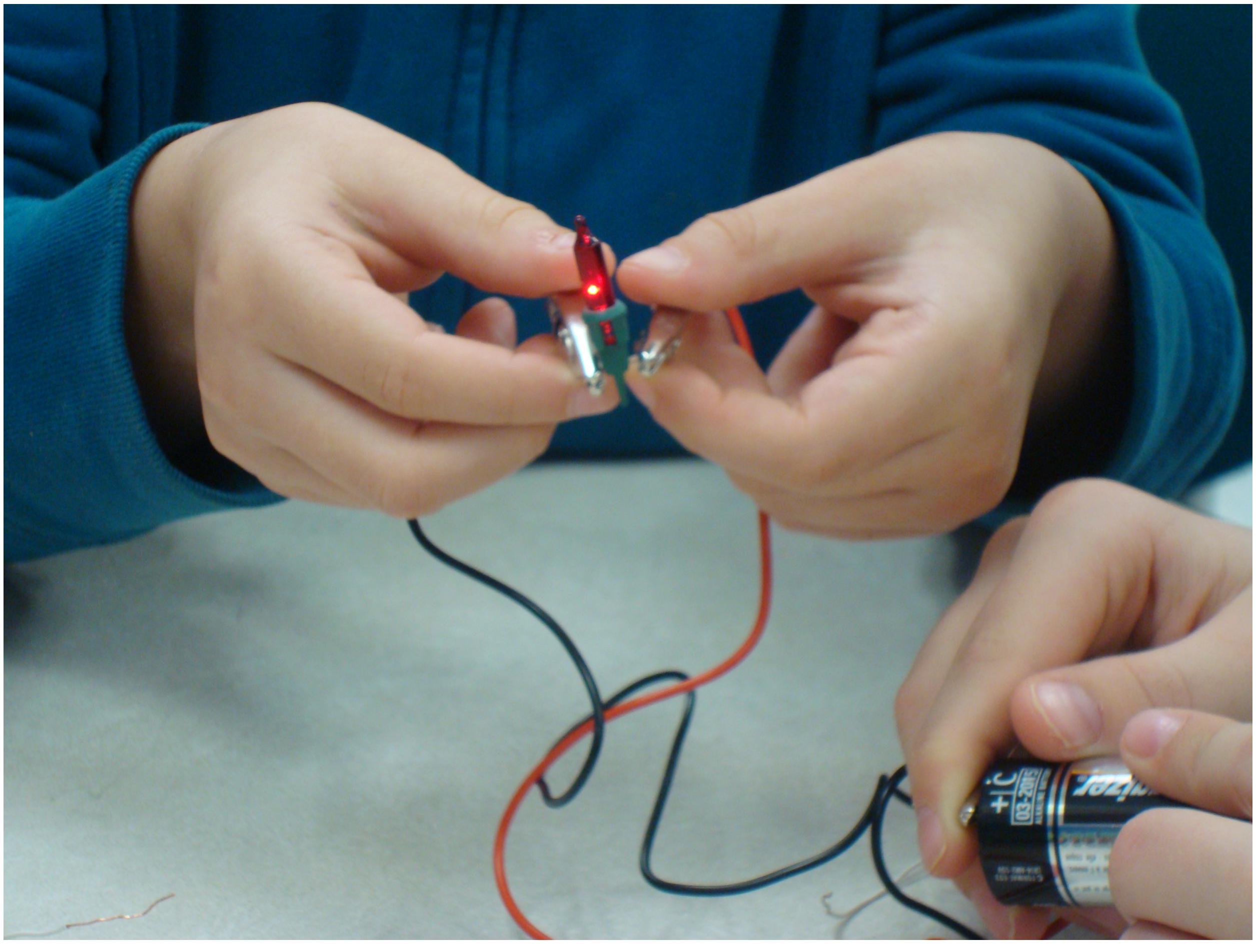

Photo 3: Students Electrify a Christmas Tree Light

Once students finished testing the items, they were allowed to test any other items in the classroom. The teacher asked questions such as, “Which item(s) caused the light bulb to light and which did not?” and “Were there patterns in what materials worked and those that did not?” Students responded that metal objects made the bulb light. When asked why, a student stated that “electricity flows through the metal.” The teacher verified through end-of-class discussion that metal conducts electricity and those inhibiting conductivity were insulators.

Light – Refraction and Reflection

Bobo Explores Light has many different games and simulations that relate to the central theme of light. 3D diagrams and information are presented throughout the app. Videos, images, facts, and more are included for each specific topic area as well as interactive content. Some of the areas of light that this app includes are photosynthesis, reflection, refraction, bioluminescence, lightning, the light bulb, fire, the sun, and more. For the purposes of this unit, the reflection and refraction chapters were used. Students can use a virtual laser to see how reflection and refraction works. This app also gives the angle measurements of refraction. It includes videos and pictures that explain these two concepts as well. *Bobo Explores Light* costs $4.99, but is well worth this price due to its plethora of interactive content. Students consistently drew diagrams from the fishbowl simulation as examples of refraction.

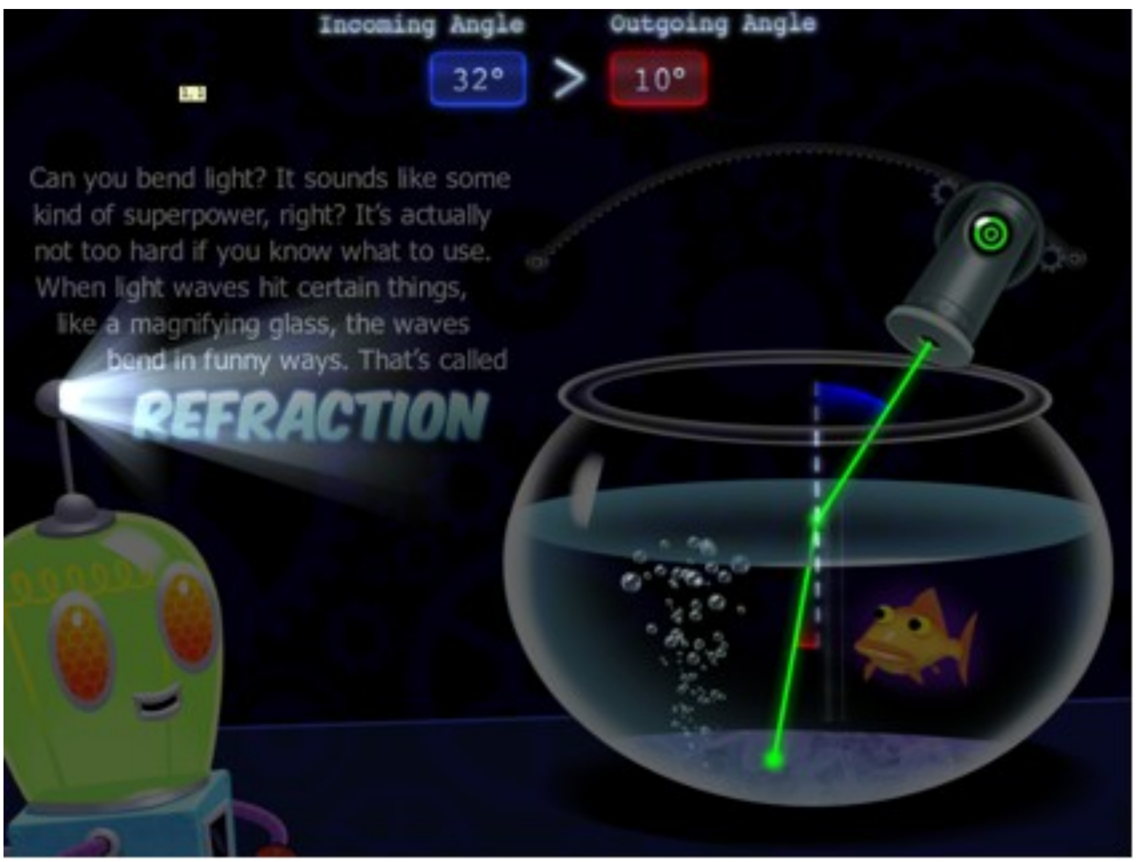

Figure 3: Screen capture *Bobo Explores Light* courtesy of Game Collage, LLC

In this Centers Activity, students were assigned to four groups. Each child was given an activity log (See Figures 4-7 for example responses), spent five minutes per station, and recorded observations throughout the activity. Each activity focused on comparing and contrasting reflection and refraction. The activites at each station were:

(1) Lines Station: Students observed a poster board with 3 lines drawn on it, drawing the observation in their log. A glass of water was placed in front of the lines. Students observed how the lines bent through the glass, again drawing observations in activity logs. A discussion of why the lines were bending, and how light refracted causing this, followed.

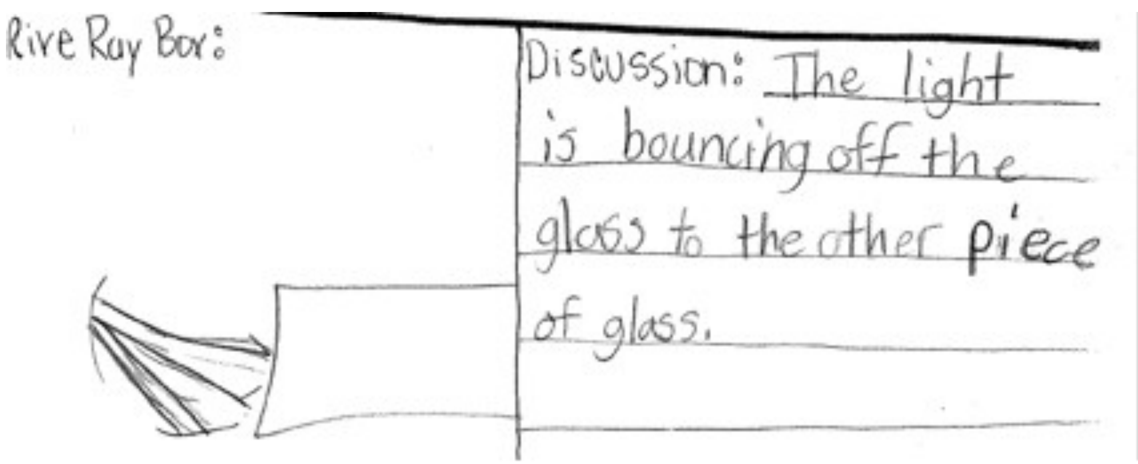

Figure 4: Lines Activity student sample

(2) Pencil Activity:

There were four beakers containing the following:

1. Air

2. Water

3. Oil

4. Air, Water and Oil

The students first made predictions about visual effects on the pencil when a pencil was placed into each beaker. The students then placed a pencil into each beaker and made observations to verify predictions. Students discussed in their group the pencil's appearance in different beakers and recorded results in activity logs.

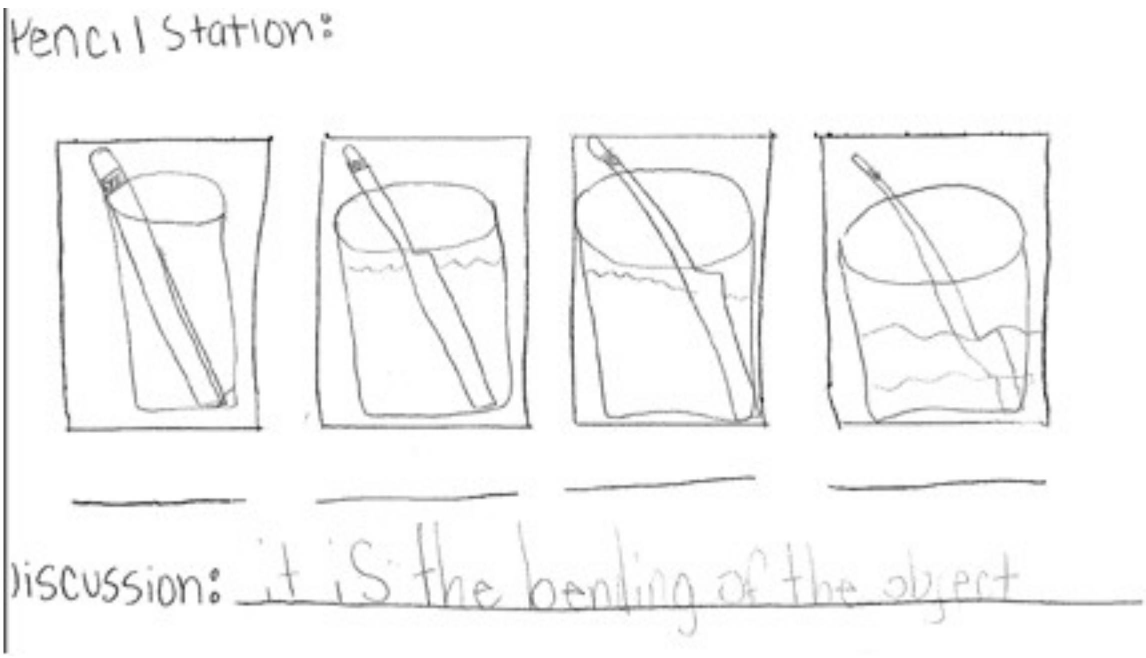

Figure 5: Pencil Station Student Sample

(3) Penny Activity

Materials needed were a medium sized bowl, water, penny, and tape. A penny was taped to the bottom of a bowl. Students stood at a distance from the bowl until they could no longer see the penny. Students recorded observations in their activity log. The teacher poured water into the bowl until the student was able to see the penny again. Once the student could see the penny again, they subsequent observations were drawn in their activity log. Discussion of refractory effect followed.

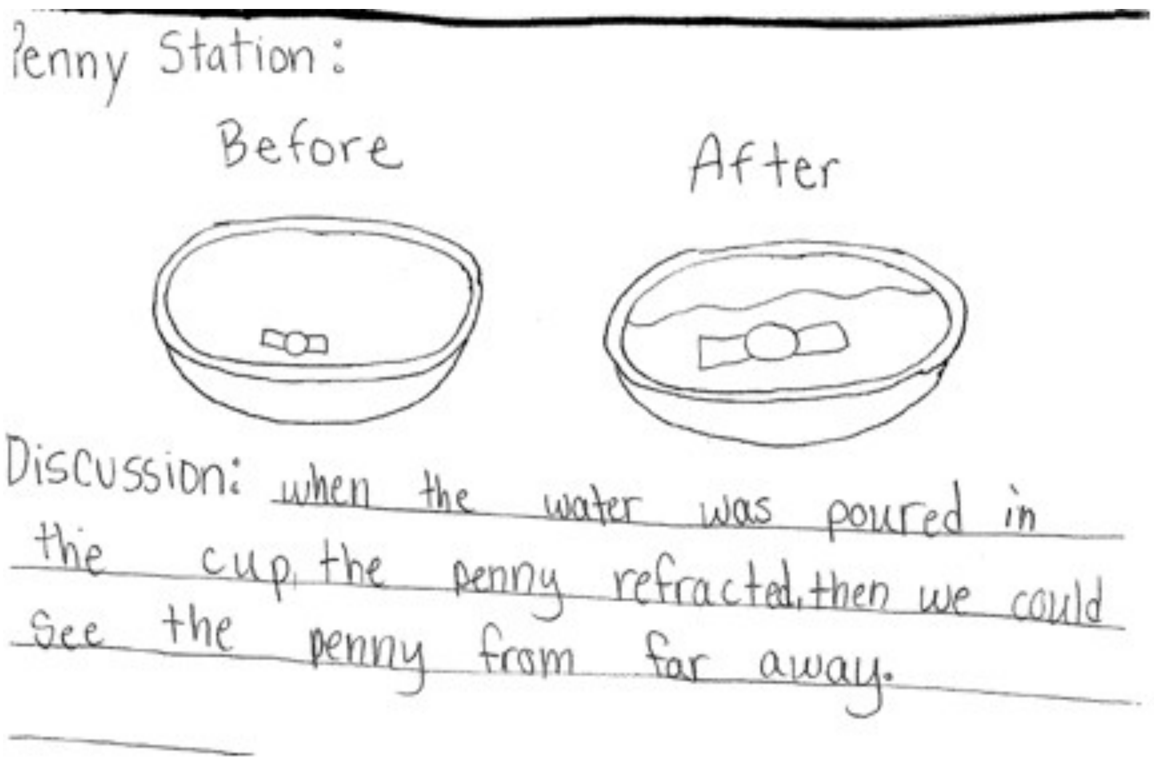

Figure 6: Penny Station Student Sample

(4) iPad App: *Bobo Explores Light*

Students could see refraction very clearly through demonstration with a laser, fishbowl, and water. Students experimented, from a fixed axis, with laser positioning on light rays shone through the fishbowl to determine angles of incidence, reflection, and refraction. This app featured a fish in the fishbowl. Students were eager to see if the laser connected with the fish or if it “bent around” the fish. Students were delighted to see that refraction effects did not affect the fish! Additional pull-down information in the app provides support and extension of refraction. Using the app allowed students to explore refraction in such a way that they could readily identify elemental data and make sense of it at their level of experience. Discussion included both refraction, its properties, and comparisons with reflection.

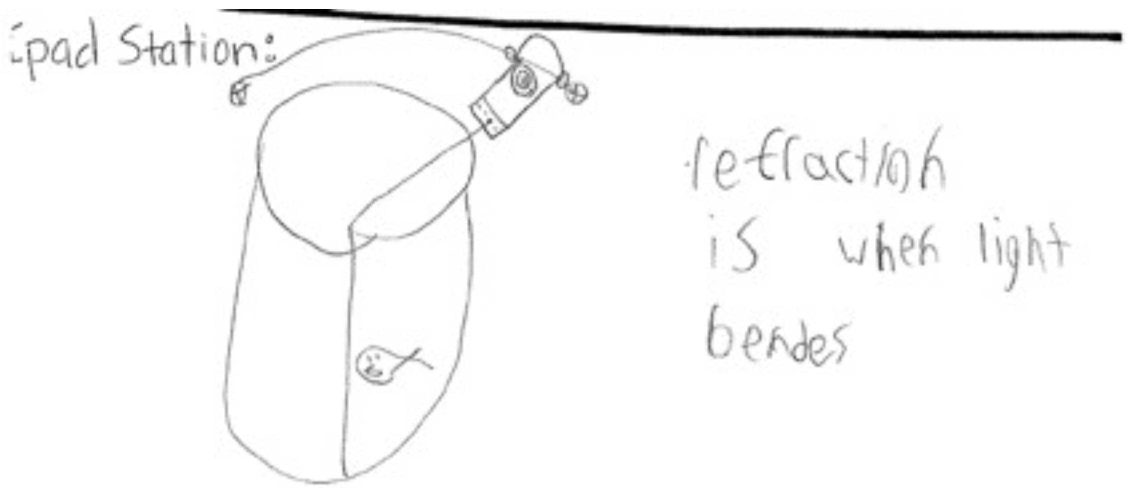

Figure 7: iPad Station Student Sample

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The reflections experiment required at least four students per group, a flashlight, one to two mirrors, and a paper target. The goal was to position the mirror, shine the flashlight on the mirror to correctly reflectively strike the target. Each child in the group was allowed to choose their job within the group (mirror(s), flashlight, target, and recorder). Student records and researcher observations indicated that students correctly positioned the mirrors to reflect the light from flashlight to hit the target. The angles of reflection and its difference to refraction, though, were not established until the use of apps. As mentioned above, *Bobo Explores Light* has a good app for teaching about reflection. The interactive content in the mirrored ball (reflection) activity proved to be a good support for understanding reflection.

Results

A comparison of the pre and post-test scores (Table 1) indicated that 31% (N=14) of the total population of students showed improved achievement in their understanding of circuits, conductors, insulators, and light/heat. The total number of students in both classes was 45; due to multiple reasons, many students did not participate in both pre and post-testing. The test items came from Kentucky CCT Coach Science Grade 4 (2004). Copying of materials from the book was prohibited.

Table 1: Electricity and Light Pre and Post-Test Comparison of KCCT Unit Objectives

Question Number	Percentage Correct Answers Pre-test (N=14)	Percentage Correct Answers Post-test (N=14)	Question Topic
1	33	83	Circuits
2	16	75	Circuits
3	50	92	Light/Heat
4	50	75	Conductors/Insulators
6	41	92	Conductors/Insulators

Questions 1 and 2 regarded identification of open and closed circuits. Question 1 asked students to choose the correctly listed parts of a closed circuit. The correct answer included the items wire, battery, bulb, and closed switch. Question 2 showed an open circuit (switch clearly not engaged) and asked students to choose a true statement. The correct answer was that the circuit was open. Students seemed to demonstrate understanding of closed and open circuits. Students received experiential learning with both circuit kits (Photos 1-3) and apps. The circuit kits were useful in producing serial circuits; *Simple Circuits* was useful in producing both serial and parallel circuits. Students using *Simple Circuits* demonstrated a serial circuit, open and closed connections, and discussed purpose of batteries. The apps reinforced building circuits in ways not available to students. When asked to connect more than one bulb to a serial circuit, students were more successful with the app than with hands-on kits. Students could increase the voltage on the apps to accommodate more bulbs whereas with kits, more voltage was not available. Students also discussed the conversion of stored, chemical energy to electrical energy more readily with apps.

Students appeared to demonstrate an increased understanding of reflection and refraction, as opposed to absorption. Question 3 asked the effect the difference between the sun striking a white or a black t-shirt on a summer day if you felt warmer in a black t-shirt. The correct answer was that the heat was absorbed by the black t-shirt. The increase is largely due to demonstrations with mirror and flashlights (reflection) and experiential stations involving mirrors (refraction). *Bobo Explores Light* was a very useful app for several items in this unit including refraction. Students defined refraction as the bending of light, then drew a picture on the board of light hitting a mirror and light shining through a fish bowl. Students used the app graphics in many situations to explain refraction. Students drew the outgoing angle of light in each instance. They talked about how the angles in reflection and refraction are different, and what they observed at each center. The students were perhaps more focused on the angles of refraction versus the angle of reflection because of their app use. *Bobo Explores Light* is particularly useful for angles of refraction. The simulation measures both the incoming and outgoing angles for the laser as students rotate the laser to shine through water in a fishbowl.

Questions 4 and 6 dealt with conductors and insulators. Question 4 asked identification of a conductor. The correct answer was copper. Question 6 asked which item was a good description of an insulator. The correct answer was that heat could not easily pass through it. The apps addressed neither conductors nor insulators. *Circuit GoGo* allowed voltage manipulation so that one may have dimly lit bulbs or slower gizmos on a circuit. Students had access to tape, which acted as an insulator, during the hands-on experiment. They also encountered corroded and burned wires. Students quickly understood that the wires should be clean with no plastic coating and tape-free for best connection to light the LED bulb. Students also quickly learned that alligator clips were efficient conductors.

Recommendations:

Students truly needed more time with iPad apps (Prensky, 2010; Davis, 2009). Apps are a prescient force for elementary students. Their use reaches students in a relevant way. It appears that the use of *Bobo Explores Light* contributed to the overall understanding of refraction. Students continually referenced the fishbowl and its angles of light entrance/ exit as examples of refraction. *Simple Circuits* appeared to teach and reinforce electrical circuit concepts. In discussion, students referenced the circuit templates and its ability to dim or strengthen light based on the flow of electricity. Students appeared to have a better grasp of energy flow resulting from this app rather than from the battery-powered LED light kits. If apps are to contribute to overall achievement gain, they should be available during centers, indoor recess, and as needed throughout the day. iPads should become ubiquitous as a teaching technology. Anecdotally, the teacher and researchers noted more contact with students in one-to-one learning when students were using apps, the researchers still see technology being used in a "hands-off" way. Teachers in general cite stress of student abuse and/or breakage. There were rules in place for the iPads, such as not walking or eating near the devices. These rules from a Pinterest board may help in your classroom: http://www.pinterest.com/pin/27443878953058101. We also followed some simple rules to minimize damage and teach students about the devices:

- Teach students to properly clean the screens and care for the devices.
- The teacher distributed/collected iPads to/from students seated at desks.
- iPads worked well for groups of two IF sharing rules were established. The researchers used a timer to change iPads every five minutes. These were interactive apps requiring student manipulation.
- A grouping of four single desks placed in a square maximized on-task discussion among students while reducing procedural questions.
- Maintain iPads in hard shell cases. We purchased cases at a local store. The cases reduced surface damage to the screen and back panel.

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Resources:

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