Jerome S. Bruner’s Discovery Learning Model

as the Theoretical Basis of Light Bounces Lesson

Susan L. Champine, Shawn M. Duffy, James R. Perkins

EDT665 Fall 2009

December 14, 2009
Abstract

Jerome Bruner’s discovery learning theory was applied to the lesson *Light Bounces* and presented to third graders at a nearby suburban elementary school. A teaching approach using discovery learning presents questions and activities that challenge students to utilize their prior knowledge in order to build upon and improve their current understandings, as is demonstrated in *Light Bounces* (Schunk, 2008). Bruner believed, from a constructivist perspective, that "education is a process of personal discovery" (Clabaugh, 2009). This theoretical model was used to enhance students’ learning experiences. Research has shown that discovery learning increases the likelihood of students retaining knowledge for future lessons. Further discussion will show how discovery learning theory influenced the lesson *Light Bounces*. 
Introduction

*Light Bounces* is a single lesson that is part of a larger science unit designed to introduce third or fourth grade students to the exploration of light as a natural phenomenon in our world (Cusack, 2004). For this project, the teaching and learning aspects are based on Jerome S. Bruner’s discovery learning model of instruction (Schunk, 2008, p. 280-81). Discovery learning seems appropriate for *Light Bounces* because the socially-based investigative activities and materials motivate students to make inquiries such as “why does light bounce?” and “how does light bounce?” (Schunk, 2008, p. 281). Students gain knowledge of how light travels, why it is important to know this information, and also work with new vocabulary words to help structure connections that promote memory retention and knowledge transfer as they progress through the unit (Clabaugh, 2009; Mandrin & Preckel, 2009).

Bruner’s discovery learning is generally associated with constructivist teaching principles with its emphasis that students learn best when engaged in active social learning processes that help them to form new ideas based on existing knowledge (Clabaugh, 2009; CUREE, n.d.). Discovery can be designed as a minimally or more directly guided learning experience (Maderin and Preckel, 2009; Schunk, 2008, p. 280-1). *Light Bounces* has been designed as a minimally guided student centered lesson that, according to Bruner (1961), works best with activities designed to encourage searching, manipulating, exploring, and investigating (as cited in Schunk, 2008, p. 280). Additionally, it is important that students possess prior knowledge of the subject to be taught in order for minimally guided instruction to effectively support development of increased understanding (Schunk, 2008, p. 282).

Bruner’s discovery learning model was chosen as the theoretical basis for *Light Bounces* because the theory seems well suited for science, as the subject ordinarily involves
experimentation and reflection of observations. Problem-solving, also an important part of
discovery learning, and this lesson, encourages students to observe, predict, experiment, record,
and then to actively think about why and how light bounces (Schunk, 2008, p. 280). The key to
discovery in *Light Bounces* is that students actively participate in constructing their own meaning
and work to find out why and how things happen allowing them to draw conclusions
independently, rather than being told by the teacher, and then being asked to memorize correct
answers for tests (General Teaching Council for England (GTC), 2006). Discovery learning also
allows students the opportunity to make thoughtful guesses and to ask questions. All of these
actions, according to Bruner, help students in various stages of development, to conceptualize
big ideas (GTC, 2006; Lewin, n.d.).

The *Light Bounces* lesson is modular in nature and is designed to facilitate active student
participation and encourage their full mental and physical engagement (Gorman, Plucker &
Callahan, 1998). As stated earlier, active student participation supports constructivist teaching
principles and subsequently supports the discovery learning model (Schunk, 2008). Although the
lesson seems basic on some levels, the overall hope is for students to grasp new concepts about
light and its importance and relationship to them and to the world around them.

Students interact with their socially constructed learning environment as they practice
and solve the problems of how light bounces. Sharing prior knowledge and working with new
ideas in small groups helps students to create more meaningful understandings with their peers
(Lewin, n.d.). The lesson can be planned over the course of one or two days depending on pre-
and post-assessment determinations as well as the interest level of the class, and as time permits.
Therorist, van Joolingen (1998) states that the learning environment should be arranged to
promote activities that motivate students to fully participate. Ideally, the teacher, as facilitator,
should guide students toward developing a hypothesis and then to ask thoughtful questions and even to make guesses (Van Joolingen, 1998).

A basic concept of discovery learning is that teachers should facilitate instruction that allows students to discover predetermined outcomes according to the level of learning required by the curriculum standards (Mandrin & Preckel, 2009). Hopefully, students will pose relevant questions such as “what if there was no light?” or “how does light move from place to place?” Discovery learning allows for deeper thought into the subject.

For this lesson, a pre-assessment (see appendix B) of student understanding is conducted prior to beginning the light unit. Activating prior knowledge about the topic and reviewing previous lessons in the unit should promote deeper understanding and can help knowledge transfer happen in an organized manner so that future recall of information can occur (GTC, 2006). Bruner’s vision about “spiral” curriculum becomes evident when learners can relate back to pre-existing knowledge and then strive to build on that to construct new meanings when new knowledge is added (CUREE, n.d.; GTC, 2006).

As an introductory activity, the teacher, acting as facilitator, should prompt students to recall knowledge and experiences from previous lessons, and encourage student participation. The teacher should then guide students in applying already existing knowledge to new information to construct deeper levels of meaning and understanding (CUREE, n.d.). This gives students an active opportunity to apply what they already know about the topic to the new situation (Schunk, 2008).

After introducing the purpose of the lesson, the teacher describes the materials that will be used in the experiment and then models the actions and procedures for the students (GTC, 2006). Ongoing observation and feedback by the teacher during the experiment can help clear up
students’ misconceptions and help the teacher to modify instruction, as needed.

Students begin the actual lesson by asking questions, guided by the teacher prompts, and then try to guess at possible right answers. They move to actively observing light and experimenting with it in small groups. Ultimately, they discover that when light hits an object, it can reflect directly back in one direction, or it can scatter in many directions (Cusack, 2005). The lesson should wrap-up with a short written assessment (see appendix D) in order for the teacher to determine whether each student gained understanding in a meaningful and constructive manner (Schunk, 2008).

Preparation for Light Bounces can be modified depending on the needs of the students. It is also a lesson that might inspire teachers to be creative and experiment with instructional materials. Examples include hanging a three-dimensional mobile or posting a two-dimensional drawn vocabulary web that allows students to make appropriate word connections (see appendix C). According to Schunk (2008), these types of instructional visual aids support constant vocabulary review and memorization that link to the larger concept of light bouncing (Mandrin & Preckel, 2009). Using Bruner’s “spiral curriculum” as a reference, the web can be a highly effective way to connect ideas from the past and present learning of the topic (CUREE, n.d.; GTC, 2006). Lessons that are well-organized and build upon one another may enhance the overall understanding of concepts (Mandrin & Preckel, 2009).

For the Light Bounces lesson to be most effective, additional visual aids such as flashlights, ping pong balls, and other objects will help to demonstrate the principles of how light seems to move. Visual aids also help students to see first-hand how light behaves as opposed to having to think about how light might behave after reading from a text or listening to the teacher describe the process (Mandrin & Preckel, 2009). A higher rate of knowledge transfer is more
likely to occur when students engage in hands-on meaningful activities such as these (GTC, 2006). When students see first-hand how light reacts when it encounters certain objects, the combination of physical and mental processes working together create more opportunities for lasting and meaningful understanding to develop (Brown and Abell, 2007; Schunk, 2008). Active learning also promotes memory connection as new knowledge links to earlier ideas and experiences (Brown and Abell, 2007). As the lesson progresses, the teacher, as facilitator, should observe and question students to ensure that correct new information is being learned and understanding is developing as well as to clarify misconceptions (Brown and Abell, 2007).

A complementary model to discovery learning is called “the learning cycle” and is based on “a form of scientific inquiry” that encourages students to independently grasp scientific concepts, “explore and deepen that understanding, and then apply the concept to new situations” (Walbert, 2003). Re-stated, the learning cycle allows for exploration, concept introduction, and concept application (Brown & Abell, 2007). It was designed by David Walbert for use as a key concept in the planning of science instruction (Brown & Abell, 2007).

Light Bounces incorporates some aspects of the learning model. For example, the teacher introduces the concept of light by asking questions to promote student engagement and to provide opportunities for students to recall what they already know. Students will hopefully add new information to their existing base of knowledge and will be able to construct deeper meanings than they had before participating in the lesson (Brown & Abell, 2007). Brown & Abell (2007) suggest that exploration allows students to visualize and understand science concepts better than had they just read text about the subject, took notes, or listened to lectures. The small group work phase of the student centered learning experience places emphasis on active collaborative knowledge sharing and encourages meaningful learning experiences to
progress (Brown & Abell, 2007). Additionally, the learning cycle, as part of discovery’s problem-solving aspect, helps to facilitate the process of information storage from short-term to long term memory (Brown & Abell, 2007).

Further analysis of the instructional aspects of Light Bounces follows the review of the historical development of discovery learning theory as well as its most common uses in the educational realm.

The Man Behind the Theory

Jerome Seymour Bruner’s prolific texts, The Process of Education (1960) and Toward a Theory of Instruction (1966), enlightened twentieth century educators and influenced a sweeping movement of change in the way American school curricula were designed and taught (Smith, 2002). The latter publication essentially launched the popularization of “cognitive learning theory as an alternative to behaviorism” that had, up until then, been the predominantly used educational theoretical model of the time and, in effect, it “had a direct impact on [educational] policy formation in the United States” (Sass, 2009; Smith, 2002). His educational and developmental psychology contributions span research and development in cognitive studies to educational instructional design models which subsequently evolved into his widely adopted Discovery Learning Theory (Smith, 2002).

Bruner was born in New York City in 1915 to Polish immigrant parents; blind at birth, two cataract surgeries as an infant corrected his vision (Smith, 2002). Following the death of his father when he was just twelve years old, Bruner and his mother frequently moved causing continuous interruption to his early education. From this obscure beginning emerged an influential scholar who was awarded his first academic degree from Duke University and in 1947, a Ph.D. in psychology from Harvard University (Smith, 2002). Although his early career
focused on social and developmental psychology, including exploratory work for the U.S. Army Intelligence during World War II, he is famed for his innovative work in educational theory, most of which he undertook during his years at Harvard’s Center for Cognitive Studies (Smith, 2002). There, as co-founder and director, his concern with “cognitive psychology led to a particular interest in the cognitive development of children (and their modes of representation) and just what the appropriate form of education might be” (Smith, 2002). He “has been at the forefront of what is often called the Cognitive Revolution [taking off in the 1960s] - which today dominates psychology around the world” (Kinnes, 2009).

Bruner’s theory of discovery learning evolved from this research and from his interest in two other prominent educational theorists. The first was Lev Vygotsky’s (1978) Zone of Proximal Development (ZPD) that showed “developmental processes lag behind the learning processes pointing out that children can often complete tasks with the help of others that they could not accomplish working independently” (CDI, 1998-2009; Schunk, 2008, p. 246-7). Vygotsky theorized that social influences affect cognitive development (Schunk, 2008). The second was Jean Piaget, a twentieth century developmental biologist who formulated four age-related stages of cognitive or intellectual development he identified as “sensory motor/0-24 months; pre-operational/2-7 years; concrete operational/7-12 years; and formal operational/12 years and up” (CDI, 1998-2009; Schunk, 2008). Piaget determined that children were not “empty vessels” and were able to actively construct meaning (Schunk, 2008). These widely known and accepted theoretical approaches contributed to discovery learning’s synthesis; however, it should be noted that Bruner’s theory goes beyond the fundamental philosophies of Vygotsky and Piaget and is more associative with contemporary models of constructivist teaching and learning principles (Smith, 2002; Schunk, 2008).
Bruner’s theory aligns with constructivist principles because it evidences the idea that children learn best when actively and collaboratively engaged (Clabaugh, 2009). His theory transcends Vygotsky’s ZPD and Piaget’s somewhat limited cognitive operational stages of development by suggesting the idea that learning takes place through “active transmission, conducted via discovery learning” (Clabaugh, 2009). While the discovery model incorporates essential aspects of Vygotsky and Piaget’s work, it is fundamentally based on Bruner’s own researched theoretical models of cognitive growth and scaffolding.

Discovery learning, according to Bruner (1961), is an “inquiry-based, constructivist learning [philosophy] that takes place in problem-solving situations where the learner draws on his or her own past experience and existing knowledge to discover facts and relationships and new truths to be learned;” in essence, “obtaining knowledge for oneself” (Clabaugh, 2009; as cited in Schunk, 2008). When children interact with their environment through exploration of objects and then work together to form hypotheses, they are actively engaged in the process of developing problem-based learning skills (Clabaugh, 2009; Schunk, 2008). Bruner believed that as a result of this learning process, students were “more likely to remember concepts and knowledge discovered on their own” (Clabaugh, 2009). Further, Schunk emphasizes that the discovery model “is a type of inductive reasoning” that allows students to move from “studying specific examples to formulating general rules, concepts, and principles…. through a minimally guided instructional approach [that] involves direction; teachers arrange activities in which students search, manipulate, explore, and investigate” (Schunk, 2008, p. 280-1).

According to Bruner’s theory of cognitive growth, as children’s cognitive abilities mature, they progress through three stages of learning that he termed “enactive,” “iconic,” and “symbolic” that describe how “people represent knowledge” (Clabaugh, 2009; Schunk, 2008).
Described more fully, the *enactive* stage involves motor responses that opportune learning through active manipulation; the *iconic* stage involves the “capability to think about objects that are not physically present and to recognize objects;” and, the *symbolic* stage allows for the understanding of abstract concepts (Schunk, 2008, p. 342-3). In a constructivist classroom, Bruner’s “scaffolding theory” promotes learning through these three developmental stages with sufficient support in the form of resources, tasks, guidance, and social interactions when concepts and skills are first introduced (Schunk, 2008).

Bruner “advocated learning through inquiry,” with the teacher providing guidance to accelerate children’s thinking, and recommended that the early teaching of any subject should emphasize grasping basic ideas intuitively. After that, he believed, the curriculum should revisit these basic ideas, repeatedly building upon them until the pupil understands them fully as is defined by his *spiral curriculum* (GTE, 2006). The most important aspect of the spiral idea is that children need to exhibit a “readiness to learn” and, that is why it becomes vital that teachers revisit concepts before new knowledge is presented (Cruey, 2009).

Fast-forward to the twenty-first century. In Bruner’s 1996 publication, *The Culture of Education*, the theorist who was on the leading edge of the radical educational change-over from behaviorism to cognitivism in the 1960s, reveals that his thinking has broadened from focus on individual brain development and learning experience to a more inclusive view that *culturalism* is key to the process and progress of human brain development and subsequent learning (Bruner, 1996). Culturalism, as he explains, is the idea that human evolution and socio-cultural interactions are the predominantly determining factors that fuel the progression of human learning (Bruner, 1996). He goes on to explain that learning in schools should embrace the socio-cultural aspects of human learning in order to view learners on a broader, more all-encompassing
basis rather than focusing on stringent models of cognitive development alone (Bruner, 1996). More simply stated, Bruner supports the idea that people do not fit into strict modes of intelligence and learning potentials and that schools should strive to design more flexible and socio-cultural based models of instruction (Bruner, 1996). These ideas are rooted in what is known as cultural psychology that has recently drawn the interest of educators with its shift from logical scientific thinking to narrative thinking which arises from cultural aspects of song, drama, fiction, and theater (London, 1998).

Bruner’s perspectives continue to evolve and that is to be expected from a man who has devoted his life’s work to the belief that the human mind is not a fixed entity but is, in essence, a mobile mechanism that is full of potential and is always actively seeking opportunities to explore, manipulate, experiment, and inquire. In this light, discovery learning can be viewed as enabling the continued process of learning in a natural and meaningful progression. Discovery, then, seems an enduring theoretical application that is as relevant today as it was at its first dawning.

**Light Bounces**

Designed for a third or fourth grade class, this lesson on light meets expected state content standards for scientific inquiry and literacy, and addresses the content standards concerning the role of light as energy in our world (Connecticut State Department of Education (CTSDE), 2009). This lesson serves as the fourth lesson in a unit that explores various aspects of light as a natural phenomenon in our world. All explorations conducted by the students are intended to foster scientific inquiry skills such as observing, predicting, experimenting, recording, and interpreting (Cusack & Gayle, 2005). Talbut and McLaughlin (1993) explained that in today’s society, students need to be able to build on and improve current understandings
of subject matter (as cited in Bransford, 2000, p.132). Appropriately designed science lessons, such as *Light Bounces*, provide students with these opportunities.

At the beginning of this light unit, the teacher administers a *My Model of Light* pre-assessment (see appendix B) to gauge each student's initial understanding about the role of light in our world. This pre-assessment is designed to spark students’ questions about light, and the hands-on activities incorporated into each lesson allow students to "search, manipulate, explore, and investigate" (Schunk, 2008, p. 280). After the final lesson in the unit, and after gaining a better understanding of light as a natural phenomenon in our world, the students will make revisions to their initial *Model of Light*. Prior knowledge about light synergizes with the new knowledge, allowing students to generalize the concepts more globally (Clabaugh, 2009).

The exploratory nature of this light lesson reflects Jerome Bruner's discovery learning method. The big idea encompassing this light lesson is that students begin to understand when light hits an object; it can bounce off the object, go through the object, or be absorbed by the object. John Bransford explains that children carry with them their own beliefs about how the world works (Bransford, Brown, & Cocking, 2000, p.15). Light is an abstract concept. Thus, each lesson about light is an opportunity to develop or challenge students' assumptions (Bransford et al., 2000, p.15).

To begin the lesson, the teacher initiates a discussion by asking students to describe what they think happens when light hits an object, based on what they have learned about light in previous lessons. It is important for students to continually share their beliefs and knowledge so that their ideas can be altered or developed (Bransford et al., 2000, p. 15). After allowing students to share their ideas and respond to others, the teacher provides the essential question for students to discover through exploration: What happens when light hits objects?
Teaching in a discovery learning method means posing questions or problems and challenging the students to use or call upon their prior knowledge and instincts to resolve the problem as it is in *Light Bounces* (Schunk, 2008). Presenting an essential question also provides a kind of structure for students because discovery learning can be designed as a "minimally guided instructional approach" to solving a problem (Schunk, 2008, p.280). Learning activities are not directed by the teacher. Rather, learning activities are structured by the teacher so students receive guidance and support, but are left to utilize their own strategies (Schunk, 2008, p.283).

After posing the essential question, the teacher introduces new vocabulary words – *bounce, reflect, scatter* – and adds these words to the concept vocabulary web (see appendix C) begun during lesson one. Jerome Bruner believed that cognitive growth depended on "increasing language facility" (Schunk, 2008). Therefore, providing students with these vocabulary words gives them a common language to communicate their understandings. It also challenges and expands upon their initial comprehension of the meanings of these vocabulary words. Bouncing and scattering are usually observable events but, in this lesson, students will discover that these vocabulary words have a more abstract meaning as well.

Because discovery learning is a type of inductive reasoning, students must be exposed to specific examples of a concept and then have opportunities to actively manipulate materials before being able to fully comprehend the information (Clabaugh, 2009). In this lesson, the teacher can begin with a demonstration where students drop three balls on a flat, hard surface. Students should note the similarities between the balls and then discuss how the balls traveled after hitting the flat, hard surface. Next, students drop three balls on a rough, uneven surface and students discuss how the balls traveled after hitting the surface. This model provides students
with a specific, concrete example of how materials can bounce, reflect, and scatter, thus creating a connection to the abstract concept of how light travels. According to Bruner, "students must then confirm or disprove these generalizations by themselves through discovery learning.” (Clabaugh, 2009).

Bruner believed, from a constructivist perspective, that "education is a process of personal discovery" (Clabaugh, 2009). He affirmed that students progress through three stages of development: enactive, iconic, and symbolic. In this first stage – enactive – students need to manipulate concrete materials to make sense of a concept (Schunk, 2008). The enactive stage of learning during this lesson begins with the aforementioned teacher and student demonstration, and then carries over to the discovery learning activity introduced by the teacher.

Using a piece of smooth tin foil, crumpled tin foil, and a flashlight, the teacher models how students will use these materials to discover the answer to the essential question: What happens to light when it hits objects? During independent work time, students work in pairs, and in their science journals, use well-structured questions to guide their investigation and encourage application of scientific inquiry skills. Throughout this activity, students move into the iconic stage of learning, where students "mentally transform objects and think about their properties separately from what actions can be performed with the objects" (Schunk, 2008). As students shine flashlights onto the tin foil and make observations about how light bounces, reflects, or scatters, they begin to "visualize concrete information" and make connections to the concrete example shown during the demonstration done prior to the main activity (Clabaugh, 2009).

Following the students' exploration, the class reconvenes for a demonstration of how light bounces. The teacher initiates a synthesizing discussion, where students share the observations they made during their discovery learning activity. The teacher should direct the students'
attention back to the concept vocabulary web and discuss how the words *bounce*, *reflect*, and *scatter* relate to how light travels. The teacher should encourage students to make connections between their explorations with tin foil and flashlights and the demonstration done prior to the discovery learning activity. The discussion allows the students to communicate their understandings about how light travels. Because "the understandings that children bring to the classroom can already be quite powerful," students are likely to hold onto some of their current beliefs (Bransford et al., 2000, p. 15).

Bruner believed that making mistakes and then working to correct them are essential for learning to take place (Schunk, 2008). Thus, all activities designed to address how light travels must be active discovery processes conducted by students so they can "uncover the interrelationships between concepts and ideas" (Clabaugh, 2009). Students' knowledge about the abstract idea of light develops over time through repeated discovery learning experiences (Clabaugh, 2009). The ultimate goal of this lesson is to move the students closer to achieving a symbolic representation of how light behaves in our world. According to Bruner and his beliefs about a spiral curriculum, “students should address topics at increasing levels of complexity as they move through the curriculum rather than encountering a topic only once” (Schunk, 2008, p. 344).

Assessment for this discovery learning activity should include ongoing observations by the teacher while the students are engaged in their explorations, as well as a short written assessment following the synthesizing discussion (see appendix D). During the lesson, the teacher should be assessing the students on how they conduct simple investigations to understand the essential question of the lesson. The teacher should listen to the students’ conversations to gauge how they use relevant light vocabulary, as well as whether students need further
instruction due to misunderstanding. On the short written assessment following the lesson, the teacher will check how students are able to communicate their understanding about how light travels through words and pictures based on their explorations during the discovery learning activity. The written assessment also serves as an exit slip so the teacher knows what level of understanding the students have achieved regarding how light travels. This way, the teacher knows whether he/she needs to spend more time reviewing this scientific concept before moving on to other lessons.

*Light Bounces* is a lesson that enables students to actively explore, manipulate, experiment, and inquire. The lesson activates students’ prior knowledge and allows students to build on, improve, and reconstruct current understandings in a natural, meaningful progression. Discovery as a student-centered learning experience helps students make sense of new knowledge as they construct their own beliefs about the world around them.
REFERENCES


**EXTERNAL LINKS**


Constructivist Theory (J. Bruner). Retrieved September 28, 2009 from
http://tip.psychology.org/bruuner.html.


constructivist model and the spiral curriculum for teaching and learning. Retrieved

How inquiry differs from discovery learning. Retrieved October 29, 2009 from
http://www.thirteen.org/edonline/concept2class/inquiry/index_sub1.html.

Jerome Bruner and the process of education. Retrieved November 2, 2009 from


Dublin. Retrieved November 14, 2009 from
Appendix A

Name of Lesson: **Light Bounces**

<table>
<thead>
<tr>
<th>Grade level:</th>
<th>Subject:</th>
<th>Prepared by:</th>
</tr>
</thead>
</table>

**Overview & Purpose**

In this lesson, students investigate what happens when light bounces off objects. The students engage in experiments to discover that when light hits an object, it can reflect directly back in one direction, or it can scatter in many directions. Students will also use a model to describe what happens when light hits objects.

**Standards & Benchmarks**

**Connecticut Standards**

5.1.b: Light is a form of energy that travels in a straight line and can be reflected by a mirror, refracted by a lens, or absorbed by objects.

Grades 3-5 Core Scientific Inquiry, Literacy, and Numeracy: How is scientific knowledge created and communicated?

**National Standards**

N.S.K-4.1. Science as Inquiry: All students should develop: abilities necessary to do scientific inquiry; and understanding about scientific inquiry

N.S.K-4.2 Physical Science: All students should develop an understanding of; properties of objects and materials, position and motion of objects; light, heat, electricity, and magnetism

**Objectives**

**Students will demonstrate an understanding of how light bounces by...**

1. conducting scientific explorations, making observations, and recording discoveries in science journals

2. describing what happens when light hits an object using the terms *bounce, reflect, and scatter.*

3. illustrating how light reflects and scatters using labeled diagrams and arrows.

4. modeling what happens to light when it hits objects using ping pong balls and discussing the connection to their exploration.
Materials

- Flashlights
- Tin foil
- Ping pong balls & assorted balls
- Science journals
- Pencils
- Assessment Masters
- Smart Board & accompanying technology

Procedure

Introduction

1. Begin with a class science discussion. Activate students' prior knowledge by asking, "Based on what you have learned about light through previous explorations, what do you think happens when light hits an object?" Allow students to share and respond.
2. Provide the essential question for the lesson's exploration: What happens when light hits objects?
3. Introduce new vocabulary terms: bounce, reflect, scatter
4. Encourage students to help define the terms and place them on the ongoing concept vocabulary web (begun during lesson 1) using the Smart Board.

Modeling

1. Provide a concrete example for students to develop their understanding of what happens when light hits objects.
2. Show students a ping pong ball, a tennis ball, and a small bouncy ball. Ask students to describe what these items have in common. Ask the students to describe the floor of the classroom. Guide the students' responses toward commenting on how the balls travel and what happens when they hit the flat surface of the classroom.
3. Choose 3-4 students to hold the balls above the smooth, hard floor. The students drop the balls and the teacher asks students to describe what happens when the balls hit the smooth hard surface.
4. Next, choose 3-4 other students to hold the balls above a rough, uneven surface (place piled books, blocks, etc on the floor where the balls will drop). Have the students describe the surface now. The students then drop the balls and the teacher asks students to describe what happens when the balls hit the rough, uneven surface.

Explanation of activity

1. Introduce the discovery learning activity, and explain that the students' explorations will help them better understand the answer to the essential questions: What happens when light hits objects?
2. Model for students how to use the flashlight, smooth tin foil, and crumpled tin foil to discover the answer to the essential question.
3. Discuss with students how they can use light-related vocabulary words from the concept vocabulary web to communicate their understanding during their exploration.
4. Explain to students how they will use the questions in their science journals to guide their explorations and to record their observations.

**Main Activity**

1. Students receive one piece of smooth tin foil, one piece of crumpled tin foil, and a flashlight.

2. Students shine the flashlight onto the smooth tin foil and record their observations. Students answer the following questions in their science journals: *What does the smooth tin foil look like when you shine the flashlight on it?* *What does the area around the smooth foil look like when you shine the flashlight on the foil?* *What do you think happens to the light that hits the smooth tin foil?*

3. Students shine the flashlight onto the crumpled tin foil and record their observations. Students answer the following questions in their science journals: *What does the crumpled tin foil look like when you shine the flashlight on it?* *What does the area around the crumpled tin foil look like when you shine the flashlight on the foil?* *What do you think happens to the light that hits the crumpled tin foil?*

**Synthesizing Discussion & Modeling Technique**

5. Students reconvene for a follow-up science talk to discuss their observations.

6. Teacher encourages students to use light-related vocabulary to describe their observations about how light traveled during their exploration.

7. During the discussion, the teacher should encourage students to make a connection between their exploration with flashlights and tin foil and the model used prior to the lesson’s main activity.

8. Direct the students’ attention back to the concept vocabulary web on the Smart Board and encourage students to discuss how the terms *bounce, reflect,* and *scatter* relate to how light behaves when it hits objects.

**Assessment**

Assessment for this discovery learning activity includes both ongoing observations by the teacher, as well a short written assessment following the activity and the synthesizing discussion. The teacher should assess how the students conduct their exploration to understand the essential question of the lesson: *What happens to light when it hits objects?* The teacher should be listening for how students use light-related vocabulary to communicate their observations, as well as how students recorded observations in their science journals. Any misunderstandings recognized by the teacher can be discussed during the exploration.

The written assessment following the lesson checks how the students can communicate their understanding of the essential question through words and pictures. The assessment serves as an exit slip so the teacher can gauge the students’ level of understanding about what happens to light when it hits objects. The teacher can address any misunderstandings during the next lesson in the sequence.
Extension Activities:

1. Science – relate light bouncing off of various objects to the topic of the moon. How does the moon get light? Is the moon a light source? How are we able to see the moon at night?
   a. Create a model (with volunteers) of what makes day and night, focusing student attention on the moon.
   b. Visit www.discoveryeducation.com and/or www.brainpop.com to allow students to watch short video clips about the moon. Brainpop also provides students with various on-screen activities and graphic organizers.

2. Language Arts – Writing prompt: Imagine what the world would be like without light. Describe how the world would be different.
Appendix B

Name: ______________________        Date: ____________

My Model of Light

Lesson 1

Light is everywhere! Below, draw your model of light. What does light mean to you? In your drawing, be sure to answer the following:

- Where does the light you see in the room come from?
- How does light get into the room?
- How does light enable us to see objects in the room?
- How does light travel?
Appendix D

Name: ____________________  Date: __________

**Light Bounces: Lesson 4**

**Directions:** Use the words from the word bank to describe *on the lines* what happens when light hits objects.

<table>
<thead>
<tr>
<th>bounce</th>
<th>reflect</th>
<th>scatter</th>
<th>shine</th>
</tr>
</thead>
</table>

Draw a picture of the flashlight pointing down on the *smooth* foil. Draw arrows to show what happened to the light.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Draw a picture of the flashlight pointing down on the *crumpled* foil. Draw arrows to show what happened to the light.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
## Light Bounces Rubric

<table>
<thead>
<tr>
<th>Light-Written Assessment</th>
<th>4: Exceeds Grade Level Expectations</th>
<th>3: Meets Grade Level Expectations</th>
<th>2: Approaching Grade Level Expectations</th>
<th>1: Below Grade Level Expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student work shows a strong understanding of how light travels.</td>
<td>Student work shows a good understanding of how light travels.</td>
<td>Student work shows a developing understanding of how light travels.</td>
<td>Student work indicates poor understanding of how light travels.</td>
<td></td>
</tr>
<tr>
<td>Diagrams are clear, labeled, and include captions using specific light-related vocabulary.</td>
<td>Diagrams are clear and include captions using some light-related vocabulary.</td>
<td>Diagrams are somewhat unclear and captions include little light-related vocabulary.</td>
<td>Diagrams are unclear and include many errors.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Light-Student Observation</th>
<th>4: Student exploration reflects strong investigatory skills.</th>
<th>3: Student exploration reflects good investigatory skills.</th>
<th>2: Student exploration reflects developing investigatory skills.</th>
<th>1: Student exploration reflects poor investigatory skills.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student recorded and explained all observations clearly and with detail.</td>
<td>Student recorded and explained observations.</td>
<td>Student recorded some observations.</td>
<td>Student did not communicate observations and understandings using light-related vocabulary.</td>
<td></td>
</tr>
<tr>
<td>Student communicated observations and understandings using light-related vocabulary.</td>
<td>Student communicated observations and understandings using some light-related vocabulary.</td>
<td>Student communicated observations and understandings using little light-related vocabulary.</td>
<td>Student did not communicate observations and understandings using light-related vocabulary.</td>
<td></td>
</tr>
</tbody>
</table>