The Golden Hour

Scene 3: Surgery

Lesson 3: Surgery

I. Overview
The focus of this lesson is Scene 3 of The Golden Hour in which students are guided through surgery to remove the hematoma in the patient’s brain. To prepare for the surgery, students learn more about the protective layers around the brain. With the use of diagrams and images, they discuss the skin, skull, and meninges layers. A demonstration using a water-filled balloon and a marble is also used to illustrate the role of cerebrospinal fluid in protecting the brain from harm. During the surgery scene of The Golden Hour, students are able to see how these layers around the brain are peeled back in order to remove the hematoma. At the end of the game, they are required to draw on their knowledge of brain anatomy and function in order to postulate what difficulties the patient may have due to the location of injury.

II. Standards

National Science Education Standards
Content Standard F: Personal and Community Health

- Hazards and the potential for accidents exist. Regardless of the environment, the possibility of injury, illness, disability, or death may be present. Humans have a variety of mechanisms—sensory, motor, emotional, social, and technological—that can reduce and modify hazards. (9-12 F: 1/1)
- The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease-producing organism. Many diseases can be prevented, controlled or cured. Some diseases, such as cancer result from specific body dysfunctions and cannot be transmitted. (9–12: F: 1/2)


- Form and function are complementary aspects of objects, organisms, and systems in the natural and designed world. The form or shape of an object or system is frequently related to use, operation, or function. Function frequently relies on form. Understanding of form and function applies to different levels of organization. Students should be able to explain function by referring to form and explain form by referring to function. (K-12: 1/2)
Benchmarks for Science Literacy
The Human Organism: Mental Health

- Biological abnormalities, such as brain injuries or chemical imbalances, can cause or increase susceptibility to psychological disturbances. (6F/H2)

Common Themes: Models

- The behavior of a physical model cannot ever be expected to represent the full-scale phenomenon with complete accuracy, not even in the limited set of characteristics being studied. The inappropriateness of a model may be related to differences between the model and what is being modeled. (11B/H5** (SFAA))

III. Learning Objectives

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<th>Learning Objective</th>
<th>Assessment Criteria</th>
<th>Location in Lesson</th>
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<td>Identify the layers that surround the brain and explain their function.</td>
<td>Looking at an image, students should be able to identify the skin, skull, dura mater, arachnoid, and pia mater. They should be able to explain that these layers help to protect the brain from harm.</td>
<td>Activities 1 &amp; 2</td>
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<td>Explain where the cerebrospinal fluid (CSF) is located and its function.</td>
<td>Students should be able to explain that the cerebrospinal fluid is located between the arachnoid and the pia mater. This fluid works as a cushion for the brain in the case of a head impact.</td>
<td>Activity 1</td>
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<tr>
<td>Assess the strengths and weaknesses of a model.</td>
<td>Students should be able to explain why the balloon demonstration helps to visualize the role of the CSF while recognizing the weaknesses of the model and how the model falls short of a completely accurate representation of the brain within the skull.</td>
<td>Activity 1</td>
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<tr>
<td>Explain potential functional outcomes of a patient’s TBI.</td>
<td>Students use knowledge of brain anatomy and function to predict functional outcomes based on the location of injury</td>
<td>Activity 2</td>
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IV. Adaptation/Accommodations

Parts of the lesson require that the students have access to computers in order to play a computer game. If access to computers is limited, 2–4 students can be assigned to each computer.
Safety
In this lesson, students will be using balloons filled with air and water. Ask students to handle the balloons carefully and also to keep them at a distance from electronics. Students allergic to latex should not handle the balloons or balloons that are safe for them to come in contact with should be purchased.

V. Timeframe for lesson

Opening of Lesson
- Review content from previous two lessons – 5 minutes

Main Part of Lesson
- Activity 1: Protective layers surrounding the brain – 20 minutes
- Activity 2: The Golden Hour Scene 3: Surgery – 25 minutes

Conclusion of Lesson
- Whole class discussion about the neuroscience to TBI – 5 minutes

VI. Advance prep and materials

Activity 1: Protective layers surrounding the brain

Materials:
- Image of layers surrounding the brain (GH_L3_Image_LayersSurroundingBrain)
- Projector
- Balloons (2 per every 3 students)
- Marbles (2 per every 3 students)
- Water

Preparation:
- Prepare the image and projector so that image can be projected for the whole class to see
- Place a marble in each balloon. Prepare stations of two balloons. Each station should have one balloon filled with air and one marble and one balloon filled with water and one marble.

Activity 2: The Golden Hour Scene 3: Surgery

Materials:
- Computers (one computer for every 1-2 students)
- Student sheet “Surgery Report” (GH_L3_StudentSheet_SurgeryReport)
- Printer (optional: for printing student work)
Preparation:

- Make copies of “Surgery Report” (1 per student)
- There are two ways to prepare the computers for students:
  - Option 1: Make certain all computers will have online access while students play the game. Open The Golden Hour game through the Project NEURON website (neuron.illinois.edu).
  - Option 2: Download The Golden Hour game from the Project NEURON website onto each computer prior to class. An internet connection will not be necessary to play the game once downloaded onto the machine.
- Conduct a trial run of Scene 3: Surgery of The Golden Hour game on a computer before beginning the lesson to make sure it can be accessed and is running smoothly on the computers. Prepare all the computers so students can quickly and easily begin the game.

VII. Resources and references

References
VIII. Lesson Implementation

Opening of Lesson:
Review with the students what they have done so far in The Golden Hour game. Have the students recap what happened by asking questions such as the following (questions can be asked selectively):

- What happened in Scene 1?
- What are the different things you needed to do to check the patient’s vitals?
- Overall, what did his vitals indicate?
- What was his GCS score?
- What does this mean?
- What did you do in Scene 2?
- What are the different major landmarks in the brain?
- Can you remember what the functions of these areas are?
- What are the different types of brain injuries you learned about?
- How does a CT scan work?
- What type of injury does the patient, Quinn, have?
- Which hemisphere and area of the brain is the injury affecting?

Explain to students that, in today’s lesson, they will learn more about the brain and go on to finish treating their patient in The Golden Hour.

Main Part of Lesson

Activity 1: Protective layers surrounding the brain
As was recommended at the end of the CT Scan scene, the students need to now conduct surgery on the patient to remove the hematoma in order to relieve the pressure it is putting on the brain. To get them thinking about the surgery, ask the students:

- In order to get to the brain, what will you, as you perform surgery, need to cut through first? Students will likely say the readily known layers such as the scalp and the skull.

Project the image showing the layers outside the brain onto a screen for the whole class to see. (The image can be found in the following file: GH_L3_Image_LayersSurroundingBrain.

In this image students can see five different layers that surround the brain: skin, skull, dura mater,
arachnoid, and the pia mater. The dura mater, arachnoid, and pia mater layers are collectively called the “meninges”. The meninges are the protective covering of the brain and spinal cord. The dura mater is the tough protective outer layer that lines the skull, the middle arachnoid layer contains blood vessels and the pia mater is a very thin layer that lines the brain and closely follows the sulci and gyri (or dips and raises) of the brain’s surface.

Ask the students the following questions:

- Based on what you know about the patient’s injury in The Golden Hour from the CT scans, where is the build-up of blood, the hematoma? Correct answer: The patient has a subdural hematoma which means the blood that needs to be removed is between the dura mater and the arachnoid mater.
- What layers will you need to cut through during the surgery to get to the hematoma? Correct answer: The skin (scalp), skull, and dura mater.

Now draw the student’s attention to one more element of the layers surrounding the brain—the cerebrospinal fluid (CSF). This is a clear, colorless body fluid that is located between the arachnoid layer and the pia mater. Ask students:

- What do you think is one of the purposes of the cerebrospinal fluid?

Take a few students’ responses to this question before beginning the demonstration with the balloons.

**Teacher Pedagogical Content**

In the following activity, students should handle the balloons a safe distance away from the computers they will be using in the second part of this lesson. Remind students to take care not to pop the balloons. Still, handling the balloons in a separate area from the technology will ensure that the computers will not be damaged even if there is an accident. Another option would be to do this activity as a demonstration at the front of the class.

For the demonstration, give each group of 3 to 4 students two balloons, one containing air and a marble and the other containing water and a marble. Ask students to take turns so that each person gets a chance to shake each of the two balloons. When they shake the balloon full of air, they should hear and feel the marble rattling around. When they shake the balloon filled with water, they will not really be able to hear or feel the marble since it does not hit the sides of the balloon as much or as hard. After the students have an opportunity to shake the balloons and make observations of what happens, collect their attention to have a discussion using the following questions:

- What did you notice?
- Were the two balloons the same or different? How?
- What did the water appear to be doing?
• If we were to use these balloons as a model for the skull, brain, and CSF, what would represent the skull? The brain? The CSF?
• How might this model help us to understand the role of the CSF?
• This balloon demonstration is a model—what are some shortcomings of this as a model for the brain, CSF, and skull?

By the end of the activity, students should come to understand that although the balloons are not a completely accurate model of the brain, skull, and CSF, this model still helps to understand how the cerebrospinal fluid can protect the brain from harm if the head experiences an impact by providing a layer of cushioning around the cortex. Though the CSF does help to protect the brain from minor injuries, it cannot prevent harm to the brain in all cases of injury.

**Activity 2: The Golden Hour Scene 3: Surgery**

Tell the students that they will now play through Scene 3 (Surgery) of The Golden Hour. To begin the game, ask the students to click the link to “Golden Hour”. Once the menu screen appears, ask the students to click on the “Scenes” button and then on “Scene 3.0 Surgery”. As was the case for previous scenes, students can proceed through the game by clicking the right pointing (next) arrow in each dialogue box or by clicking as directed by the dialogue. Also, at times, if a player is not responding, an object in the game will flash yellow to further direct the player on what to do next.

Hand out the student sheet “Surgery Report”. Remind students to record their procedure and findings on this report as they play through the game.

In Scene 3, the Surgery scene, a neurosurgeon will guide the students through a step by step surgery procedure to remove the hematoma. In this process the students will experience the following steps.

- Disinfect the patient’s head before beginning
- Use a scalpel to make an incision in the scalp
- Use a bone drill to separate and then remove a piece of the skull
- Use a dura scalpel to cut through the dura
- Use irrigation and suction to break up and remove the hematoma
- Place a surgical sponge at the site of the hematoma

*Note:* The Golden Hour game will continue to be updated. Therefore, some of the details provided here may change. However, overall, the content covered in each section of the game will remain the same.

After completing the surgery, students are prompted to fill out a report to record the surgery procedures and findings and submit it in the game. Once they have submitted a complete and accurate report, they are led through a dialogue with the lead physician, Dr. Blackwell. This dialogue is designed within the claim, evidence, reasoning (CER) framework and encourages students to think critically about traumatic brain injury. In this scene, students are asked to make a claim about what difficulties the patient may experience after the surgery. They are also asked to provide evidence and reasoning in support of their claim.
Students can use the back of the “Surgery Report” student sheet to construct their recommendation. They can first use the C, E, and R, columns to organize their thoughts about the three different components of a scientific explanation. Then, at the bottom of the page, in the “Medical Recommendation” section, they should synthesize these ideas into a coherent explanation written in paragraph form. As students work, scaffold them to write their recommendation for what the next step should be (their claim), add evidence they collected that supports that claim, and provide reasoning that explains how the evidence supports the claim.

If students chose to type their recommendation within the space provided in the game, they can either take a screen shot or copy-paste the paragraph into a word document in order to print it. If a printer is not available, students can copy their recommendation paragraph onto the back of the Surgery Report student sheet.

**IMPORTANT:** Medical recommendation responses submitted within the game will not be saved once students exit the game. Students should have their medical recommendation written on their student sheet or copied into a word document on the computer before exiting the scene.

This explanation completed by the students in a CER-style format can be collected and evaluated as an assessment of what they have learned thus far in the game.

The following is one example of what a recommendation summary (CER explanation) for the Surgery Scan scene of the game may look like.

**Example Recommendation Summary**
For post-surgery, I expect that the patient may have difficulties with language processing and face recognition during recovery. These predictions can be made because the brain is made up of certain regions and neuronal circuits, each of which is associated with certain functions. In this case, a hematoma was found pressing on the patient’s right temporal lobe; this is an area of the brain that is associated with language processing and face recognition. Therefore, damage to the right temporal lobe may cause the patient to have problems with these functions.

**Conclusion of Lesson**
Once students have completed The Golden Hour’s Scene 3, gather the class’s attention to review that they just did. Begin the discussion by asking the following open-ended questions:

- What did you like about this scene?
- What are some of the new things you learned about doing a surgery?
- Did anything surprise you?

Then ask the students questions about the neuroscience of TBI content that was covered in this scene.

- Did you remove the layers that we had discussed before starting the game? What layers did you have to cut through?
• What are some of the difficulties the patient might have after surgery?
• What is your evidence? What is your reasoning?
• What kinds of difficulties might he have had if the hematoma was in the frontal lobe? The occipital lobe?

**Assessment**
In addition to the informal evaluations during whole-class and group discussions throughout the lesson, the recommendation summary (CER explanation) can be used as a formal assessment, assessing students’ ability to reason and apply the content.