Lesson 1: What is traumatic brain injury?

I. Overview
This lesson serves as the introduction to the “Why dread a bump on the head?” unit. Students are introduced to traumatic brain injury (TBI) through pictures and discussions that help students break down prior assumptions and begin to think about TBI from a scientific perspective. Students learn about and discuss the three classifications of TBI, mild, moderate, and severe. These categories are presented through the reading and discussion of news articles. Students then examine a hypothetical situation where they are the doctors on a brain injury case. Based on the knowledge gained from the readings, they identify critical information they would collect about their patient in order to effectively assess their condition after a potential brain injury. They then assume the role of a medical student as they play the first scene of an interactive computer game called The Golden Hour.

In the first scene of The Golden Hour, as the player, students go out with an emergency services medical team to respond to a bike accident in which the biker hit his head. Students learn how to check the patient’s vital signs and assess severity of the head injury and then record their findings in a report for the lead physician. Finally, students synthesize what they have learned by making a recommendation of what the medical team should do next (a claim), provide evidence from their findings to support this claim, and provide their reasoning for how the evidence supports their claim.

Connections to driving question
Students begin to understand that brain injury can result from a variety of different situations and contexts. They are also introduced to the complexity of traumatic brain injuries and the impact they can have on behavior and function.

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)

Benchmarks for Science Literacy
The Nature of Science: The Scientific Enterprise
• Progress in science and invention depends heavily on what else is happening in society. (1C/H3a)
• Scientists can bring information, insights, and analytical skills to bear on matters of public concern. Acting in their areas of expertise, scientists can help people understand the likely causes of events and estimate their possible effects. (1C/H6ab)
• Because science is a human activity, what is valued in society influences what is valued in science. (1C/H10** (SFAA))

The Human Organism: Mental Health
• Biological abnormalities, such as brain injuries or chemical imbalances, can cause or increase susceptibility to psychological disturbances. (6F/H2)

III. Learning Objectives

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<td>Question underlying assumptions and conventions associated with traumatic brain injury</td>
<td>During the initial discussion, student responses should illustrate that they are questioning their prior assumptions and beginning to re-evaluate them.</td>
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| Explain traumatic brain injury by describing the type of accidents (minor and major) that can result in TBI and the types of consequences that can result | Student descriptions include:  
  • All types of accidents can result in TBI.  
  • It can be difficult to gauge the severity of the injury based on how the injury occurred.  
  • An accident can result in different and multiple types of injuries.  
  • Consequences of the injury can depend on the severity of the impact, location of injury, time elapsed before treatment and other factors.  
  • There is great range and variability in the types of consequences that can result. Some examples include: nausea, headaches, changes in behavior/personality, memory loss, awareness of limbs, hypersensitivity to light and sound.  
  • There can be a lot of variability between cases since effects of the accident and the potential outcome are based on many different factors. | Throughout lesson                  |
Recognize there are three general classifications of TBI (mild, moderate, severe) that fall on a gradient of severity and are used to describe a patient’s condition.

Student explanation may include:
- The three classifications of TBI are not discrete and there are gray areas between them.
- The classification is often determined through the GCS which assesses cognitive function.
- The TBI classification can be used to inform treatment of patient and may predict long-term outcome and recovery of the patient.

Establish questions that are critical to understanding and diagnosing a traumatic brain injury.

Through the readings and The Golden Hour, students learn more about the necessary information to collect when responding to and diagnosing a TBI. Students may describe the following as important pieces of information to gather from TBI patients:
- Vital signs such as blood pressure, lung function, pupillary reflex, and temperature.
- GCS score (verbal, motor, and eye responses to measure cognitive function).

### IV. Adaptions/Accommodations

For the opening activity, it is suggested that a projector be used to show the class some pictures of TBI patients. If the classroom/school does not have access to a projector, pictures can be printed and held so that all members of the class can see. Some example pictures are provided with the lesson documents (*U4_L1_Supplement_Images*).

There is a handout (*U4_L1_StudentSheet_QuestionsAboutTBIreadings*) available with questions to guide students while they are reading. These questions emphasize what students should be sure to pay close attention to and can be used for those students that would benefit from extra scaffolding. The questions in this handout can also be used as a form of assessment.

The examples of Natasha Richardson and Gabby Giffords that are used in the introduction of the lesson may be changed to include more recent examples if they are no longer as relevant to student lives.

Parts of the lesson require that the students have access to computers that are connected to the web. If access to computers is limited, two to three students can be assigned to each computer. If computers and/or the internet cannot be accessed the day of the lesson, the activities requiring The Golden Hour game can be revisited at a later time and used to review and to support further learning of the concepts covered in this lesson.
Safety
There are no additional safety concerns associated with this lesson.

V. Timeframe for lesson

Opening of Lesson
  • Discussion to reveal current thinking about traumatic brain injury – 15 minutes

Main Part of Lesson
  • Activity 1: TBI Stories – 25 minutes
  • Activity 2: The Golden Hour: Scene 1 – 35 minutes

Conclusion of Lesson
  • Closing discussion and explaining homework – 10-15 minutes

VI. Advance prep and materials

Opening of Lesson

Materials:
  • Pictures to start discussion (options can be found in a PowerPoint file titled U4_L1_Supplement_Images)

Preparation:
  • Set up the projector with the pictures

Activity 1: TBI stories

Materials:
  • News articles pertaining to each category of TBI-Suggested articles are as follows:
    o Mild: “Soldiers and TBI: Why a Concussion Isn’t Just a Simple Bump on the Head”
      • U4_L1_Reading_SoldiersAndTBI_Mild
    o Moderate: “Rebuilding a Life”
      • U4_L1_Reading_RebuildingALife_Moderate
    o Severe: “Accidents and Unpredictability of the Road”
      • U4_L1_Reading_AccidentsAndUnpredictability_Severe
  • Worksheet: U4_L1_StudentSheet_QuestionsAboutTBIreadings
  • Worksheet: U4_L1_StudentSheet_VennDiagram
  • (Optional) Glossary of terms relating to traumatic brain injury: U4_L1_Supplement_TBI_Glossary
    o This glossary can be used either as a teacher resource or student resource to support learning of the content covered in the lessons.
Preparation:
- Make copies of all materials needed for each group (one copy of each document per 1-two students)
- Familiarize yourself with the definitions of Mild, Moderate, and Severe Traumatic Brain Injury found in the Glossary (U4_L1_Supplement_TBI_Glossary)

Activity 2: Golden Hour: Scene 1

Materials:
- Large sheet of paper to record questions
- Markers
- Journals (or notebooks)
- Computers connected to the internet (one computer for one to three people)

Preparation:
- Tape the paper onto the board
- Open the link to The Golden Hour game through the Project NEURON website (neuron.illinois.edu). Conduct a trial run of Scene 1: Emergency Medical Service (EMS) 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.

Conclusion of Lesson/Homework

Materials:
- Homework handout: U4_L1_Homework_PhineasGageInternetSearch
- Answer Guide to the homework handout: U4_L1_Homework_PhineasGageInternetSearch_ANSWERS
- Student Journal handout: U4_L1_Homework_LessonJournal

Preparation:
- Make copies of homework handout (1 per student)
- Make copies of Student Journal (1 per student)

VII. Resources and references

Teacher resources
- For information on U.S. Department of Defense and the issue of traumatic brain injury: http://maketheconnection.net/conditions/traumatic-brain-injury?gclid=Clvngc7W7LACFeUBQAodpFgHuA
For information on National Football League and traumatic brain injuries:


References

Supplement Images:
- http://maketheconnection.net/conditions/traumatic-brain-injury?gclid=ClVngc7W7LACFeUBQAdpFgHuA
- http://www.flickr.com/photos/9346632@N07/3614205726
- http://www.healthadvocates.info/2008/03/poor-kids-lives-are-only-half-worth.html

Soldiers and TBI:

Rebuilding a Life:

Accidents and Unpredictability of the Road:
VIII. Lesson Implementation

Opening of Lesson:
The goal of this lesson opening is to reveal and revise students’ underlying assumptions and conventions associated with traumatic brain injury. Begin the lesson with a short discussion about Traumatic Brain Injury (TBI) to discover what students know or have heard. Ask:

- What do you know about Traumatic Brain Injury?
- Have you heard or seen anything in the media about brain injury?
  - If so, what did you see/hear?
- Do you have any personal experiences with Traumatic Brain Injury that you would like to share?
  - Do you have any relatives or friends that have sustained a traumatic injury to their head?

Follow this discussion by projecting at least two pictures of individuals, one injury that looks bad and one that hardly appears to be an injury (possible pictures are available in the file: U4_L1_Supplement_Images).

Ask students to describe what they see. Have a discussion about TBI and the assumptions that people have. There are no correct answers but encourage students to question the ideas that they (and society) have about TBI. At some point in the discussion, explain to students that the people in both pictures have sustained a head injury. This will likely shift student discussion and prompt them to ask interesting questions about what TBI actually is. Questions that could be asked to stimulate conversation include:

- Which individual has an injury?
- Which individual has a worse injury?
  - Why do you say that?
- Is it possible to tell which injury is worse by looking at appearance?
- Which images show an open head injury? A closed head injury?
- Can an injury be severe even if the patient appears to be fine?
- What other types of injuries or conditions (outside of TBI) are not obvious physically?
- What are some examples of situations that support your thoughts? (See below for further discussion on this question).

Teacher Pedagogical Knowledge
There are many well-known and current examples of traumatic brain injury in the press. If students are showing great interest in these initial discussions or if further discussion and investigation into the topic would be a valuable and engaging exercise for students, it may be appropriate to introduce some additional information about TBI. The following are two resources/examples that can be used to extend class discussion about TBI or serve as a starting point for students to begin their own
investigations into the topic.

1) The U.S. Department of Defense has made it a priority to prevent and/or minimize effects of traumatic brain injury because of the high prevalence of TBI among war veterans. In a short video on a website created by the U.S. Department of Veteran Affairs, veterans speak about their experience with TBI. This video can be shown to students for additional examples of people affected by TBI. The video can be found at this link: http://maketheconnection.net/conditions/traumatic-brain-injury?gclid=CIVngc7W7LACFeUBQAodpFgHuA

2) The National Football League (NFL) has also begun to pay more attention to the cases of concussions and TBI that occur on the field during games and practices. A program at Boston University studies head injury in athletes and brought this phenomenon to the attention of many people. Some sources for more information include the following websites:
   • http://www.usatoday.com/sports/football/nfl/2009-09-14-brains-donations_N.htm

As real-life, publicized examples, lead a discussion about Natasha Richardson and Gabby Giffords. For additional information about these two individuals, please see:

Richardson fell during a mountain skiing lesson and had no visible signs of a head injury. She felt fine but after an hour or so began to develop headaches. Two days later she died as a result of her injury. Giffords, on the other hand, suffered from a penetrating gunshot wound to her head, which left her in a coma. With the help of intensive therapy, three months later she was able to walk, talk, and fly to see her husband’s space shuttle launch. She still has a long recovery ahead of her and may never completely return to normal, but she lived and is doing better than expected. After describing these examples to those that are not familiar with them, ask students:

   • What do these examples show us?
   • Have they changed your previous thoughts and assumptions about TBI?
Main Part of Lesson:

Activity 1: TBI stories

Explain to students that they are now going to work in groups to read and discuss some news articles about real situations involving TBI.

Tell the students that cases of TBI fall into one of three different general classifications: mild, moderate, or severe. They will now read three different articles, each of which discusses an example of one of the three different TBI classifications. While reading they should make sure to identify and write the main points that could be used as distinguishing factors to help classify the cases of TBI. Ask students to be sure to think about the following information. Write key words on the board as a student reference so that they can make sure to take note of all the required points.

- How the injury occurred
- Immediate consequences of the injury that were noticeable (i.e. loss of consciousness) and how long they lasted
- If there were any accompanying injuries (i.e. brain contusions)
- If there were any long-term effects or symptoms that persisted

Once instructions have been given, split the class into groups so that each article is read by two groups. Hand out copies of the following articles to the students (each article should go to two of the groups):

- U4_L1_Reading_SoldiersAndTBI_Mild
- U4_L1_Reading_RebuildingALife_Moderate
- U4_L1_Reading_AccidentAndUnpredictability_Severe

Do not tell the students yet which article represents which classification of brain injury. They will need to decide that themselves after reading and discussing the articles. After students have had time to read and discuss the articles, number off the students in each group so that new groups can be created to carry out a jigsaw activity. These new groups should have at least one person to represent each of the articles and thus each of the three classifications of traumatic brain injury.

In these groups, students should briefly explain their article and the background story associated with how the injury happened. Ask students to create a Venn Diagram with three overlapping circles. Draw a very large version of a Venn Diagram on the board for students to see and for later use. This diagram is also available as a handout in the document titled U4_L1_StudentSheet_VennDiagram.

To complete the Venn Diagram, students need to assign one of the articles to each of the circles. Remind them that each of these articles/circles represents a different classification of TBI, and that they are trying to determine the distinguishing factors of these classifications. Instruct students to write 5 main points/characteristics that distinguish the injuries they learn about in each of the articles (i.e. highlight the differences between the categories).
Then have students discuss any similarities that the articles have and explain that these should be written in the overlapping areas between the circles. If there is anything that all three of the articles have in common, it should be written in the very center (students may need to draw an arrow to the center because of the size).

Once students finish discussing in their groups, open up the discussion to the whole class. Call on students to explain some of the main points that they incorporated into their Venn diagram. As students give responses, add them to the diagram that is on the board and briefly discuss each item. Talk about the similarities and differences between all of the articles and then begin to help them determine what could qualify a patient to be under a certain category. Some of the following could be asked:

- Do you notice anything that could be useful to classify these three articles as mild, moderate, or severe?
- In any of the cases was the victim unconscious at all? If so, for how long? Do you think that may be important?
- Look at the numbers that are included for the GCS.
  - What is the Glasgow Coma Scale?
  - What do you think the GCS numbers could mean?
  - Could they help to identify what category a patient would be in?
  - Do you think the higher numbers indicate a more or less severe brain injury?
- Are there any associated injuries with any of the cases (i.e. contusion, hematoma)?
- Based on all of this information, which article do you think is about a mild TBI? Moderate? Severe? Why?
- Is it difficult to clearly define which case goes into which category?
  - After students respond, begin a discussion about how these classifications are not distinct categories, but instead are more along a gradient. There are crossovers and gray areas between them. Each case of TBI can be very different and have varying characteristics so it is often difficult to put them into a specific category.

Teacher Content Knowledge

The following information (also included in the TBI Glossary Supplement) describes some of the important aspects of the mild, moderate, and severe classifications of TBI. It is important to keep in mind that TBI classification is determined upon initial examination by a medical professional, during which the patient’s level on the Glasgow Coma Scale is often assessed. Typically the classification predicts the severity of the long-term outcome and the recovery of the patient.

- Mild Brain Injury – This is the least severe of the groups and is often referred to as a concussion. It consists of a potential brief loss of consciousness or amnesia, which could last anywhere from a few seconds to 30 minutes. Severe complications such as hematomas are not associated with this classification of
injury. Patients in this category have a Glasgow Coma Scale (GCS) of 13-15.

- Moderate Brain Injury – Patients have a loss of consciousness that could last from minutes to a few hours. Then for a few days or weeks, they are confused and disoriented. While it is not always the case, Moderate Brain Injury can include complications such as contusions on the brain. Patients in this category have a GCS of 9-12.

- Severe Brain Injury – This category is used to describe injuries that have resulted in unconsciousness or coma for an extended period of time (days, weeks or longer). Other complications do occur, including hematomas, contusions, nerve fiber damage, and/or anoxia. Patients in this category have a GCS of 8 or less.

Activity 2: The Golden Hour - Scene 1

Present the class with a hypothetical situation based on “The Golden Hour” game. Quinn and his friend were biking in the mountains one day. After hitting a large tree root with his front tire, Quinn flew over the handlebars and hit his head hard on a rock. He was not wearing a helmet. His friend was very concerned that he may have sustained a head injury so she decided to contact medical personnel.

Explain to the students that they are going to become the doctors on this case. In order to provide a diagnosis, they need to ask the patient questions that will tell them more about the situation.

- This situation is meant to present an injury and problem, but not give away very much detail to the students about the symptoms.

Have the class work together to brainstorm questions (or things they could look for) that they could ask this “patient” to help them figure out what kind of brain injury he has.

- Write suggestions on the board or a big sheet of paper.

If students have difficulty developing questions, encourage them by asking some of the following:

- What are vital things to consider after an injury to the head?
- Could the friend tell us any information that the patient could not? (i.e. unconscious, how he landed, etc.)
- Could brain damage hinder any other functions of the body that are not commonly associated with the brain area sustaining the initial injury?
- What could we ask to discover if the patient is experiencing any abnormalities in his daily life?
- Do you think that mood change or behavior change could be a result of a brain injury?
- Would there be anything that we could potentially discover by looking at the appearance of the patient?
After a list has been generated and the discussion has covered multiple aspects, ask each person to write down three “critical questions” that they would want to know about the patient.

- These questions should reflect what the students would ask if they were the doctors and could only ask three specific questions about the condition of the patient. Students should defend their questions and provide a rationale for why they think those particular questions are important.

**The Golden Hour Scene 1: Emergency Medical Services**

For this computer activity, have the students work alone, in pairs or in groups of three. Introduce the game to students by explaining, in this game the player—the students—is in the role of a medical student. As the medical student, they are working on a medical emergency case in which they have to respond to Quinn’s bike accident in the situation described and discussed earlier. Through the game, students will get an opportunity to experience what kinds of questions are often asked of a patient with a potential brain injury.

Ask students to click the link to “The Golden Hour”. The game will load and show an opening scene of an emergency helicopter and Quinn’s friend waving to it. Once the menu screen appears, ask the students to click on the “New” button to begin the game at the start of Scene 1.

- (Scene 1 can also be accessed from the menu screen by clicking on the “Scenes” button and then on “EMS Scene”.)

Allow students to proceed through the game by clicking the right pointing (next) arrow in each dialogue box or by clicking as directed by the dialogue. If a player is not responding, an object in the game will flash yellow, to further direct the player on what to do next.

In Scene 1, the Emergency Medical Services (EMS) Scene, students play the role of a first responder to the bike accident case. The scene opens in the helicopter interior with the player seated across from the EMT and next to the patient’s friend. The patient is lying down in front of the player. The EMT will begin the conversation by explaining to the player that the “golden hour” is a period of time after an injury during which the medical decisions made have a great impact on the outcome of the patient. In this scene the player will do the following:

- Check the patient’s vital signs (airway, breathing, circulation, temperature, and pupillary reflex)
- Use the Glasgow Coma Scale (GCS) to assess the patient’s cognitive function by testing his verbal, motor, and eye responses. The player will use the results of the GCS to classify the brain injury as “severe”, “moderate”, or “mild”.
- Ask the patient’s friend questions about what happened (How old is he? Were you wearing helmets?)
Note: The Golden Hour game will continue to be updated. Therefore, some of the details provided here (i.e. quoted dialogue) may change. However, overall, the content covered in each section of the game will remain the same.

At the end of Scene 1, students are prompted to complete a report to record their findings. After filling out the report, they are led through a dialogue with the lead physician in charge of this case (Dr. Picotte) where they need to decide the most appropriate next step for the patient and support their decision.

- This series of questions and subsequent written explanation can be used as the assessment section of the game in which students are asked to make sense of the information they gathered in scene 1.

This scene is designed within the claim, evidence, reasoning (CER) framework and encourages students to think critically about the information they have gathered. Through the dialogue and multiple-choice questions, the students are guided to select their claim, evidence, and reasoning for recommending next steps. At the end of the dialogue, students are prompted to write their recommendation in paragraph form. Here, encourage students to write their recommendation for what the next step should be (their claim), the evidence they collected that supports that claim, and the reasoning that explains how the evidence supports the claim.

Remind students they can pull up the tablet (by clicking on the tablet icon in the lower right corner of the game window) for help during this assessment scene. The tablet records the information they have collected and makes it available for the students’ reference.

After students have completed writing the summary of their recommendation, 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 write their recommendation on a separate sheet of paper. 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 EMT scene of the game may look like.

**Example Recommendation Summary**

_I recommend that the patient be taken in for a CT scan to verify and identify the potential brain injury._

_Evidence that supports this recommendation is the GCS score which indicates that the patient has sustained a moderate brain injury. As the GCS is only an indicator of injury, a brain scan is needed immediately in order to determine more detailed information about the presence, location, and type of brain injury. Additionally, the patient’s condition is considered stable enough to endure the lengthy CT scan procedure because his airway, breathing, circulation, and pupillary reflex are within normal range._
Scientific Practices: Constructing explanations and engaging in argument from evidence

Scientists must constantly exercise the ability to defend their claims, incorporate evidence, and work with peers to develop the best explanations of scientific phenomena. An important goal of science teaching is for students to use their understanding of science and the evidence available to them to construct logical and coherent explanations.

In the final portion of The Golden Hour scene described above, students are given the opportunity and appropriate scaffolds to practice these important skills. Situated in the format of a conversation with the lead physician, students are guided to make and defend a claim based on the evidence and knowledge they have accumulated. The claim, evidence, and reasoning framework used to develop this scene supports students and further structures the process as they develop the ability to construct explanations and engage in argument from evidence.

Conclusion of Lesson:
After the students have completed Scene 1 and its assessment in The Golden Hour game, have a whole class discussion. Ask the students to consider at least some of the following questions:

- Of the questions you wrote before the game, which ones were in the game? Which were not? Why? Should they have been in the game? What information would these extra questions add?
- What were some of the groups’ summaries for their recommendation for the next step?
- What were some of the new things you learned from the game?
- How is the GCS level of a patient determined? What are the three actions that are measured?
- What does the GCS score tell us about the severity of a patient’s brain injury?
- What additional information is needed to know what is happening inside Quinn’s head?

Through this discussion, students should be able to review the learning objectives set out for this lesson.

Explain to students that their homework assignment will focus on a famous case of Traumatic Brain Injury that was very important for neuroscience research. Phineas Gage, the study patient, suffered a penetrating head injury. To find out more about Gage, students will conduct an internet search. This will lead to Lesson 2, which introduces that different parts of the brain are associated with different functions through a brain dissection activity. Hand out the “Phineas Gage Internet Search” hand-out (U4_L1_Homework_PhineasGageInternetSearch) for students to use as a guide for their internet research. An answer sheet (U4_L1_Homework_PhineasGageInternetSearch_ANSWERS) is also provided for assessment purposes.

Also as homework (or an in-class assignment, depending on the time available) have students fill out the Lesson Journal for Lesson 1 (U4_L1_Homework_LessonJournal).
Students will fill out this journal for each lesson in the unit. As the class progresses through TBI unit, the journal will help students to bring concepts together and build understanding, and will help teachers to assess understanding and identify areas that are still confusing or challenging to the students. At the end of the unit, the completed journals are used as a review and assessment tool in the final lesson as students work to develop a “zine” that integrates ideas and content from the unit.

Teacher Pedagogical Knowledge

A zine (pronounced ZEEN) is a form self-publication with original text and images. Similar to a magazine, the topics are usually of a particular interest and the method of reproduction is via photocopiers.

Assessment

Students should be evaluated based on their feedback and participation during the group reading activity, the class discussion of the different classifications of TBI, developing their critical questions, and participating in the game. The EMS recommendation summary (CER paragraph) the students complete in The Golden Hour game can also be used as forms of assessment. Additionally, the homework items can serve as assessment opportunities.