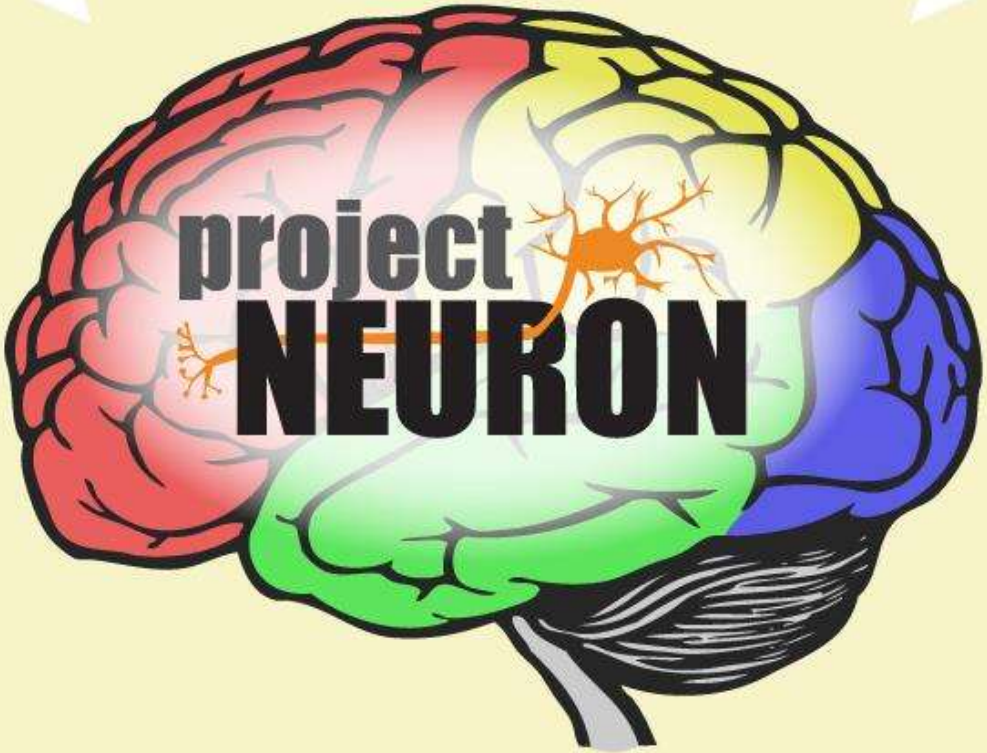
Evidence, evaluations, and explanations through neuroscience



NABT 2013 in Atlanta

Hillary Lauren, Chandana Jasti, Barbara Hug -- University of Illinois

What is Project NEURON?

- Curriculum development
  - Inquiry-based
  - Connect to standards
- Professional development
  - Summer institutes
  - Conferences
- Educators, scientists, and graduate students

Project NEURON Curriculum Units

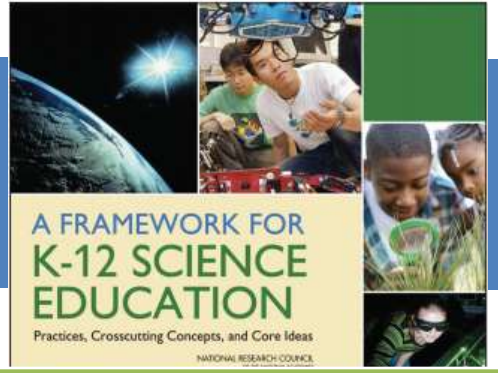
- **Do you see what I see?**
  - *Light, sight, and natural selection*
- **What can I learn from worms?**
  - *Regeneration, stem cells, and models*
- **What makes me tick…tock?**
  - *Circadian rhythms, genetics, and health*
- **What changes our minds?**
  - *Toxicants, exposure, and the environment*
  - *Foods, drugs, and the brain*
- **Why dread a bump on the head?**
  - *The neuroscience of traumatic brain injury (TBI)*
- **Food for thought: What fuels us?**
  - *Glucose, the endocrine system, and health*
- **What makes honey bees work together?**
  - *How genes and environment affect behavior*
- **How do small microbes make a big difference?**
  - *Microbes, ecology, and the tree of life*

Available at:
neuron.illinois.edu

Presentation Outline

- Overview of "Why dread a bump on the head?" unit
- Activities:
  - Use CER in a computer game (Lessons 1-3)
  - Examine micrograph data (Lesson 5)
  - Explore data related to sports injuries (Lesson 6)

A Framework for K-12 Science Education



Dimension 1: Scientific & Engineering Practices	Dimension 2: Crosscutting Concepts	Dimension 3: Disciplinary Core Ideas
1. Asking questions 2. Developing/Using models 3. Planning/Carrying out investigations 4. Analyzing & interpreting data 5. Using math, information and computer technology, and computational thinking **6. Constructing explanations** **7. Engaging in argument from evidence** **8. Obtaining, evaluating, communicating information**	**1. Patterns** **2. Cause and Effect** 3. Scale, Proportion, and Quantity 4. Systems and System Models 5. Energy and Matter **6. Structure and Function** 7. Stability and Change	Life Sciences • **LS1.A: Structure and Function** • **LS1.D: Information Processing**

What do you know about TBI?

What experiences do you have with TBI?

Why dread a bump on the head?

- L1: What is traumatic brain injury?
- L2: What does the brain look like?
- L3: How does a CT scan help diagnose TBI?
- L4: How to build a neuron
- L5: What happens to neurons after TBI?
- L6: Exploring the data behind brain injury
- L7: What can we tell others about TBI?

Why dread a bump on the head?

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The Golden Hour Game

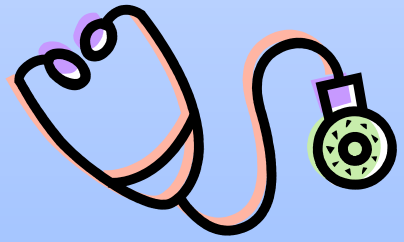
As the "super" medical student, the player must…

Scene 1: EMS

-Respond to 911 call

-Check vital signs

-Assess consciousness



Scene 2: CT Scan

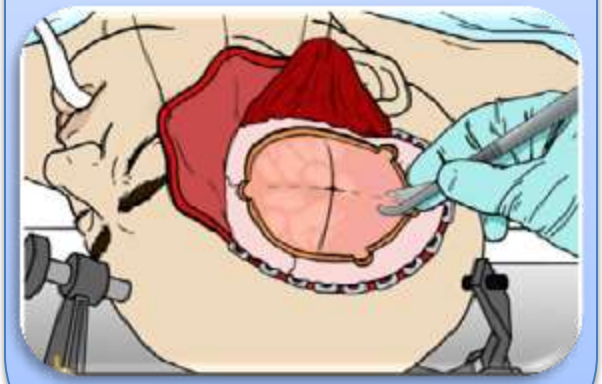
-Review brain anatomy and function

-Interpret CT scans

-Identify TBI location and type

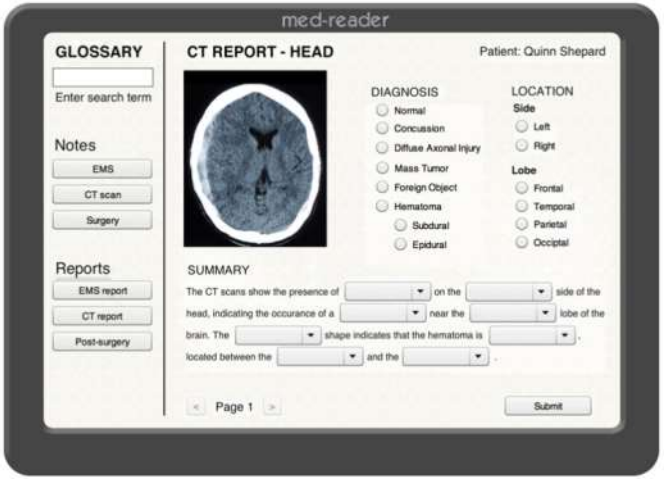
Scene 3: Surgery

-Conduct brain surgery



Assessment Scenes

- After each main scene
- Summative report
  - Data collection
- Multiple choice dialogue
- Open response: scientific explanation (CER)



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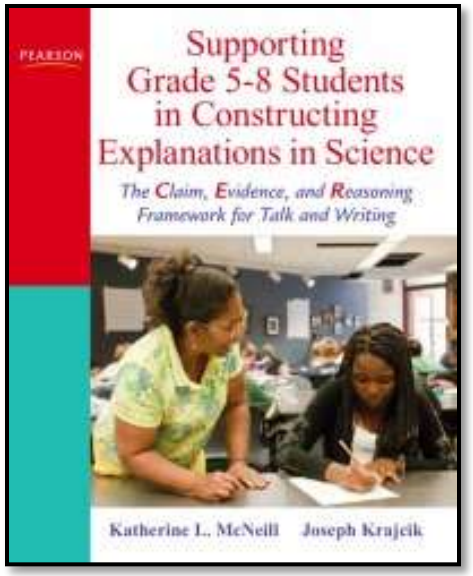
Claim, Evidence, and Reasoning

A framework for scientific explanation



McNeill & Krajcik (2012)

Claim

- A statement that expresses the answer or conclusion to a question or problem

Evidence

- Scientific data that supports the claim

Reasoning

- The justification that links the evidence to the claim

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Play time!

- Desktop icon:
  - Select “New Game”
  - Fill out paper reports and recommendations

- Online: **neuron.illinois.edu/goldenhour/**

Jump to Scene 1.5

- Refresh browser page
- Click on “Scenes”
- Select “Scene 1.5”

Why dread a bump on the head?

- L1: What is traumatic brain injury?
- L2: What does the brain look like?
- L3: How does a CT scan help diagnose TBI?
- **L4: How to build a neuron**
- **L5: What happens to neurons after TBI?**
- L6: Exploring the data behind brain injury
- L7: What can we tell others about TBI?

Lesson 5: What happens to neurons after TBI?

Objectives:

- Explain that TBI results in two types of cell death: necrosis and apoptosis.
- Compare/contrast the major characteristics of necrosis and apoptosis.
- Describe and explain multiple pieces of evidence of necrotic and apoptotic cell death.

Lesson 5: What happens to neurons after TBI?

What do micrographs of a typical neuron look like?

What is the morphology of cell death?

Which neurobiology technique to use?

What do results from the [second analysis] show us?

Typical Neuron

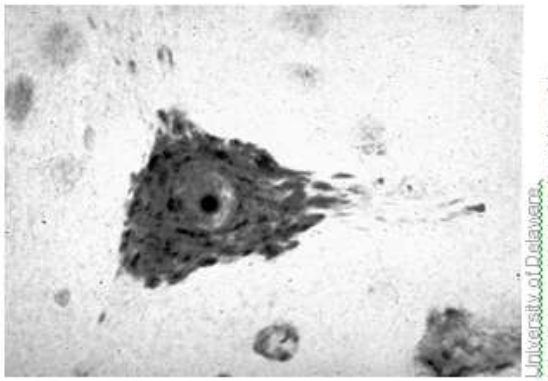


Figure 1: Typical neuron

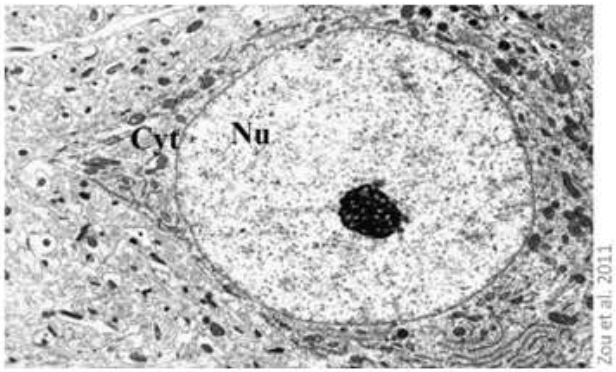


Figure 2: Typical nucleus of neuron

Use Figure 1 to answer Questions 1 & 2

1. In Figure 1, identify the following parts of a neuron. Use arrows and labels to indicate where they are.
   - Neuron
   - Nucleus
   - Nucleolus
   - Soma
   - Dendrites

2. The axon and axon terminal are not clearly identifiable in Figure 1. Why might this be the case? Where might they be?

Use Figure 2 to answer Questions 3 & 4

3. Describe the light gray material that can be seen inside the nucleus.
   a) What is it?

   b) Describe the state that it is in.

4. Why is the light gray material in this state?

Lesson 5: What happens to neurons after TBI?

What do micrographs of a typical neuron look like?

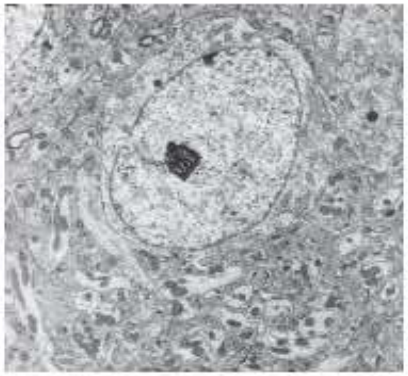
What is the morphology of cell death?

Which neurobiology technique to use?

What do results from the [second analysis] show us?

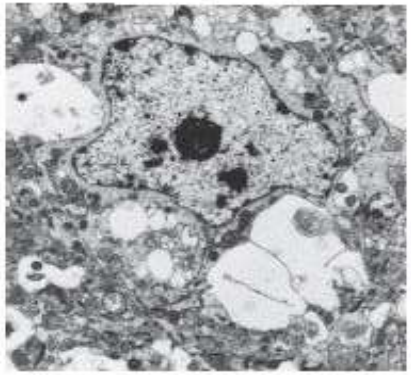
Below are images that show the sequences of neurons undergoing two different types of cell death. In each sequence, the first image (1-A and 2-A) show a typical nucleus. The following three images of each sequence show what was observed to happen to the neurons after a traumatic brain injury. Images 1,2-B and 1,2-C zoom in on the nucleus. Images 1,2-D zoom out to the whole cell level with an arrow pointing at the final stages of the neuron being observed.

Morphology of cell death over time: Type 1



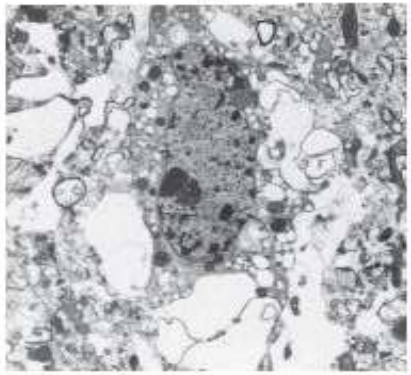
Martin et al. 1998

1-A. Typical nucleus



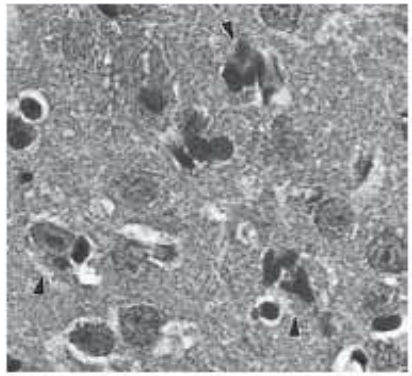
Martin et al. 1998

1-B. Nucleus



Martin et al. 1998

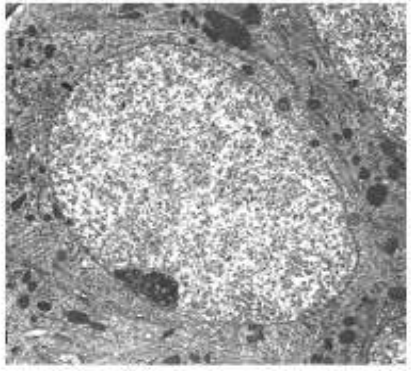
1-C. Nucleus



García et al. 1997

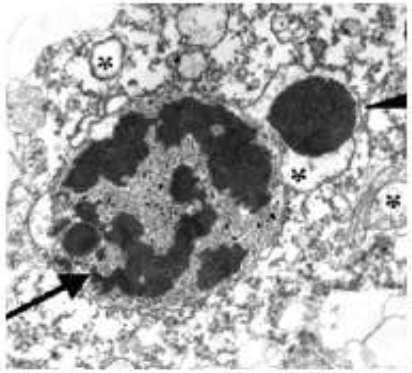
1-D. Whole cell

Morphology of cell death over time: Type 2



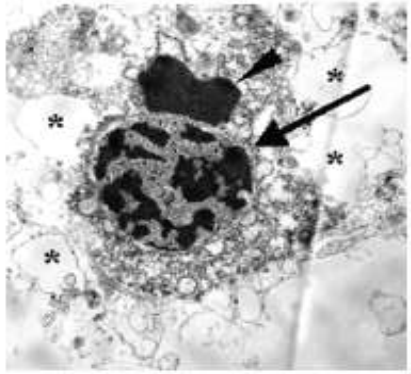
Wei et al. 2006

2-A. Typical nucleus



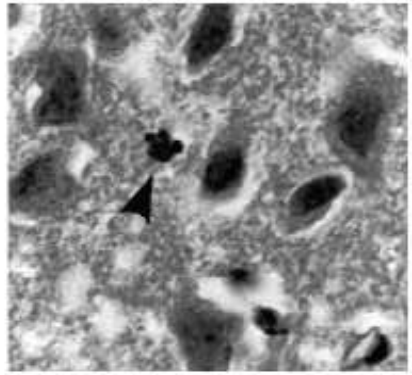
Wei et al. 2006

2-B. Nucleus



Wei et al. 2006

2-C. Nucleus



Li et al. 1997

2-D. Whole cell

Apoptosis or Necrosis?

Which cell death type do each of the morphologies show? Apoptosis or Necrosis? How can you tell?

Lesson 5: What happens to neurons after TBI?

What do micrographs of a typical neuron look like?

What is the morphology of cell death?

Which neurobiology technique to use?

What do results from the [second analysis] show us?

Lesson 5: What happens to neurons after TBI?

Evaluating Neurobiology Techniques			
Technique	**Claim**	**Evidence**	**Reasoning**
#1 Electrophysiology **#2 Animal Behavior** **#3 Gel Electrophoresis** **#4 Cell Culturing**	**This technique** **WILL / WILL NOT** **provide additional evidence about the occurrence of apoptosis and necrosis in brain tissue after TBI.**		

McNeill & Krajcik (2012)

Lesson 5: What happens to neurons after TBI?

What do micrographs of a typical neuron look like?

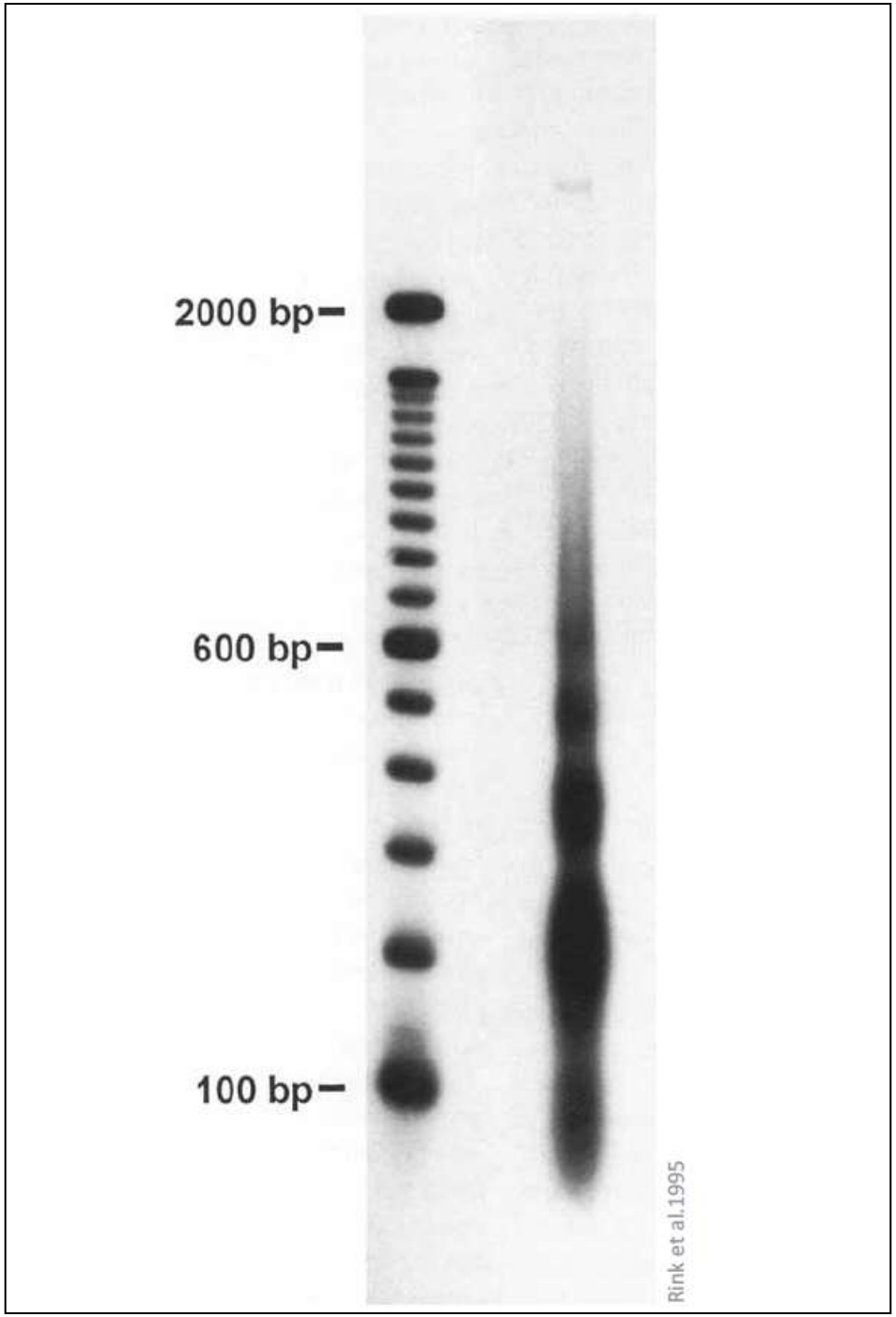
What is the morphology of cell death?

Which neurobiology technique to use?

What do the gel results show us?

DNA Gel Electrophoresis Results

What happens to cells after TBI?



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- L7: What can we tell others about TBI?

Lesson 6: Exploring the data behind brain injury

Objectives

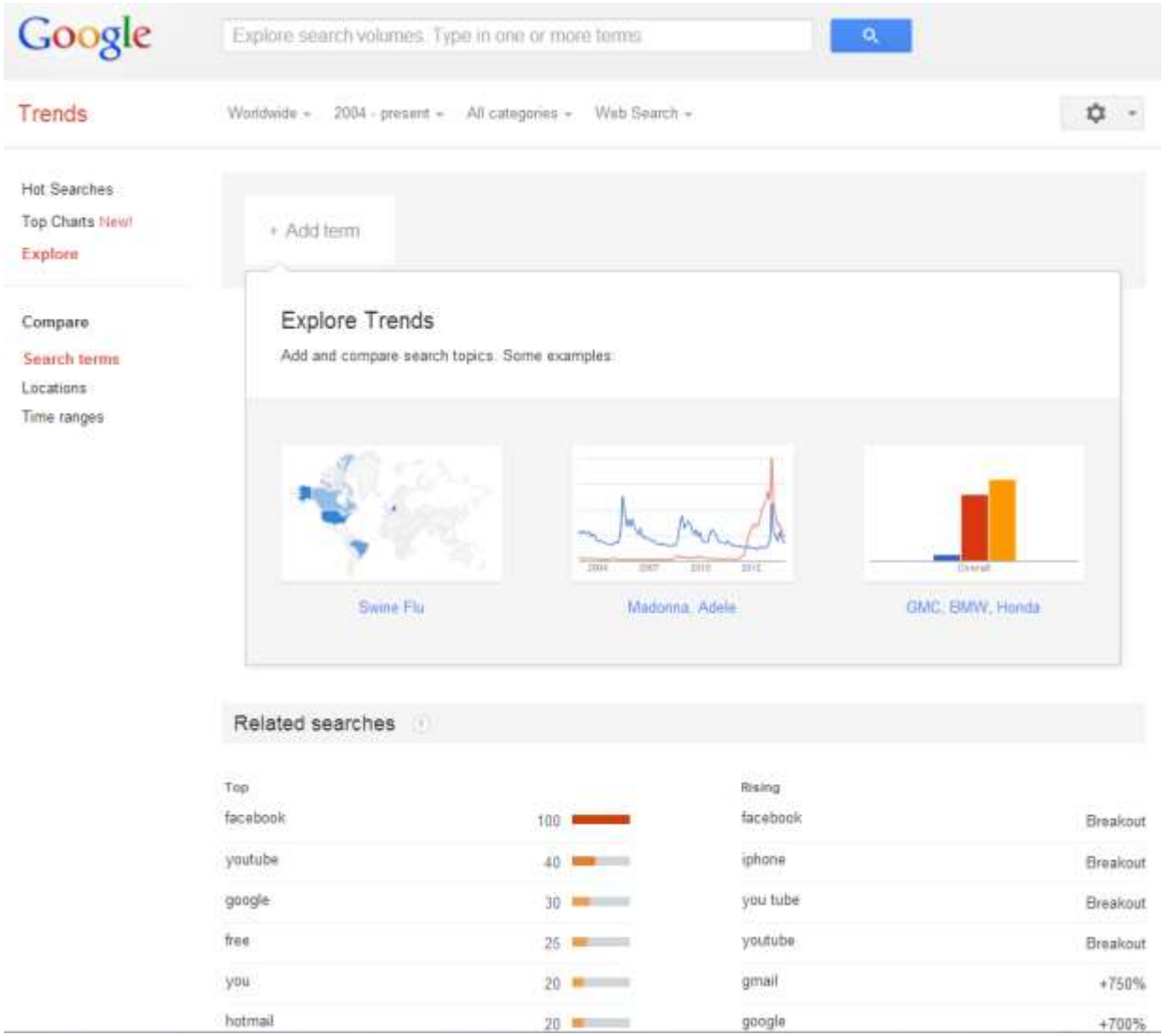
- Locate and analyze data across multiple sources to answer a question.
- Utilize web-based data sources to explore an issue.
- Develop skills to present raw data visually and communicate the data to others.

Lesson 6: Exploring the data behind brain injury

Activities:

- Exploring TBI data using Google Trends
- Using the Project NEURON dataset graphing tool

Exploring Google Trends



Project NEURON
Dataset Graphing Tool

Dataset Graphing Tool

Traumatic Brain Injury

Traumatic brain injury (TBI) covers a wide range of injuries to the brain. Data on TBI is collected from many sources such as hospitals, sporting events, the military, and surveys sent out to individuals that have sustained a head injury. Choose a dataset below that interests you to begin exploring the data behind TBI.

NCAA Injury Surveillance System

The NCAA Injury Surveillance System (ISS) was first developed in 1982 to provide current and detailed injury statistics for college-level athletics. Currently data is collected yearly via an online system where trainers and coaches can submit information about their player's injuries. The information collected by the ISS is used by the both colleges and the NCAA when making decisions and creating new policies for a particular sport. The system is free and periodically the NCAA publishes a summary of their data for 15 men's and women's sports. The data included here is from the most recent summary report in 2004.

NCAA Web link: http://www.ncaa.org/wps/portal/ncaahome?WCM_GLOBAL_CONTEXT=/ncaa/NCAA/Academics+and+Athletes/Personal+Welfare/Iss/index.html

The NCAA ISS data is divided into three subsets, each exploring a different aspect of sports injury:

Data Subsets:

Games and Practices With Associated Injury Rates

This subset of data shows the total number of games and practices, and injury rates reported for a particular sport since data collection was started. Injuries rates are divided out by the time during the season (preseasons, in season, and post season) and whether the injury occurred during a game or a practice. Use the table below to preview the kind of information presented in this dataset:

Variable	Explanation
Total Number of Games Reported	This is the overall number of games played across all teams reporting injury information to the NCAA ISS since data collection was started for the sport.
Game Injury Rate per 1000 Athlete Exposures	The rate of injuries sustained out of 1000 exposures to a possible injury during a game.

Using the Dataset Graphing Tool

1. Look carefully at each of the datasets to see what kind of information is available.
2. Find an article that connects with the available data.
3. Ask a question that is relevant to the article and can be investigated by the data.
4. Filter for the relevant data.
5. Generate a graph.
6. Analyze the results

An example

Text adapted from: Study: (2011, April). NHL players had 559 concussions from 1997-2004. *USA Today*.

A new study finds that the amount of time NHL players missed because of concussions increased from 1997 to 2004.

The report published Monday in the Canadian Medical Association Journal, the largest and most detailed analysis of concussions in hockey, examined physician reports from seven regular seasons. There were a total of 559 concussions during regular-season games, a concussion rate of 5.8 for every 100 players, or an estimated 1.8 concussions per 1,000 player-hours.

"We found some interesting trends — one being a gradual increase in post-concussion time loss over the seven years of study," said lead author Dr. Brian Benson of the Sport Medicine Centre at the University of Calgary's faculty of kinesiology. "That may be due to the concussions being severe or physicians being more conservative in their return-to-play decisions."

Benson said the NHL was looking at the data closely.

Of the 529 cases in which lost time was recorded, 31% involved players missing more than 10 days of competition. In 11% of those cases, players continued to play and then later reported symptoms to medical staff after the game.

The highest concussion rate recorded was 7.7 per 100 players in the 2000-01 regular seasons, while the lowest was 4.6 in 1997-98. The last year covered by the statistics — 2003-04 — saw a rate of 4.9 per 100 players.

Discussion

- How can students be supported in the critical analysis of the data and the graphs they generate?

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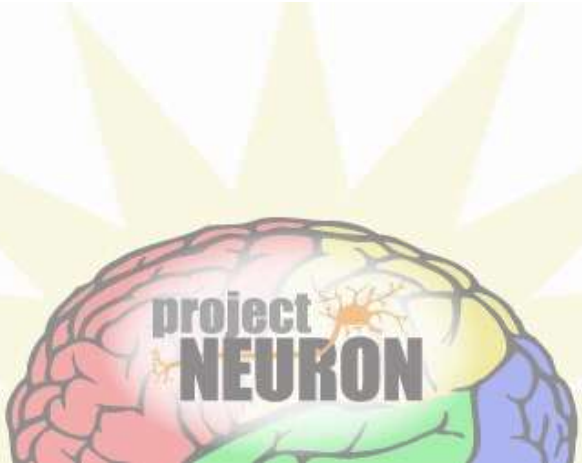
Lesson 7: What can we tell others about TBI?

- Explain the causes and effects of traumatic brain injury (TBI) to family members, friends, and people in the community.
- Design a page in a zine that incorporates past lessons and materials.
- Critically examine and evaluate peer work.



Discussion

- Pair and share
- How would you use these activities in your classroom?

Acknowledgements

- NIH, SEPA
- University of Illinois

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Thanks!

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