Supplementary Materials for

Teaching to expand student inclusion of societal concepts in science

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Supplementary Table 1: *List of IA Topics and Activities implemented in the Ideologically Aware section*. Full activities and annotated lectures available at https://tinyurl.com/IdeologicalAwareness.

IA Topics	Descriptions of Active Learning Activities
Representation in STEM	Students read select portions of a research article (Wood et al., 2020) dissecting representation within introductory science textbooks. Students scan textbooks for graphic depictions of scientists, analyze the themes, draw predictive graphs, and then discuss/critically analyze the results from the peer-reviewed article to compare to their own predictions. Additionally, students create scientist spotlights of a selected role model including the scientists' background, research, and why they picked this scientist to spotlight. Resources included: Project Biodiversify, Scientist Spotlights, 500 Queer Scientists, 500 Women Scientists, Science Buddies: Hispanic Scientists and Engineers, and Cross Talk: 1000 Inspiring Black Scientists in America.
Biological Research Ethics	Students learned about unethical experimentation in biology and medicine. Students worked in groups to research and present on an assigned unethical study. Topics included Josef Mengele's German Twin Experiments; Japan's Imperial Army Unit 731 experiments; Tuskegee Syphilis Study; and J Marion Sims' Gynecology Surgical Experimentation. This was then followed by a discussion of the ethical violations, how society responded, and what current rules would prevent these experiments from happening including an explanation of the Belmont Report and the ethical framework that led to the development of the Institutional Review Board (IRB). Additionally, Students read "The Immortal Life of Henrietta Lacks" by Rebecca Skloot (2010) throughout the course. At the end of the semester, they debated the legality of tissue ownership drawing from the lesson on biological research ethics and the story of Henrietta Lacks. In detail, they spent the first part of class building an argument to support their pre-existing opinion. Students then participate in a debate supporting their original opinion. To finish the activity, students switch sides and form an argument to support the opposite viewpoint.
Integration of Evolution and Religion	A brief lecture defining cultural competency and evolution is presented. Students are asked to discuss "is evolution controversial?" Students break into groups and determine what can and cannot be properly evaluated using the scientific method from a list of examples. Discussion of the coexistence of science and religion including quotes from religious leaders and evolutionary biologists of faith. In this lesson students will learn about the affordances and limitations of science and develop their cultural competency through collaboration, discussion, and a variety of class activities to understand that science and belief in religion can coexist.
Genetics of Gender and Sexuality	Students read articles and chapters written by biologists related to organisms' sex and sex determination process, access and communicate their prior knowledge, and learn the appropriate terminology when discussing sex and gender. Students then reflect and discuss the interaction of societal norms and science. This includes the use of a "know, want to know, learned (KWL) chart", group, and class discussion.
Environmental Justice	Students discuss the basic principles of pollution, exposure to chemical releases, and air pollution. This includes specific examples (Flint Water Crisis, Cancer Alley, Uniontown AL, and Cheraw SC). Students predict pollution and emissions across the United States based on population and compare it with data collected from the CDC to examine which populations are considered to be "at risk", and discuss how we make decisions about pollution management as a society. Students will be exposed to how the implications of environmental factors are disproportionally felt by oppressed populations across socioeconomic status, race, ethnicity, and gender axes. This activity combines predictive graphing with peer-reviewed article critiques and group discussion.
Healthcare Disparities	Students will learn about the healthcare disparities among people with historically excluded identities (racial, gender, and socioeconomic) by reading healthcare articles in groups and developing concept maps both individually and collaboratively. Students will have a deeper understanding of the healthcare field by learning about the sources, effects, and solutions for healthcare disparities on marginalized communities. Students will know how to synthesize and connect concepts related to the sources, effects, and solution of healthcare disparities from primary research

Designer Babies & Genetic Modification	Students receive information about the latest gene editing technology including CRISPR-Cas9. Students then discuss/debate hypothetical pre-natal gene editing cases in small groups and answer a series of discussion questions. One case is based on medical necessity and another is cosmetic. They discuss the ethical implications of gene editing and the societal implications. The activity concludes with a class discussion and reflection questions as an assessment.

On the next page, we include the concept map final assignment. This 4 page PDF was given to students as instructions for their concept map. Includes links to tutorials, instructions, software resources, and primary literacy about how concept maps work as learning tools. It also includes the specific prompt for their concept map. It then includes a tips and tricks section, and grading procedure.

Final Exam Concept Map Assignment

Prior to Beginning Your Concept Map

Hello! As part of your final exam, you will be completing a concept map of all the biological information you learned this semester. If you have never completed a concept map before, this may be a bit challenging. If you have experience with concept maps, this will likely be the most extensive map you have created to date. Please look through all of the links provided below in order to familiarize yourself with concept maps and how to properly produce this particular map for your final exam.

1. Visit this webpage and watch the tutorial on completing concept maps: https://www.youtube.com/watch?v=8XGQGhli0I0
2. Visit the following links for more detailed written directions on concept mapping, as well as a guide on an alternative program "cMAP". https://www.evidencebasedteaching.org.au/concept-mapping-complete-guide/
3. Choose a platform to create your map. The above YouTube video uses a free web-based platform "Lucid". You are welcome to do that. Additionally, you may draw it by hand, or use one of the other following programs:
   ClickCharts Diagram & Flowchart Software and Gliffy are web-based products that include built in templates to help you get started.
   Visual Understanding Environment is a free open source software that you can download to your personal computer.
   cMAP from the Florida Institute for Human and Machine Cognition (IHMC).
   Microsoft Office products have many templates for displaying relationships and processes, The SmartArt feature is built into the Insert tab within Microsoft Word and PowerPoint that you can use to create your concept map
4. Check out this paper detailing the importance and usefulness of concept mapping as a learning tool. The author provides advice on using concept maps in regards to structure, feedback, exam alignment, and learning styles and study habits. Reference: Weimer, M. (2015, January 20). Keeping students on board with concept maps. Faculty Focus. Retrieved from http://www.facultyfocus.com/articles/instructional-design/keepingstudents-board-concept-maps/

Creating Your Own Concept Map

Create a concept map to describe the relationship between the core biology principles taught in this class (i.e.. Ecology, evolution, genetics, etc.) and their interconnectivities. Tap into the interdisciplinary nature of science by creating connections within the map to display the relationship between science and society.

This should be a depiction of all you've learning this semester. Make sure you represent each biological concept fully. The amount of connections and topics you have should be a reflection of your knowledge. The amount of stuff you have written tells me how much you learned. In order to do this properly, we expect it will take you multiple hours.

Essential Reminders

Tips and tricks:

1. Use arrows to explain the connections between your key terms
2. Don't forget to show the interconnectivity of topics. Remember to show how biological concepts relate to each other in addition to the societal topics. This is not a flow chart and should not be entirely linear. If you need to, look up additional information on the differences between flow charts, concept maps, and mind maps.
3. Touch on as many biological topics as possible- including specifics. Start with your main topics (genetics, anatomy, physiology, ecology, evolution, cells, the nature of science, etc.) and continue to build on those main topics to include more detailed explanations. For example, under genetics, you may want to detail trait dominance, inheritance, Mendel, Punnett squares, pea plants, etc.). Then be sure to connect those specific details to additional topics, such as the connection between inheritance and reproductive physiology.
4. Add in any connections you can make with society. Think about your everyday life and what is going on around you. In what ways do the core biological concepts taught in class related to those societal topics. One example may be the relationships between viruses and vaccines, but be sure to include enough detail to describe that relationship within the concept map.
5. We want to know what you know, not what google knows. Each one of you will turn in a vastly different concept map, and that is okay! Do not panic about catching every little detail from the semester, just be a thorough as possible. This is open-note in the sense that you may use your notes and your textbook. Do not use the internet. This assessment is made to help you draw connections, and internet searches will not help you do that. We are very familiar with the results from such google searches, and we expect you to go beyond what can be found through such a search.
6. Be creative! Make jumps… don't get stuck on "my book doesn't say this". You will need to take the knowledge gained throughout the semester to draw new connections with the world around you. Those connections won't always be found in your text, and we **do not** expect citations. You will need to think critically, and outside the scope of information given to you explicitly in order to complete this assignment.

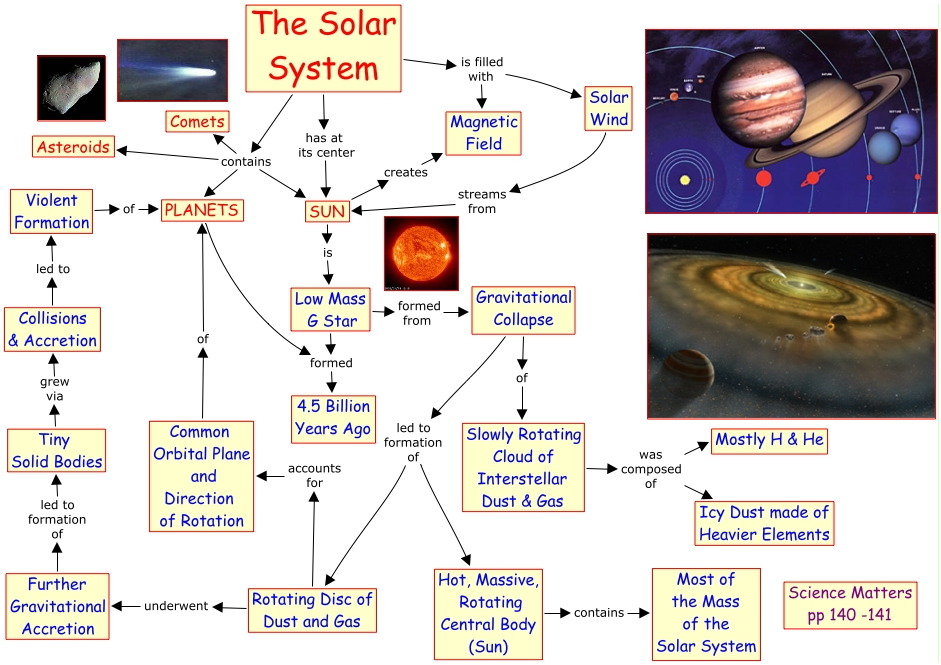
Grading Procedure

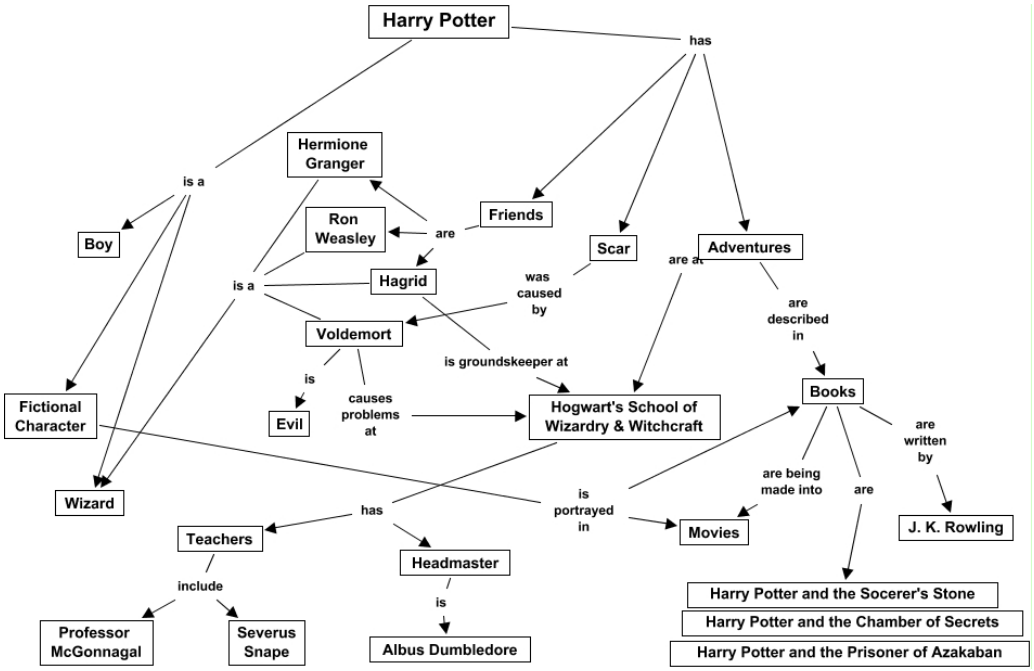
As each of you will produce a differently, creative concept map that is uniquely yours, it is not possible to give a detailed grading rubric. However, we have provided the expectations below.

1. Think of this as another form of final exam. Rather than being given a pre-determined set of questions to answer that I feel accurately reflect the knowledge you should have gained this semester, this is your opportunity to show me what you have learned. Therefore, whatever you turn in should accurately portray your knowledge base. This means that your concept map will likely be incredibly complex, and will take you quite some time to put together.
2. You will receive credit based on:
    a. The number and thoroughness of biological concepts included;
    b. The proper formation of a concept map (using connection words on lines, including major concepts as well as detailed objects). If these terms confuse you, see the YouTube link on page one and take a second to review the tutorial);
    c. Your ability to connect the biological concepts to one another;
    d. Your ability to connect biological concepts to societal issues and ideas;
    e. The thoroughness of your concept map as a whole;
    f. The presentation of your concept map; and
    g. The amount of effort dedicated to the assignment

Example Concept Maps:

Note: This is a guide as to style. Remember, yours will be much more extensive, and include the societal component as well.





See this page for 10 additional examples if needed:
https://mindmapsunleashed.com/10-really-cool-mind-mapping-examples-you-will-learn-from