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IB Theory of Knowledge 2007-2008

Some Strategies for Use in Math and Natural Science Units

NATURAL SCIENCE:

SOME SUGGESTED RESOURCES:

1. *The Examined Life* Video Series: http://www.tutorace.com/html/the_examined_life.html
   Episodes 15 & 16
   15. How does science add to knowledge? highlights the classic, Baconian inductivist view that grew out of the Scientific Revolution and the challenges posed by Karl Popper (falsification) and Thomas Kuhn. Includes consideration of Kuhn's views about the role that paradigm theories play in scientific revolutions.
   16. Does science give us truth? looks at correspondence, coherence, and pragmatist theories of truth, and how conflicts have carried over into realist vs. antirealist views of science, including the Einstein-Bohr debate about quantum mechanics.

2. UC Berkeley Online Tutorial about the Nature of Science: http://evolution.berkeley.edu/evosite/nature/index.shtml

3. IB Scientific Method diagram (attached) from a Biology Teacher Training Workshop

4. "Importance of Teaching the Nature of Science" by Larry Flammer (attached); published in *The Biology Teacher*. http://www.indiana.edu/~ensiweb/pap.nos.id.lar.html

5. Quiz on the nature of science as an area of knowledge (also from Larry Flammer; also attached) http://www.indiana.edu/~ensiweb/lessons/sci.tst.html

6. In-class scientific investigation. I provide students with a number of butterflies (these can be purchased from various online suppliers. I use only common native species, as these will not damage the ecosystem and they may serve to interest students in observing the butterflies in our region.) I provide them with no other resources, but tell them that their job is to identify as many of the butterflies as they can. They cannot take the butterflies with them. I give them over a weekend to try to find identifications from their class notes (or drawings, if they make any—surprisingly few think of it!). The next class, I give them a "quiz" in which I show photos of the butterflies we actually observed in class along with very similar species. Students are asked to state a) whether that butterfly was in class and b) if it was, what kind of butterfly it is. Naturally, very few, if any, butterflies are correctly identified. This leads to a discussion of the nature of observation, the problems of data collection, the role of assumptions, attitude, effort, persistence, and so on. It also generally leads to a discussion of what constitutes a species, which also lends itself to a discussion of the role of classification (as a human construct) within the greater role of trying to learn about the physical character of the universe.

MATHEMATICS:

SOME SUGGESTED RESOURCES:

7. Ideas about mathematics: the requirement for certainty (the nature of "proof"); the impossibility of establishing certainty through trials;); the difference between probability and certainty; the nature of coincidence; the abstract nature of math and how that abstraction allows for calculations of ideal situations that cannot be realized in the physical world (Zeno's paradox of the racecourse; http://faculty.washington.edu/smcohen/320/zeno1.htm)

8. *The Proof*: http://shop.wgbh.org/product/show/7827 . This is a 1997 video from PBS that tells the story of Andrew Wiles and his solution to Fermat's Last Theorem. This is a great video and prompts discussion about many aspects of math ranging from the social nature of making knowledge to the formal process of peer review, to the need for certainty, to the emotional nature of this (or any other) high level academic pursuit. This is not, so far as I know, available as a DVD.

9. The Monty Hall Problem: I use this sometimes with mathematics and sometimes with the unit on reason as a way of knowing. There are a zillion places to get information about this; one good source with links to simulators is:
   http://www.grand-illusions.com/articles/monty_hall/index.shtml
   This provides a great opportunity for students to discuss the problem of pre-conceptions and intuitive "knowledge" vs the rigorous nature of math. It also provides a great example of how emotion keeps us from being able to reason clearly. Provides an opportunity to discuss probability and the reliability of a small number of tests vs. a very large number of tests. Simulator at: http://www.grand-illusions.com/simulator/montysim.htm

10. In-class mathematical investigation: I ask students to prove Pythagorean's Theorem. They generally cannot, although they are very familiar with it and trust it. I then show them a video from Project Mathematics (out of the California Institute of Technology): http://www.projectmathematics.com/pythag.htm (I have this on a regular VCR tape, but apparently the clips are now available online! The online videos, however, are very small, and not great for whole class use, unless each student has access to a computer.) Use segment 11, "A Dissection Proof" (segment 10 is also very cool). After they see this proof, I give students scissors, paper, etc., and ask them to replicate it. They almost never can, because they are not careful. They don't measure, they don't cut straight, they assume that their "square" is "square" because it looks "square," and so on. You can order the regular video at: http://www.projectmathematics.com/bookstor.htm

11. I have sometimes used this website to examine connections between mathematics and art, generally after we have done some work with perspective drawing and the idea of the golden ratio. http://www.vermeersriddlerevealed.com/music_lesson.shtml This is prepared by one individual, who thinks that he has found clues to a secret religious society hidden in the paintings of Vermeer. He claims to demonstrate all these secret mathematical principles in the drawings on this website. Often, however, the mathematical basis he claims for each painting seems to be entirely arbitrary. This leads to lively discussion about the validity of this author's claims, and to a discussion more generally about evaluating claims.