Chapter 1 (The Scientific Method)

Big Ideas:

- ➢ If you cannot verify your aims, it's not science.
- ➢ Scientific inquiry aims to acquire more knowledge
- ➢ Scientific hypothesis must be verifiable, refutable, and reproducible
- ➢ If a hypothesis is never falsified after lots of testing → theory

Notes:

- Science: A coherent body of knowledge related to certain categories of facts, objects or phenomena obeying laws that are verifiable through experimental methods.
- Two approaches:
    - Description based (e.x. Describing nature)
    - Hypothesis-based (e.x. Explaining nature)
    - You need to describe nature before you can explain it!
- The Scientific Method:
    - Inductive reasoning → linked to descriptive-based approach
        - Making a generalization often based on numerous specific observations
        - Look at something particular several times to make a generalization
        - Not good method for science
        - E.x you see 400 people entering a classroom, and make the general assumption that there is a lecture. High chance that the assumption is either right or wrong.
    - Deductive reasoning → linked to a hypothesis-based approach
        - Stating a hypothesis and drawing conclusions (after observations/experimentation) from this hypothesis
        - With a generalization, you make a hypothesis and test something particular
        - This is what method scientists should use, easy to eliminate wrong generalizations with testing, and modification of hypothesis can take place
    - Inductive reasoning (and scientific inquiry as a whole) always starts with an observation and leads to a generalization which can be tested with an hypothesis
    - The scientific process must be implemented to lead to a result of an explanation
        - In the case of the media, observation is more valuable than the explanation (e.x. Hundreds of fish die in a lagoon, with no explanation given), as gaining an explanation takes time
    - Without testing, generalizations get muddy.
        - You need tests with your generalization to come up with a conclusion
- The Scientific Process
    - Hypothesis must be verifiable (can be tested), refutable (can be challenged with proof), and reproducible (can be retested and applied to similar scenarios)
    - Fraud occurs all the time when there is not a clear process outlined, in which the path of the question/generalization is determined with tests

- From a hypothesis you can make a prediction, prediction is help in proving hypothesis, must be testable and composed into an if/then statement
    - There needs to be a way to test a hypothesis if you want to make a scientific inquiry
        - Test is the mechanical verification
- You can NEVER prove that a hypothesis is scientific truth. That's why hypothesis always get retested
- If your hypothesis is falsified, you need to make a new hypothesis, tweaked with the new observations you have made
- If a hypothesis is tested multiple times and still holds up, turns into a theory
- Observations → hypotheses → predictions → tests → Hypothesis (which if refuted goes back to hypothesis stage, but if non refuted goes back to more testing)
    - This is theoretically how science progresses
    - If you want to produce date and further scientific knowledge, you must follow the science-data contract and its rules
- Rules/contract between science and knowledge (the ability to know)
    - Skepticism on Facts
        - We ask honest questions on facts and hypothesis (tangible/real things) and we always retest what has been found
    - Realism
        - The world is older and exists independently from my perception of it (the realm of ideas does not have the priority over the real world)
        - Study the real world, not a/your perception of it = no biases
        - You must look at nature for what it is, not through and biases or your perception of it
        - Never try to find your result, try to falsify your hypothesis/result
    - Rationality
        - Logic: demonstrations from a scientist must be the result of coherent steps
            - Conclusion must be the result of logical steps
        - Parsimony: methodological principle which states that acceptable theories are hypothetically the most economical in assumptions
            - What scientists prefer is to go for the simplest assumptions (less is better)
                - E.x. No one knew how crop circle enigma came about, some believed it was extraterrestrial life. Started looking in super detail at DNA, etc. Turns out it was just humans, which was the original simple/straightforward hypothesis
                - Simplest hypothesis might be closer to the truth
    - Methodological Materialism

- All that is experimentally accessible in the real world is material or has a material origin - not supernatural
    - You cannot prove with ideas, has to be verifiable in the real world

- Examples
    - Association with Color, mimicry
        - Important, sign that the animal is toxic, warning to predators
        - Monarch butterfly lays in milkweed, in which the caterpillars get toxic through eating this plant
        - Once a bird tries it, it spits it out and doesn't try eating it again
        - Viceroy takes advantage of this fact
        - Batesian mimicry: non toxic species copes toxic species coloration (birds have more tendency to avoid them)
        - Test: They tested this mimicry and the bird was fed both bodies and spat both out. Turns out viceroy was toxic.
        - Mullerian mimicry: toxic species copies toxic species to decrease chance of mortality, better sends the message across
    - Fur colouration
        - The mouse can either be white or brown, same species
        - The white mice are found in the white sandy region, and the brown are found in the desert areas
            - These are adaptations in mimicry to the environment
        - Test: To see if their colouration pattern does not match their habitat, then they will be preyed on more heavily than the native, well camouflaged mice.
        - Shows importance and real assiscation with colour and the environment