Quantitative Literacy:
Thinking Between the Lines

Crauder, Noell, Evans, Johnson

Chapter 1:
Critical Thinking

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Lesson Plan

- Public policy and Simpson's paradox: Is "average" always average?
- Logic and informal fallacies: Does that argument hold water?
- Formal logic and truth tables: Do computers think?
- Sets and Venn diagrams: Pictorial logic
- Critical thinking and number sense: What do these figures mean?

1.2 Logic and informal fallacies: Does that argument hold water?

Learning Objectives:

- Study of Logic and examine informal logical fallacies:
  - Logical arguments
  - Fallacies of relevance
  - Fallacies of presumption
  - Inductive reasoning and pattern recognition

1.2 Logic and informal fallacies: Does that argument hold water?

- **Logic** is the study of methods and principles used to distinguish good (correct) from bad (incorrect) reasoning.
- A logical argument consists of **premises** (**hypotheses**) and a **conclusion**. The premises are assumptions that we accept as a starting point. The argument is **valid** if the premises justify the conclusion.
- **Example:** Identify the premises and conclusion of the following argument. Is this argument valid?

  All wizards have white beards. Gandalf is wizard.

  Therefore, Gandalf has a white beard.

- **Solution:** The premises are: (1) *All wizards have white beards* and (2) *Gandalf* is a *wizard*.

  The conclusion is: *Gandalf* has a *white beard*. This is a valid argument.

1.2 Logic and informal fallacies: Does that argument hold water?

- The **fallacy** refers to an argument that may on the surface seem to be correct but is in fact incorrect.
- An **informal fallacy** is a fallacy that arises from the content of an argument, not its form or structure. The argument is incorrect because of *what* is said, not *how* it is said.
- A **formal fallacy** arises in the form or structure of an argument. The fallacy is independent of the content of the argument.

1.2 Logic and informal fallacies: Does that argument hold water?

- **Fallacies of relevance:**

the premises are logically irrelevant to, and hence incapable of establishing the truth of, their conclusions.

A. **Appeal to ignorance:**
   1. A certain statement is unproven.
   2. Therefore, the statement must be false.

- **Example:** *For over 75 years people have tried and failed to show that aliens have not visited Earth. So we must finally accept the fact that at least some of the UFO reports are based on actual alien visits.*

B. **Dismissal based on personal attack:**

1. A person presents an argument or point of view.
2. The character of that person is brought into question.
3. Based on the character attack, it is concluded that the argument or point of view is incorrect.

- **Example:** *My political opponent is against government-funded health care, and she also has a reputation for being heartless. She refused to seek medical treatment for her own father when he was ill. So government-funded health care is a good idea.*

C. **False authority:**

1. A person makes a claim based on his or her authority.
2. The claim is outside the scope of that person's authority.
3. The truth of the argument is concluded based on the authority of the claimant.

- **Example:** *Over the past few years, I have starred in a number of the most popular movies in America, so I can assure you that Johnson and Johnson's new anti-nausea drug is medically safe and effective.*

D. **Straw man:**

1. A position or point of view is presented.
2. The case for dismissing a distorted or *different* position or point of view (the straw man) is offered.
3. The original position is dismissed on the basis of the reputation of the straw-man position.

- **Example:** *A group of my fellow senators is proposing a cut in military expenditures. I cannot support such a cut because leaving our country defenseless in these troubled times is just not acceptable to me.*

E. **Appeal to common practice:**

1. The claim is offered that a position is popular.
2. The validity of the claim is based on its popularity.

- **Example:** *It is OK to cheat on your income taxes because everybody does it.*

1.2 Logic and informal fallacies: Does that argument hold water?

- **Example:** Identify the fallacies of relevance.

1. *I have scoured the library for information on witchcraft. I cannot find a single source that proves that anyone accused of witchcraft was actually capable of anything magical. This shows that there is no such thing as a real witch.*
2. *The popular actress Jane Fonda condemned America's involvement in the Vietnam war. So we know that conflict was a civil war in which America should never have been involved.*

- **Solution:**

1. We rely on a lack of proof to draw the conclusion. This is appeal to ignorance.
2. This argument involves false authority. Jane Fonda was a popular actress does not lend authority to her opinion about the war.

Fallacies of presumption:

False or misleading assumptions are either tacitly or explicitly assumed, and these assumptions are the basis of the conclusion.

A. False dilemma:

1. An incomplete or inaccurate list of consequences of not accepting an argument is presented.
2. A conclusion is drawn based on the best (or least bad) of these consequences.

- **Example:** *You'd better buy this car or your wife will have to walk to work and your kids will have to walk to school. I know you don't want to inconvenience your family, so let's start the paperwork on the automobile purchase.*

B. **False cause:**

1. Two events occur together, or one follows the other.
2. The fact that the events are related is used to conclude that one causes the other.

- **Example:** *Studies have shown that many people on a high-carbohydrate diet lose weight. Therefore, a high-carbohydrate diet leads to weight loss.*

C. **Circular reasoning or begging the question:**

1. A position or argument is offered.
2. The position or argument is concluded to be true based on a restatement of the position.

- **Example:** *Establishing government-run health insurance would be a mistake because it is just flat wrong to do it.*

D. **Hasty generalization:**

1. A statement is true in several cases that may be atypical.
2. The conclusion that it is generally true or always true is drawn based on the few examples.

- **Example:** *I know the quarterback, the tight end, and the center on our football team, and all three are excellent students. The athletes at our university do not shrink their scholarly duties.*

Some Common Informal Fallacies

- **Appeal to ignorance:** A statement is either accepted or rejected because of a lack of proof.
- **Dismissal based on personal attack:** An argument is dismissed based on an attack on the proponent rather than on its merits.
- **False authority:** The validity of a claim is accepted based on an authority whose expertise is irrelevant.
- **Straw man:** A position is dismissed based on the rejection of a distorted or different position.
- **Appeal to common practice:** An argument for a practice is based on the popularity of that practice.

Some Common Informal Fallacies

- **False dilemma:** A conclusion is based on an inaccurate or incomplete list of alternatives.
- **False cause:** A causal relationship is concluded based on the fact that two events occur together or that one follows the other.
- **Circular reasoning:** This fallacy simply draws a conclusion that is really a restatement of the premise.
- **Hasty generalization:** This fallacy occurs when a conclusion is drawn based on a few examples that may be atypical.

1.2 Logic and informal fallacies: Does that argument hold water?

- **Example:** Classify the following fallacies:

1. *He says we should vote in favor of lowering the sales tax, but he has a criminal record. So I think decreasing the sales tax is a bad idea.*
2. *My dad is a professor of physics, and he says Dobermans make better watchdogs than collies.*

- **Solution:**

1. We dismiss a position based on a personal attack.
2. Knowledge of physics does not offer qualification for judging dogs. This is a use of false authority.

1.2 Logic and informal fallacies: Does that argument hold water?

- A **deductive** argument draws a conclusion from premises based on logic.
- **Example:** **Premise:** (1) All men are mortal and
  (2) Socrates is a man.

Deductive conclusion: Therefore, Socrates is mortal.

- An **inductive** argument draws a conclusion from specific examples. The premises provide only partial evidence for the conclusion.
- **Example:** **Premise:** Every college football player I have ever seen is male.

Inductive conclusion: All college football players are male.

1.2 Logic and informal fallacies: Does that argument hold water?

- **Example:** A certain organism reproduces by cell division. The following table shows the number of cells observed to be present over the first few hours:

Hours	0	1	2	3	4	5	6
Number of cells	1	2	4	8	16	32	64

Describe the pattern shown by the table and suggest a general rule for finding the number of cells in terms of the number of hours elapsed.

- **Solution:** The number of cells present by raising 2 to the power of the number of hours elapsed.

Hours	0	1	2	3	4	5
Number of cells	$1 = 2^0$	$2 = 2^1$	$4 = 2^2$	$8 = 2^3$	$16 = 2^4$	$32 = 2^5$

Chapter 1 Critical Thinking: **Chapter Summary**

- Public policy and Simpson's paradox: Is "average" always average?
  - Understand that Simpson's paradox is a striking example of the need for critical thinking skills.
  - Overall average may lead to *invalid* conclusion.
- Logic and informal fallacies: Does that argument hold water?
  - Logical argument involves: Premises, Conclusion
  - Informal fallacies: *fallacies of relevance,*
    fallacies of presumption
  - Deductive arguments and Inductive arguments

Chapter 1 Critical Thinking: **Chapter Summary**

- Formal logic and truth tables: Do computers think?
  - Formal logic: The truth table
  - Operations on statements: Negation, conjunction, disjunction, conditional or implication.
- Sets and Venn diagrams: Pictorial logic
  - The Venn diagrams: Analyze logical statements.
- Critical thinking and number sense: What do these figures mean?
  - Relative sizes of numbers are indicated using *magnitudes* or powers of 10.
  - Estimation: To avoid complicated computations