

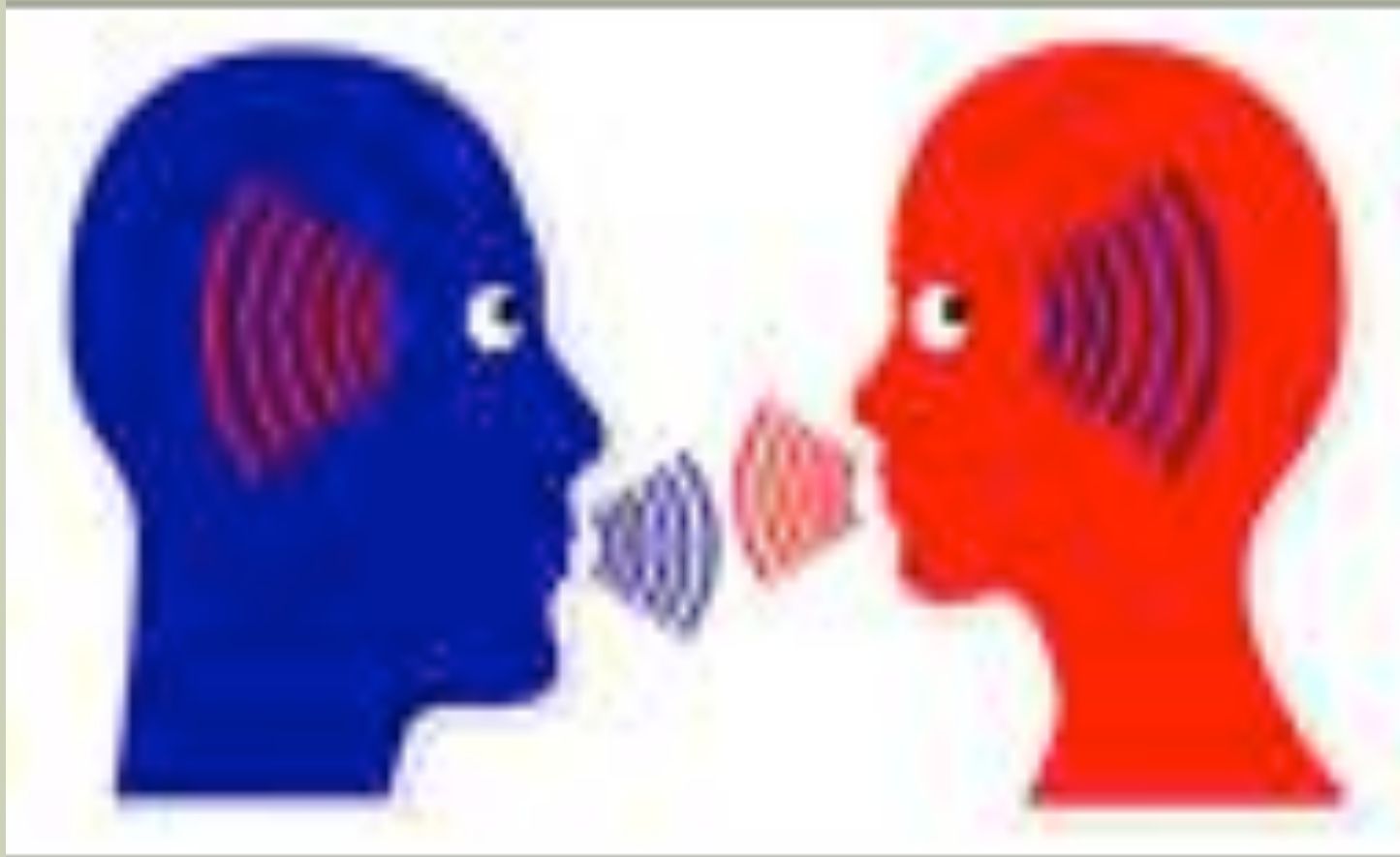
**ARGUMENTS ON THE COMPLEXITY
OF EDUCATIONAL CHANGE AND THE
COMPLEXITY OF ARGUMENTS**

Dr. E. Michael
Nussbaum
APA Division 15
Presidential
Address
Chicago, IL,
August, 2019

TWO ICONIC SYMBOLS



SPEAKING & LISTENING (DISCOURSE, ARGUMENTATION)



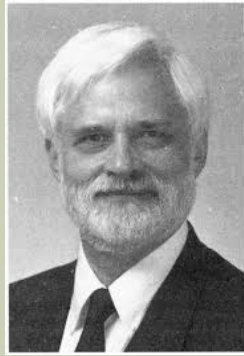
OUTLINE OF TALK

- My mentorship/interest in argumentation.
- The evolution of my research.
- Complexity in arguments and educational change.
- Implications for educational psychology.

STANFORD MENTORS



Rowe



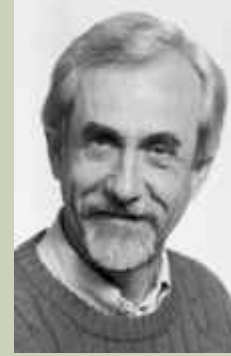
Greeno



**Haertel
(Chair)**



Snow



Case

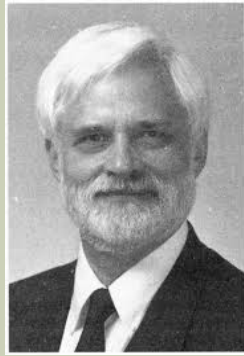


Campione

STANFORD + HIGH SCHOOL MENTORS



Rowe



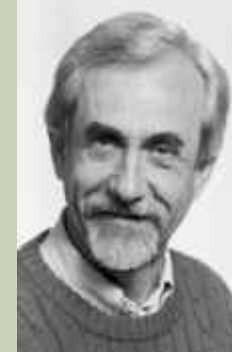
Greeno



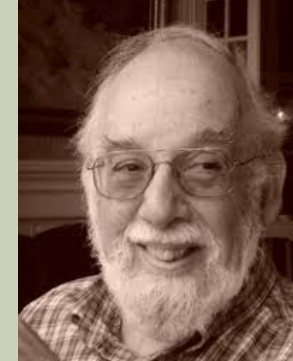
**Haertel
(Chair)**



Snow



Case



Campione



**Minstrell
(Science)**



**Lindquist
(Debate)**



**Newman
(ELA
Humanities)**



**Yanicks
(Philosophy
Humanities)**



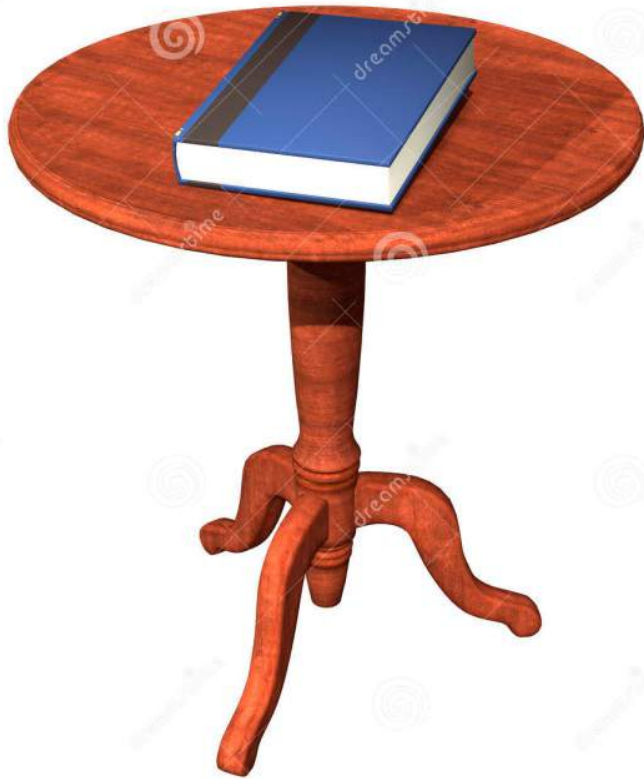
**Boyer
(American
Studies)**



**Wall
(History)**

**Bob Maeir
(American
Studies,
deceased)**

THE PROBLEM



- Discussion of what forces are acting on the book?
- Two dominant views discussed: one force (i.e., gravity) or two forces.
- “Allow students to argue for the simplest explanation that explains the most phenomena” (p. 14).

JIM MINSTRELL, "THE AT-REST CONDITION"

Explaining the "at rest" condition of an object

JIM MINSTRELL



Jim Minstrell received his Ph.D. in science education from the University of Washington in 1978. Except for leaves for working on the development of the Project Physics Course, completing graduate course work, and conducting research, he has taught physics and mathematics since 1962 at Mercer Island High School where he is currently teaching and conducting research on learning and teaching. (Departments of Science and Mathematics, Mercer Island High School, Mercer Island, Washington 98040)

Consider an object, e.g., a book, at rest on a table. What keeps the book at rest on the table? Typically, in a physics class the instructor will assert that gravity and the table exert equal, but oppositely directed, forces on the book thus keeping the book in equilibrium and at rest. Often the authority of "Newton's Law" is used as justification for this explanation, and the instructor moves on to consider conditions of moving objects, assuming that the static situation is "obviously clear" to students.

This paper demonstrates that the typical explanation is far from obvious to the student. First, students are unsure about the nature of gravity. Some distinguish the pull exerted by the earth from a heaviness of an object tending to make it go down. Many students believe that air pressure is the cause of gravity. Second, the nature of forces and how they can be exerted is "unclear" to students. How can a push or pull be exerted by an inanimate, inactive, solid, and apparently immovable object like a table?

This article describes the results of considering the "at rest" condition of an object with two physics classes at a high school in a socioeconomically affluent suburb of Seattle. In addition to pointing out the nontriviality of the static object situation, the results of my investigation suggest the following instructional factors that apparently aid in the development of the students' concept of force: a) an engaging, free thinking, free speaking social context, in which students are encouraged to articulate their beliefs, b) a juxtaposition of a variety of first-hand experiences with static objects, and c) encouragement to search for the simplest, consistent, rational argument that will explain the similarity of effects in an apparent diversity of experiences. Finally, and perhaps most important, this paper presents an example of a technique for instructing for concept development.

In attempts to describe the conceptual understanding of physics students and to identify factors that influence that understanding, discussions were tape recorded. Also, homework papers and pre- and post-instruction tests were carefully read. Thus, the investigation was conducted entirely in the natural setting of the physics classroom.

Pre-conceptions/alternative conceptions

Prior to any formal instruction regarding forces in the two physics classes investigated, students used one or more of the following mechanisms to explain the book at rest.

Air and/or air pressure may be responsible for helping to keep the object where it is. Many students drew and labeled diagrams that depicted air pressing in from all sides (Fig. 1). For others, air pressure appeared to be acting predominantly in the downward direction. Some of these students viewed the air pressure as helping gravity hold the object down to the table (Fig. 2), but a few (approximately 15%) implied with word and diagram that it was air pressure that was responsible for holding the book down (Fig. 3). "If the air was taken away, the book might drift off." For these students, it appears that gravity is a result of air pressure. A few students also suggested wind or wind currents, probably from the side, could affect the objects (Fig. 4).

RESEARCH IN ARGUMENTATION

- A number of academics and school reformers focused on enabling students to construct and critique arguments about subject matter.
 - Jim Minstrell, Rosalind Driver, Jonathan Osborne (science)
 - Deborah Ball, Paul Cobb (math)
 - Ann Brown and Joe Campione (environmental science and literacy)
 - Dick Anderson (children's literature)
 - Deanna Kuhn (social science)
 - Lauren Resnick (social issues) & James Voss (social studies)
 - Karen Harris and Steve Graham (writing)

DEFINING ARGUMENTATION

- **Argument as a Product.**
 - Claim supported by one or more reasons.
 - And other components (e.g., evidence, qualifications, rebuttals)
- **Argument as a Process.**
 - A dialogic process of constructing and critiquing arguments
 - Can be adversarial or collaborative

COLLABORATIVE ARGUMENTATION

- “Individuals working together to construct and critique arguments” (Golanics & Nussbaum, 2007; Andriessen, Baker, & Suthers, 2003).
- Not a debate, participants can make concessions, change sides flexibly, and take in-between positions.
 - Necessary for conceptual change.
- I also noticed collaborative argumentation in a small-group of introverts in my dissertation research (Nussbaum, 2002).

INTROVERTS' DISCUSSION

- 1 **Linda:** To build robots, I mean robots, or whatever they're called, I don't think it's all right, because they're gonna watch us all the time.
- 2 **Cornelia:** Maybe they could build like, um, I don't know, maybe you could have something that would make the robots not watch you.
- 3 **Linda:** Hmm.
- 4 **Cornelia:** Like they could build something with the robot.
- 5 **Sandor:** Yeah.
- 6 **Cornelia:** So it won't watch you all the time.

7 Sandor: Yeah, like transformer, they could turn into a car, anything. And when you need help, you just drive there, you don't walk, like this, doom, doom.

8 Cornelia: Or like every policeman, every two policemen have a car, but it's really a robot.

9 Sandor: Yeah.

10 Cornelia: And so when they need help, the car will transform into a robot.

11 Sandor: Yeah, and the insides comes out.

12 Cornelia: What do you think about the idea?

13 Linda: I think it's OK.

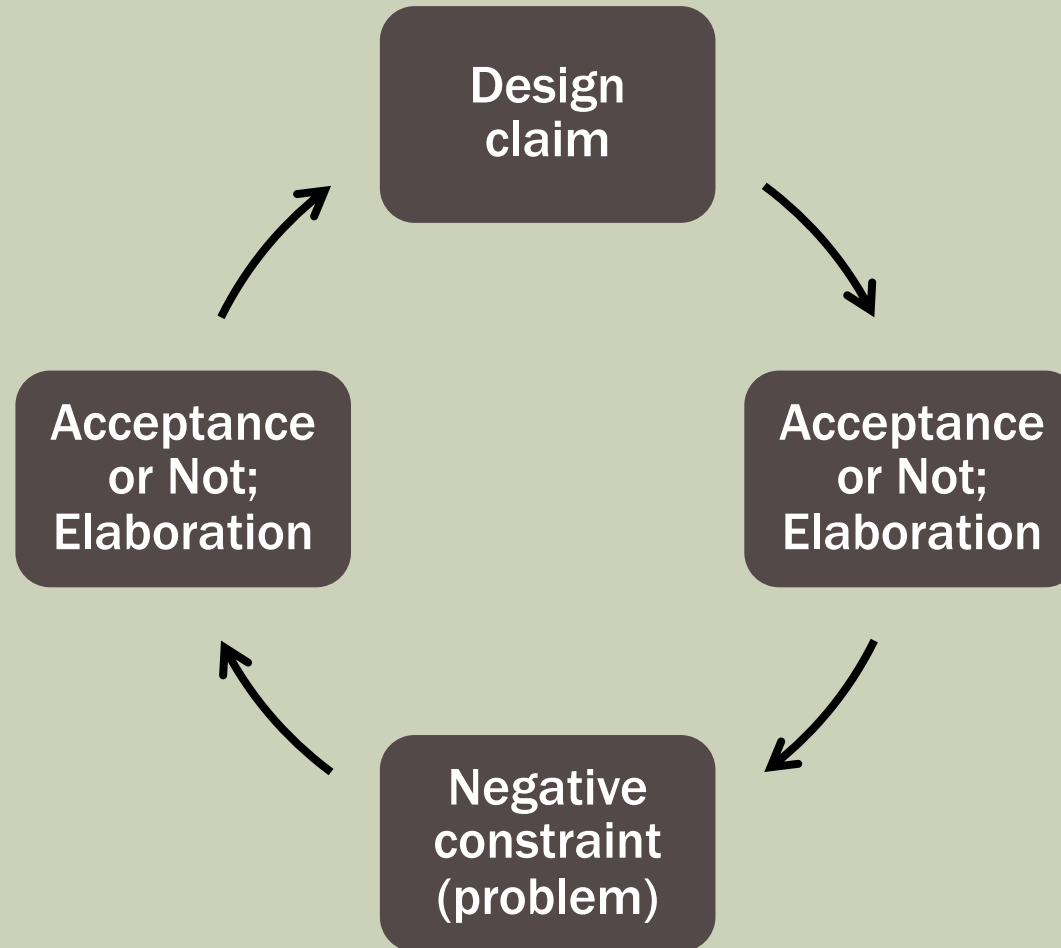
14 Cornelia: Would you spend that much money to make a robot?

15 Sandor: No.

16 Cornelia: Why?

17: Sandor: Well, by, you fix it, and then after that it broke, and you don't got no more money to fix it, and you're hungry. How you gonna do that, huh?

COLLABORATIVE DYNAMIC



BENEFITS OF COLLABORATIVE ARGUMENTATION OVER ADVERSARIAL

1. More participation from introverts and other reluctant students (Nussbaum, 2002), including those with less background knowledge (Nussbaum & Jacobson, 2002);
2. Deeper exploration of the problem space or idea space (Keefer, Zeitz, & Resnick, 2000; Mercer, 1996);
3. More facilitative of conceptual change (Nussbaum, Sinatra, & Poliquin, 2008).

IMPORTANCE OF TEACHING STUDENTS TO ARGUE

- Important social and disciplinary practice;
 - In many disciplines and in public policy.
- Argumentation can be used as a part of teaching content
 - Promoting depth of processing and conceptual change.
 - Making thinking visible, especially students' prior conceptions.
 - Contrasting alternative models
 - Engaging in critical evaluation

COLLABORATIVE ARGUMENTATION: IMPORTANT BENEFITS

- It facilitates the development of general reasoning skills (Brown & Renshaw, 2000) and reflects a central social practice in many disciplines;
- It is linked to deep subject matter understanding (Alexopolou & Driver, 1996; Bell & Linn, 2000), depth of processing (Chi, 2009; Nussbaum, 2008), and conceptual change (Asterhan & Schwarz, 2007)

ARGUMENTS CAN BE SIMPLE OR COMPLEX

- Simple arguments are easier to follow.
- Complex arguments promote:
 - Depth of processing and perspective taking,
 - Disciplinary practices.

MY RESEARCH AGENDA:

- How to introduce complexity into students' arguments.

PROMOTING COUNTERARGUMENTS AND REBUTTALS

- Much of students' written and online discourse did not contain counterarguments and rebuttals.
- I addressed by researching:
 - **Goal instructions** (Tell students to generate counterarguments and rebuttals).
 - Nussbaum, 2005; Nussbaum & Kardash, 2005.
 - Arguing the opposite side on physics problem (Nussbaum & Sinatra, 2003)
 - **Dual-positional text** (containing arguments and counterarguments)
 - Lets students generate rebuttals of one side (Nussbaum & Kardash, 2005).
 - **Note starters** ("I disagree because _____").
 - Nussbaum, Hartley, Sinatra, Reynolds, & Bendixen (2004).

EXAMPLE OF A WEAK REBUTTAL

- **Question**—Should schools require students to wear school uniforms.
- **Claim**—Yes, so students with poor-looking clothes will not be made fun of.
- **Counterargument**—that might limit students freedom of expression.
- **Rebuttal**—The criticism is just mumbo jumbo. Those kids are going to be labeled as freaks and won't fit in.

HOW TO MEASURE ARGUMENT STRENGTH? FOUR PHILOSOPHIC FRAMEWORKS.

- Toulmin
- Walton
- Bayesian
- Pollock

TOULMIN MODEL

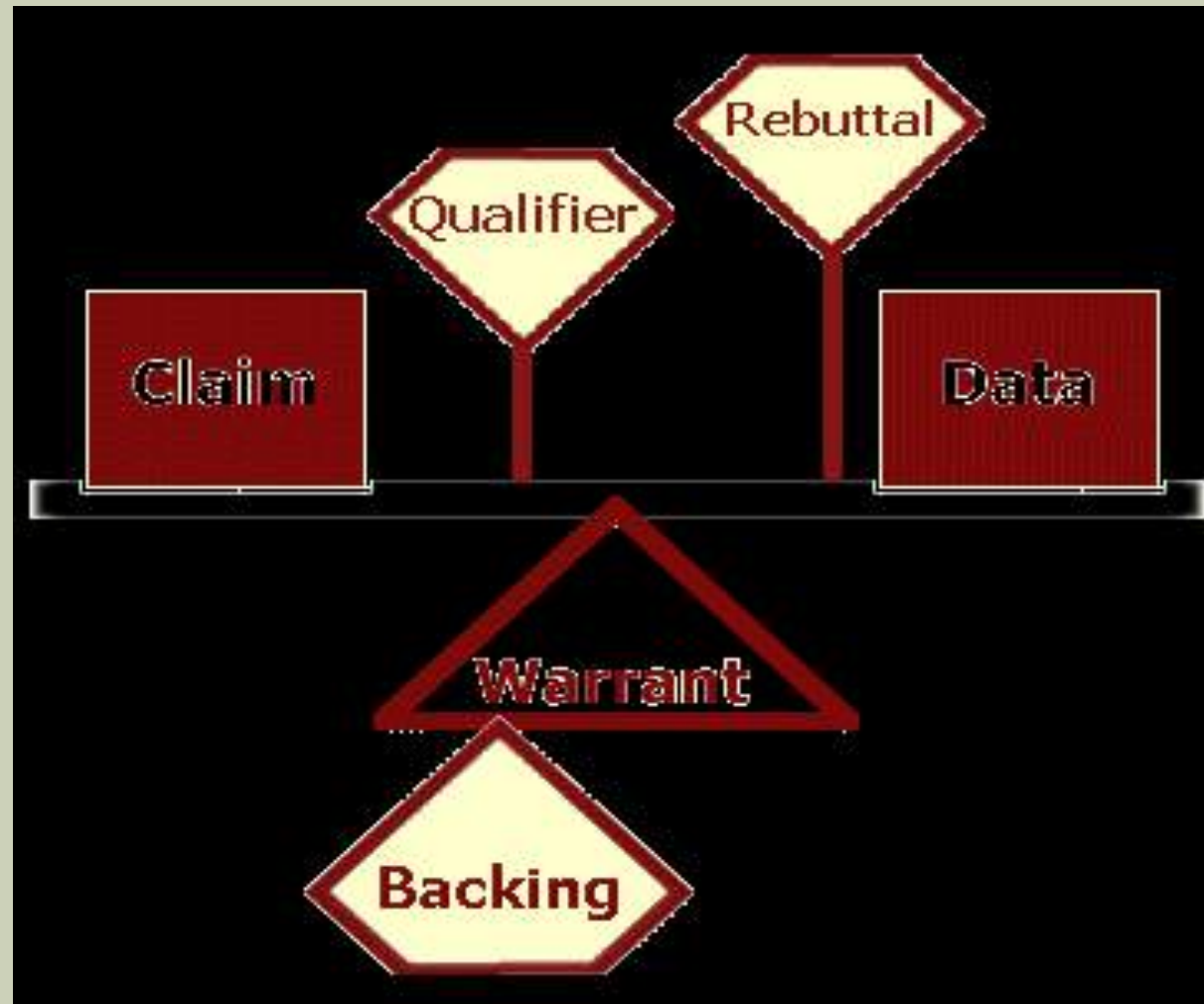


Image
from
owlet.letu
.edu

WALTON'S ARGUMENT SCHEMES AND CRITICAL QUESTIONS

- A scheme is a type of argument.
- 60+ schemes.
- Associated with each scheme, set of critical questions that should be asked about the argument in question; helps to evaluate argument.

EXAMPLES OF SCHEMES

Argument from:

- Consequences
- Evidence to Hypothesis
- Correlation to Cause
- Expertise
- Bias
- Verbal Classification

EXAMPLES OF CRITICAL QUESTIONS (WALTON, 1996)

Argument from Consequences:

- 1.** How strong is the likelihood that these consequences will occur?
- 2.** What evidence supports those claims?
- 3.** Are there other consequences of the opposite value that should be taken into account?

CQMA-A (DOVE & NUSSBAUM, 2018)

1. **Structural Components.**
2. **Quality of the Evidence.**
3. **Truth of the Reasons.**
4. **Use of Accepted Scientific Principles.**
5. **Coherence (Following Path of Argument).**
6. **Alternative Explanation or Courses of Action:** Can you rule out other explanations [or courses of action]?
7. **Completeness:** Account for everything (e.g., evidence, consequences)?
8. **Tradeoffs. Creative Solutions.**
9. **Overall Quality.**

CQMA-A (DOVE & NUSSBAUM, 2018)

1. **Structure.** Can I identify the claim, evidence, reasoning, etc.?
2. **Evidence.** Is there evidence? How good is the evidence?
3. **Reasons.** Are any of the reasons untrue or incorrect?
4. **Accuracy.** Does the argument use or connect with accepted scientific principles?
5. **Coherence/Reasoning.** Do the parts of the argument make a path you can follow or are there missing steps?
6. **Alternatives.** Can you rule out other explanations [or courses of action]?
7. **Completeness.** What is missing or weak in the explanation or argument? [Are there other consequences that should be considered?]
8. **[Tradeoffs.** Are there trade-offs (getting something at the expense of another)? Are any of the reasons/values on one side more important than those on the other? Can you design a creative solution?]

THIRD PHILOSOPHIC FRAMEWORK: BAYESIAN

- Used to quantify judgments of argument strength, when combined with other approaches.
- See Nussbaum, E. M. (2011). Argumentation, dialogue theory, and probability modeling: Alternative frameworks for argumentation research in education. *Educational Psychologist*, 46, 84-106.
doi:10.1080/00461520.2011.558816

FOURTH PHILOSOPHIC FRAMEWORK: POLLOCK

- Pollock (1987) strong argument is one that is ultimately “undefeated.”
 - Defeaters (refutations and diminishers).
 - Defeaters themselves can be defeated.
- Critical questions start this dialectical process (don't necessarily complete it).

NUSSBAUM'S ARGUMENT-COUNTERARGUMENT INTEGRATION FRAMEWORK

An integrated argument is one that addresses one or more counterargument.

- **Basic refutation (of truth or scope of premise)**
 - A carbon tax won't reduce parental income that much.
- **Design claims**
 - Use cars that do not use fossil fuels.
- **Weighing refutation**
 - Saving the planet is more important than holiday presents.

Argumentation VEE Diagram

QUESTION: Should students be graded on class participation, effort, and homework completion?

<u>ARGUMENTS</u>	<u>COUNTERARGUMENTS</u>
<u>Reason #1A:</u> Grades, participation, homework completion and effort all show student motivation	<u>Reason #1CA:</u> Students should only be graded on tests/quizzes and assignments that are graded. This shows how much the students have learned.
<u>Reason #2A:</u> Allows students to still make good grades even if they do not do well on tests and quizzes.	<u>Reason #2CA:</u> Students should be graded on what they know, if a student does not the material they should not receive grades that show otherwise.
<u>Reason #3A:</u> Students that receive grades based on participation will show interest in more topics and this could help students learn more in the process of just participating.	<u>Reason #3CA:</u> Students should be expected to participate in class and not be rewarded for being a part of the lesson.
<u>Reason #4A:</u> Students will have more opportunity to succeed and that create an environment that students want to learn in.	

Integrate arguments

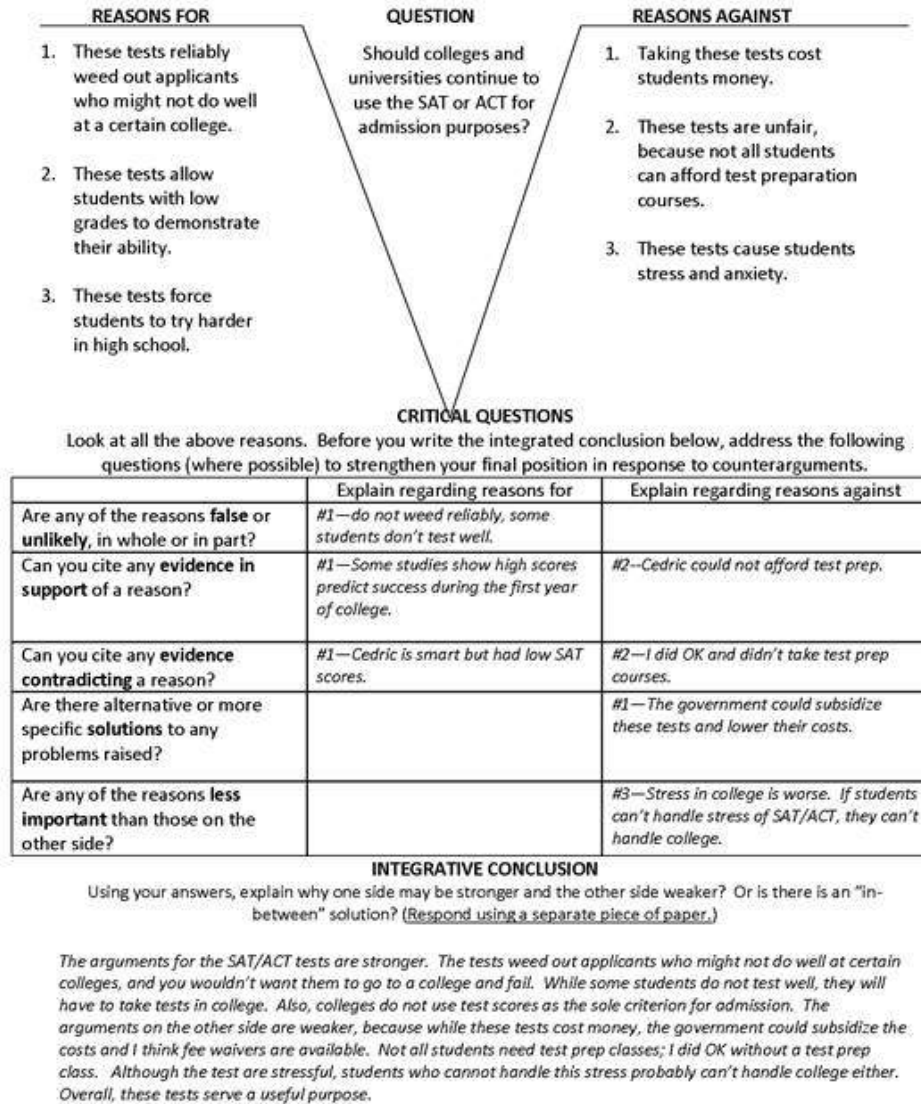
CONCLUSION AND RATIONALE
Which side is stronger, and why?
Is there a compromise or creative solution?

The arguments side is much stronger. These arguments help support the idea that students will try harder when given an incentive and this also allows students to have more opportunity to succeed. Giving students more opportunities and grades based on trying will help students to try harder and could learn more in the process of doing homework, participating in class, and just putting in effort.

Critical Questions Inserted Onto AVD (Under the Vee)

	Explain regarding reasons for	Explain regarding reasons against
Are any of the reasons false or unlikely , in whole or in part?		
Can you cite any evidence in support of a reason?		
Can you cite any evidence contradicting a reason?		
Are there alternatives or more specific solutions to any problems raised?		
Are any of the reasons more or less important than those on the other side?		

Figure 1. Model AVD, written by researchers. Italicized text reflects responses from a hypothetical student.



EFFECTS (EXPERIMENTAL & QUASI-EXPERIMENTAL)

- AVDs with critical questions vs. without questions:
 - More weighing refutations and practical designs claims in written paragraphs, and more focused discussion among middle schoolers (Nussbaum & Edwards, 2011).
 - More weighing refutations and designs claims in written paragraphs and in-class essays (no AVDs used) among undergraduates (Nussbaum, Dove, Slife, Kardash, Turgut, Vallett, 2018).
- AVDs resulted in:
 - More integrated arguments and belief change in online discussions and in opinion essays among undergraduates [Nussbaum, 2008; Nussbaum, Winsor, Aqui, & Poliquin, 2007].

GUADALUPE CASE STUDY

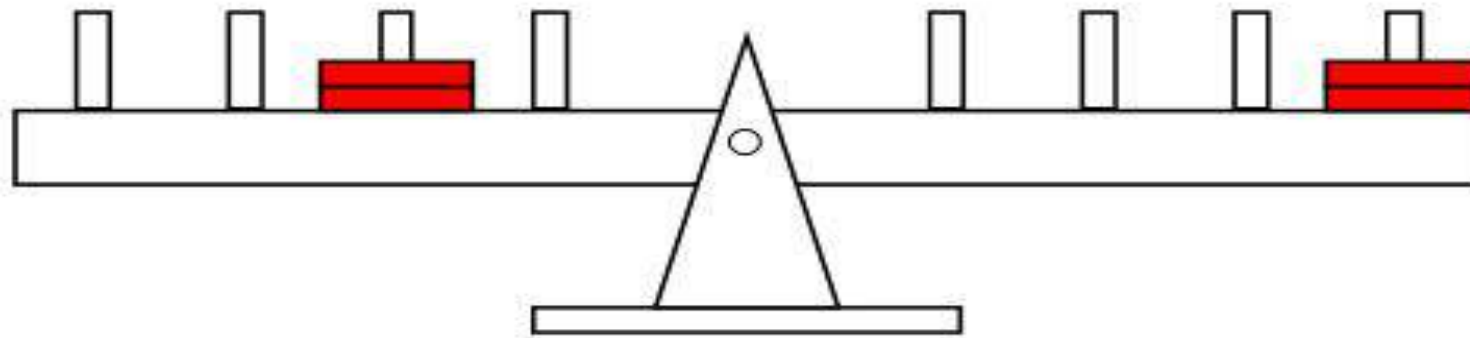
1. Pre-CQs: Elaborate on one side of issue.
2. Critical Questions: More considerations.
 - Are there other reasons for being homeless other than having dropped out of school?
 - Costs (where are we going to get the money?)
3. Weighing costs and benefits
 - I think argument is stronger because global warming is more important than holiday presents.

GUADALUPE CASE STUDY

1. Pre-CQs: Elaborate on one side of issue.
2. Critical Questions: More considerations
 - Are there other reasons for being homeless other than having dropped out of school?
 - Costs (where are we going to get the money?)
3. Weighing costs and benefits
 - I think argument is stronger because global warming is more important than holiday presents.

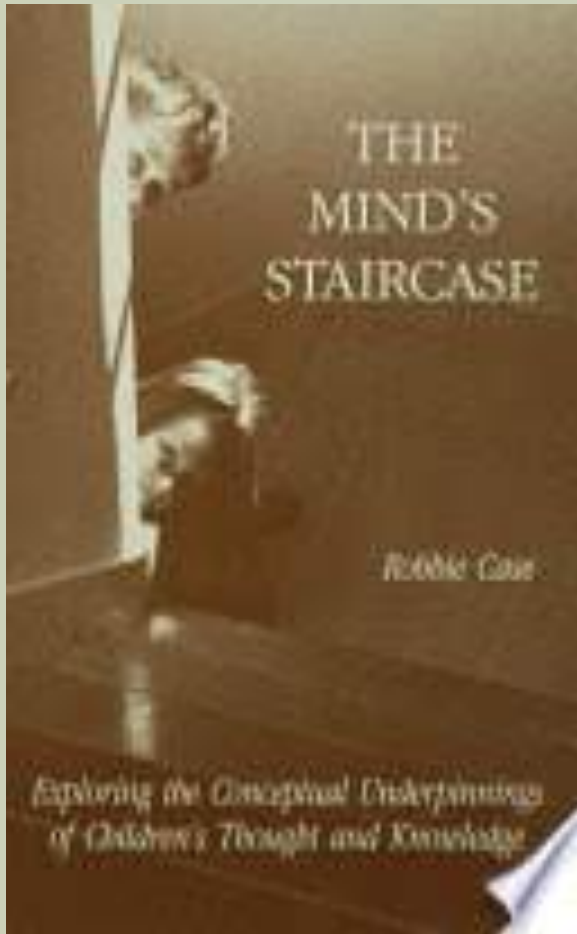
INTEGRATIVE COMPLEXITY (Suedfeld et al., 1992): Involves differentiation and integration of ideas.

Increased Mental Capacity
Development of strategies: Siegler '78



The balance beam problem:
Which side will go down?

ROBBIE CASE: COGNITIVE COMPLEXITY



- Simpler schema are coordinated in working memory, causing complexity.
- The schemas are integrated into a larger conceptual structure, causing simplicity.
- The process is repeated.
- Example:
 - Coordinating two number lines.
 - Balance beam tasks

INTERPLAY BETWEEN SIMPLICITY AND COMPLEXITY



INTERPLAY BETWEEN SIMPLICITY AND COMPLEXITY IN ARGUMENTATION

- Arguments can be simple or complex.
- Can make argumentation more complex with:
 - Critical questions.
 - Oral discussions.
 - Argument-counterargument integration moves (e.g., design claims)
- Making the complex simple with a closing, integrative argument
 - Simple, integrative and strong.
 - For example, “Saving the planet is more important than other things.”

SPIRAL STAIRCASE METAPHOR FOR COGNITIVE DEVELOPMENT



COMPLEXITY

- 1. Cognitive**
- 2. Social** – appropriation of argumentation moves, grounding (shared referents), turn taking, status, positioning, host of other social processes.
- 3. Instructional** – multiple conceptual components, standards, activities and sequences, good discussion questions, time for collaborative argumentation, discourse management, etc.

COMPLEXITY

4. Changing Teaching Practice.

Pedagogical content knowledge (about ideas & arguments)

Requires teacher learning.

- ALSS teachers wanted a second or third year of intense professional development
- Teachers wanted more models of expert teachers facilitating argumentative discussions, especially whole-class discussions.

Requires collective problem solving

- Had monthly afterschool meeting, and meetings with a discourse coach—very useful.
- Requires change in teacher beliefs and boosting teacher confidence.

SIMPLICITY WITH COMPLEXITY

- Educational change—Learning dialogic teaching
 - Must make the complex simple (simple enough to master), and
 - The simple complex (attend to multiple constraints and affordances).
- This occurs in complex social systems—where the system is changing too.

COMPLEX SYSTEMS

- Learners, classrooms, schools, school systems are complex systems.
- Host of interacting cognitive, motivational, instructional and organizational variables.
- Popularity of qualitative, mixed methods, and design-based research.
- Dynamic systems research (e.g., Jacobson, Kapur, & Reimann, 2016)—multiple levels, higher and lower levels affect and constrain one another.

EDUCATIONAL PSYCHOLOGISTS MAKE ARGUMENTS ABOUT COMPLEX SYSTEMS

- Peer review
- Arguments for practitioners and policymakers:
 - Many want simple solutions.
 - Arming teachers, or teaching to learning styles.
 - Allow them to cut through the complexity and (potentially) control the environment.

RESPOND WITH STRONG, INTEGRATED ARGUMENTS

- Learning Styles

- Individual differences are too complex to be captured by learning styles ,
teach using multiple modalities (design claim).

RESPOND WITH STRONG, INTEGRATED ARGUMENTS

■ Learning Styles

- Individual differences are too complex to be captured by learning styles , teach using multiple modalities (design claim).

■ Preventing Gun Violence

- Armed guards, arming teachers have negative effects on school climate.
 - Students are less likely to talk to adults and report on other students.
 - There is likely to be more disgruntled students.
- A preventative, public health approach more effective
 - Attend to school climate, targeting certain schools, local partnerships

INTEGRATIVE ARGUMENTS MAKE THE COMPLEX SIMPLE AND THE SIMPLE COMPLEX

- **Strong, relatively simple arguments that can be understood.**
- **While still conveying some of the complexity of the issue.**

NUSSBAUM'S ARGUMENT-COUNTERARGUMENT INTEGRATION FRAMEWORK

An integrated argument is one that addresses one or more counterargument.

- **Basic refutation (of truth or scope of premise)**
 - A carbon tax won't reduce parental income that much.
- **Design claims**
 - Use cars that do not use fossil fuels.
- **Weighing refutation**
 - Saving the planet is more important than holiday presents.

WE MAKE ARGUMENTS IN COMPLEX SYSTEMS

- Make arguments within (not just about) complex systems.
 - Academic systems (peer-review, articles, conferences)
 - Bridges to policymakers and practitioners
(textbooks, briefs, local research-practice partnerships),
- Do strong, integrative arguments made a difference in such systems?
 - Particularly to political and school systems?
 - “Sometimes.”

DO ARGUMENTS MATTER IN PUBLIC POLICY?

- Arguments make a difference at several points in process (Coplin & O’Leary, 1998):
 - When positions are being developed.
 - At outset of policy process, “as stakes are declared and agendas set.”
 - At end of process, when decisions are being made.
- Although arguments are a necessary ingredient to any strategy, they never work by themselves” (Coplin & O’Leary, 1998).
 - Political conditions need to be right for argument to be well received by a governing body.
 - May need to craft a compromise based on political interests and power.

PRESENT (AND PAST) POLITICAL CLIMATE

- **Adversarial, one-sided arguments seem running rampant.**
 - There are different stances toward “truth”.
 - Many nonepistemic goals: money, power, status, identity.
 - Mercier et al. (2016) reasoning evolved in political (tribal) contexts.
 - Pinker (2018) should appeal to the “better angels of our nature.”
 - Reason, science, technology, and ethics

CALLS TO ACTION

- **MESSAGING**—how to “message” your research to make the complex simple and the simple complex, test the effectiveness of message.
- **BUILD AT LEAST ONE BRIDGE:**
 - Between research approaches; or
 - Disciplines (at different levels of analysis);
 - Practitioners (partnerships) or policy makers.
- **LISTEN**—You have “two ears and only one mouth, use them in that proportion.” (Aron, cited in Minstrell, 2001).
 - Break down stereotypes.
- **ENGAGE IN (INTEGRATIVE) ARGUMENTATION**

QUESTIONS AND ANSWERS

