ARGUMENTS ON THE COMPLEXITY OF EDUCATIONAL CHANGE AND THE COMPLEXITY OF ARGUMENTS
TWO ICONIC SYMBOLS

EIP
APA
DIVISION 15

Yin-Yang symbol
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
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).
Explaining the “at rest” condition of an object

JIM MINSTRELL

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 that cancel the book’s motion and keep it at rest. Often the authority of “true science” and the instructor’s desire to avoid confusion on the part of the student prevent the investigation of other possible conditions of moving objects, assuming that the static situation is “obviously correct” to students.

This paper demonstrates that the typical explanation is far from obvious to the student. First, students are uncritically about the nature of gravity. Some distinguish the pull exerted by the earth from a heavier book an object tends 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 added or pulled together by an intuitive, inactive, solid, and apparent force of gravity.

This article describes the results of considering the “at rest” condition of an object with two physics classes at a high school in a socially the experiment’s condition of objects that apparently aid in the development of the student’s concepts of forces. (a) engagement, free thinking, free speaking social content, in which students are encouraged to articulate their beliefs, (b) incorporation of a variety of instructional experience with static objects, and (c) encouragement to students to consider the similarities of objects 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 taped recorded. Also, homework papers and pre- and post-instruction tests were given. The investigation was conducted entirely in the natural setting of the physics classroom.

Prior to any formal instruction regarding forces in the two physics classes, 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 book where it is. Many students drew and labeled diagrams that depicted air pressure in from all sides (Fig. 1). For others, air pressure appeared to be acting predominately in the downward direction. Some of these students viewed the air pressure as having gravity hold the object down to the table (Fig. 2); but a few students, especially with the help of the instructor, noted that both air pressure and gravity were responsible for holding the book down (Fig. 3). If the air was taken away, the book might “fall 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).
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
“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).
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 policemans 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

- Design claim
- Acceptance or Not; Elaboration
- Negative constraint (problem)
- Acceptance or Not; Elaboration
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);

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
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.
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).
  - 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 _____”).
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
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
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?
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)?
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?
Used to quantify judgments of argument strength, when combined with other approaches.

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

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

<table>
<thead>
<tr>
<th>Are any of the reasons <strong>false</strong> or <strong>unlikely</strong>, in whole or in part?</th>
<th>Explain regarding reasons for</th>
<th>Explain regarding reasons against</th>
</tr>
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<tbody>
<tr>
<td>Can you cite any <strong>evidence in support</strong> of a reason?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can you cite any <strong>evidence contradicting</strong> a reason?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are there alternatives or more specific <strong>solutions</strong> to any problems raised?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are any of the reasons <strong>more or less important</strong> than those on the other side?</td>
<td></td>
<td></td>
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</table>
Figure 1. Model ABD, written by researchers. Italized text reflects responses from a hypothetical student.

<table>
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<tr>
<th>REASONS FOR</th>
<th>QUESTION</th>
<th>REASONS AGAINST</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. These tests reliably weed out applicants who might not do well at a certain college.</td>
<td>Should colleges and universities continue to use the SAT or ACT for admission purposes?</td>
<td>1. These tests cost students money.</td>
</tr>
<tr>
<td>2. These tests allow students with low grades to demonstrate their ability.</td>
<td></td>
<td>2. These tests are unfair, because not all students can afford test preparation courses.</td>
</tr>
<tr>
<td>3. These tests force students to try harder in high school.</td>
<td></td>
<td>3. These tests cause students stress and anxiety.</td>
</tr>
</tbody>
</table>

Critical Questions

Look at all the above reasons. Before you write the integrated conclusion below, address the following questions (where possible) to strengthen your final position in response to counterarguments:

<table>
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<th>Are any of the reasons false or unlikely, in whole or in part?</th>
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<tr>
<td>#1—do not weed reliably, some students don’t test well.</td>
<td>#1—Some studies show high scores predict success during the first year of college.</td>
<td>#2—Cecil could not afford test prep.</td>
</tr>
<tr>
<td>Can you cite any evidence in support of a reason?</td>
<td>#2—Cecil is smart but had low SAT scores.</td>
<td>#2—I did OK and didn’t take test prep courses.</td>
</tr>
<tr>
<td>Can you cite any evidence contradicting a reason?</td>
<td>#3—The government could subsidize these tests and lower their costs.</td>
<td>#3—Stress in college is worse. If students can’t handle stress of SAT/ACT, they can’t handle college.</td>
</tr>
<tr>
<td>Are there alternative or more specific solutions to any problems raised?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Are any of the reasons less important than those on the other side?</td>
<td></td>
<td></td>
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Integrative Conclusion

Using your answers, explain why one side may be stronger and the other side weaker? Or is there an “in-between” solution? (Attach and staple a separate piece of paper.)

The arguments for the SAT/ACT tests are stronger. The tests weed out applicants who might not do well at certain colleges, and you wouldn’t want them to go to a college and fail. While some students do not test well, they will have to take tests in college. Also, colleges do not use test scores as the sole criterion for admittance. The arguments on the other side are weaker, because while these tests cost money, the government could subsidize the costs and they are the best tests available. Not all students need test prep classes. I did OK without a test prep class. Although the test are stressful, students who cannot handle this stress probably can’t handle college either. Overall, these tests serve a useful purpose.
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 essays among undergraduates [Nussbaum, 2008; Nussbaum, Winsor, Aqui, & Poliquin, 2007].
1. Pre-CQs: Elaborate on one side of issue.
   ▪ 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?
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
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
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.

*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.
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.
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.
Learning Styles

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