STEM, Civil Discourse, and Reasoning

Moderator: Marcia Linn, University of California, Berkeley
Presenter: Carol Lee, Northwestern University
Commentators:
Judit Moschkovich, University of California, Santa Cruz
Sepehr Vakil, Northwestern University
Essential always and timely as we address:

• A public health crisis,
• An economic recovery,
• Continuing racial injustice, and
• A climate crisis

Today we combine our expertise to deepen our understanding and jointly

• Develop compelling questions
• Identify promising strategies
Carol Lee, Northwestern University

• Lead author and force of nature!
• Career dedicated to equity, equality, and activism
• University of Chicago Ph. D.
• Fun fact. Guided 3rd graders to experience mathematics as socially constructed by introducing computers with binary numbers and an abacus featuring base 2 and 5
Mathematics education crucial for civic decision making.
AERA Fellow
Fun Fact: UC Berkeley Ph. D.
Sepehr Vakil, Northwestern University

• Function, ethics, and politics of STEM learning in world affairs.
• We met when Sepehr founded an after school program, discovered field of learning science, and contacted me at Berkeley
• UC Berkeley Ph.D.
• Fun fact: Sepehr has infant twins (and a four year old son)
EDUCATING FOR
Civic Reasoning & Discourse

Implications for Teaching Science K-12
Committee on Civic Reasoning & Discourse

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Spencer Foundation

Walter Parker
Univ. of Washington

Judith Torney-Purta
Univ. of Maryland
“What should we do?”
## Why We Need Preparation for Civic Reasoning & Discourse

<table>
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<th>Mass Shootings</th>
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<td>January 6th</td>
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<td>Social Media Misuse</td>
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<td>Political Polarization</td>
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Complexity of the American Experiment

Creating and sustaining a system of decision making sufficiently elastic to make space for dissent and difference
• Federal as well as local decision making
• Majority and minority rights
• The inalienable rights of the individual

A nation of immigrants with a contested history, forging a national identity
• African holocaust of enslavement
• War against indigenous nations
• Complex history of contestations over immigration policies and acceptance
• History of communities sustaining national as well as transnational identities

Wrestling with these complexities and ethical conundrums across our history
• No simple histories of leaders who are either simply good or bad
What is this report about?

• This report was developed by an expert committee whose charge is to recommend ways to **improve students’ learning in civic reasoning and discourse** by ensuring that the **pedagogy, curriculum, and learning environments** that they experience are informed by the best available evidence.

• Ultimately this report provides recommendations to prepare students and engage them in a student-driven process to answer the question of “what should we do” about issues in the public domain.

What is this report NOT about?

• This is not a report about particular political positions.
Unique Contributions of This Report

- Attention to the **interdisciplinary nature** of civic reasoning and discourse

- Conceptualization of the **complex demands of civic reasoning and discourse** that is grounded in research on **learning sciences** and **human development**, including students’ identity development, cognitive development, as well as moral and ethical development

- Emphasis on **equitable access** to learning environments that are conductive to student discussion and utilize **project-based** and **inquiry-oriented** approaches

- Focus on civic learning **across the K-12 sector** and **across content areas**

- Attention to the varying definitions of **citizenship** in different historical contexts and across ethnic communities
Philosophical & Moral Foundations for Research & Practice

Author: Sarah M. Stitzlein
Panel Members: Anthony Laden, Peter Levine, Jennifer Morton

Perspectives from Learning Sciences & Human Development

Authors: Carol D. Lee, Na’ilah Suad Nasir, Natalia Smirnov, Adria Carrington
Panel Members: Megan Bang, Hyman Bass, Andrea diSessa, Abby Reisman, Leoandra Onnie Rogers, Alan H. Schoenfeld, Margaret Beale Spencer, William F. Tate IV, Elliott Turiel

A Short History of Civic Education Policy & Practice in the U.S.

Authors: Nancy Beadie, Zoë Burkholder
Panel Members: James D. Anderson, Andrew Hartman, Walter C. Parker, Rowan Steineker

Report Editors: Carol D. Lee, Gregory White, Dian Dong

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Agency and Resilience in the Face of Challenge as Civic Action

Indigenous Peoples and Civics Education in the 21st Century
Megan Bang
Bryan McKinley Jones Brayboy

African American Education as Preparation for Civic Engagement, Reasoning, And Discourse
Vanessa Siddle Walker
James D. Anderson
Joy Ann Williamson-Lott
Carol D. Lee

Historicizing Latinx Civic Agency & Contemporary Lived Civics
Maribel Santiago
Cati V. de los Ríos
Kris D. Gutiérrez

Asian American Exclusion & the Fight for Inclusion
Li-Ching Ho
Stacey J. Lee

An Appalachian Spring: Hope & Resilience among Youth in the Rural South
Deborah Hicks

Structural Inequality, Migration, & Conflict

Authors:
Beth C. Rubin
Thea Renda Abu El-Haj
Michelle J. Bellino

Panel Members:
James A. Banks
Sarah Dryden-Peterson
Sarah Warshauer Freedman
Roberto G. Gonzales
Learning Environments & School/Classroom Climate as Supports

Authors:
Carolyn Barber
Christopher H. Clark
Judith Torney-Purta

Panel Members:
David Campbell
Carole L. Hahn
Deanna Kuhn

Rethinking Digital Citizenship: Learning About Media, Literacy, & Race in Turbulent Times

Authors and Panel Members:
Antero Godina Garcia
Sarah McGrew
Nicole Mirra
Brendesha Tynes
Joseph Kahne

Pedagogical Practices & How Teacher Learn

Authors and Panel Members:
Hilary G. Conklin
Jane C. Lo
Paula McAvoy
Chauncey B. Monte-Sano
Tyrone Howard
Diana E. Hess
Interests in the field of Science
On the ground initiatives

• National Science Teachers Association – 2016 – “Teaching Science in the Context of Societal and Personal Issues”
• NSTA K-12 teacher journals – 50 articles “about teaching science in societal or personal contexts”
• National Association of Biology Teachers
• Science and Civics Report – 2016 - Citizenship and American Identity
• Citizen Science Projects
• Massachusetts state science standards
• National Academies of Science and Engineering – upcoming report Call to Action for Science Education
Science and Civics – How Connected?

• But for scientific findings to be taken up in the world requires more than scientific discovery, but equally important civic action.
  • Pasteur’s work on the ground, but the civic action needed for it to be taken up in practice

• This uptake in the public arena requires civic actors who are
  • Informed
    • Scientific content
    • Its implications
    • Structures of governance through which they can have impact
  • Active
  • Critical thinkers
    • Weigh pros and cons/affordances and constraints
    • With rationality
    • Attention to the broader public good
Why grounding in science of learning and development

• Current politicizing of scientific misinformation
  • Vaccine places magnet in your body

• Current environment where attention to individual rights contest with public health attention to the collective good

• Current environment where people are influenced by sources of information, particular in the media and digital environments, without critical examination

• What constructs from the science of human learning and development can we draw upon to understand how to shift these dispositions?
  • Conceptual change
  • Implicit bias
  • Epistemological thinking
  • Moral reasoning
  • Identity development
Civic Reasoning & Discourse:
Perspectives from Learning & Human Development Research

Co-Chairs:
Carol D. Lee
Na’ilah Suad Nasir

Writers:
Carol D. Lee
Na’ilah Nasir
Natalia Smirnov
Adria Carrington

Contributions from Panelists:
Andrea diSessa
Alan H. Schoenfeld
Megan Bang
Hyman Bass
Abby Reisman
Leoandra Onnie Rogers
Key Question

What do the learning sciences and developmental research tell us about how we should be designing education for civic reasoning and discourse?
Proposition 1: Preparation for & practice of civic reasoning and discourse should happen throughout the lifespan and be incorporated across core academic disciplines.
How People Learn (Bransford et al., 1999)

Learning is...

- Social - emerging from interaction
- Situated in specific contexts
- Mediated by artifacts and tools
- Distributed across environment + time
- Differently organized for novices + experts
- Built on prior knowledge
Dimensions of Civic Reasoning

- Knowledge
- Epistemology
- Ethics
- Emotions
- Perceptions

- Implicit Bias
- Conceptual Change
- Civic Reasoning
Foundations for Civic Reasoning Begin at Early Age

- Imitation
- Cultural & Behavioral Norms
- Cause & Effect
- Creation/Destruction
- Ownership vs Sharing
- Story Structure
- Gender, Race, Value
- Morality & Fairness
Content Knowledge Impacts Civic Reasoning

SARS-CoV-2 Variants

Multiple variants of the virus that causes COVID-19 are circulating globally and within the United States. To date, five variants have been classified as a variant of concern, and the proportions of cases caused by these variants are summarized below. Based on specimens collected from March 28 to April 10, an estimated 59.2% of COVID-19 cases in the United States are caused by the SARS-CoV-2 variant B.1.1.7. The proportion of cases caused by B.1.429 is estimated at 4.5%, and the proportion of cases caused by B.1.427 is estimated at 1.8%. Variant P.1 is estimated to comprise 3.5% of COVID-19 cases, and the proportion of B.1.351 cases is estimated to be 0.9% for the two weeks ending April 10. Proportion estimates provided in COVID Data Tracker can now be viewed at the national or regional level in 2-week intervals.

• Understanding viral mutations and why they are important
• Understanding implications for mutations for impact of vaccinations and for why percentage of population matters
• Understanding multi-dimensional data displays
• How such knowledge influences policy decisions – federal, state and local
Moral development and identity development form a base for the development of civic reasoning and discourse, and our efforts to support these capabilities must be informed by what we know about development in these areas.
Moral Development

Children form personal moral understandings from a very young age.

Moral understandings involve: harm or welfare, fairness or justice, and rights.

Moral understanding shifts from early childhood to adolescence: fairness, rights, and social justice become better crystalized.

Children can separate self-interest from universal moral judgements.
Identity Development

Identity development, an important developmental task, takes place over the life-course, but particularly salient in adolescence.

Identity in general and ethnic/racial identity relevant to civic reasoning and discourse.

Social and political issues often have at their core issues of identity and belonging.

Identity and racial identity both complex: race, culture, immigrant status, language, social class matter for how one is positioned.
Proposition 2: The skills of civic reasoning & discourse demand complex, cross-disciplinary, and well-practiced repertoires of inquiry, dialogue, sensemaking, and problem-solving.
Developing Civic Reasoning

Dispositions
  - Democratic Principles
  - Question
  - Multiple Points of View
  - Listen to Others

Developed Through
  - Epistemology
  - Knowledge
  - Moral Development
  - Identity Wrestling
Challenges to Civic Reasoning & Discourse

Challenges
- Knowledge Construction
- Conceptual Change
- Implicit Bias
- Institutional Reinforcements

Influenced By
- Perceptions
- Supports
- Challenges

- Self
- Others
- Settings
- Tasks
• **Math and social justice:** applying abstract reasoning and skills of math to social challenges – wealth inequality, electoral manipulation, educational opportunities — in students’ local communities (e.g., Gutstein, 2006)

• **Ethnomathematics** – challenge the narrative that math is purely an outgrowth of European intellectual history, incorporate mathematical practices of diverse communities (e.g., Ascher, 1991)

• **Algorithmic Justice** - using computational tools to analyze algorithmic manipulation (e.g., Tate, 2019)

• **Teaching for Robust Understanding (TRU):** interdisciplinary, build on prior knowledge, collective understanding (Schoenfeld, 2014; Schoenfeld et al, 2018)
Embrace and invite **epistemic and ontological heterogeneity**, acknowledging the variety possible nature-culture relations and resulting human activity (Bang et al., 2013)

Anticipate when students’ **personal epistemology** might be influenced by ideological frames

Involve students in **citizen science projects** around watersheds, biodiversity, air quality, etc.

Teach **scientific literacy through journalism** engaging students in activities of science journalists to support use of scientific information for personal decision-making (Polman et al., 2014)
Learning the complex demands of civic reasoning and discourse requires:

1) Attention to problems of conceptual change, self-examinations of implicit bias, moral reasoning, and epistemological dispositions valuing complexity and weighing multiple points of view.

2) Learning to empathize with others, even when we disagree and to interrogate the concept of democratic values.

3) Anticipating the social and emotional demands and the ways that identity orientations and commitments play out in civic reasoning and discourse.

4) Access to sufficient data on which to base claims with evidence and to articulate warrants for why evidence should be believable.

5) Meta-linguistic knowledge about how language can be crafted and manipulated to persuade, implicitly conveying points of view and position judgements as presumed facts.

6) The development of content based and conceptual knowledge in each of the academic disciplines taught in schools.
Supporting Civic Reasoning and Discourse Across the Disciplines

1. Draw and build on students’ prior knowledge,
2. Promote a sense of emotional safety,
3. Establish relevance through engagement with real-world problems,
4. Provide opportunities to develop personal and collective efficacy through scaffolded and iterative challenges,
5. Support students in questioning sources of information and beliefs,
6. Support students in interrogating their own assumptions,
7. Support students in wrestling with complex and contradictory ideas, and
8. Ensure access to a multiplicity and variety of cultural and ideological perspectives, including ones that resonate with students’ own lived experiences and those that are less represented in the dominant culture.
Challenges to the field of science education

• What does it mean to integrate attention to
  • Social and emotional well being tied to processes of learning science in developmentally responsive ways
  • Moral and ethical reasoning

• What are implications for cultural foundations of science teaching and learning
  • Differences in cultural communities epistemological histories with the natural world (e.g. indigenous knowledge systems about relations among humans and the natural world)
  • How to conceptualize relevant sources of prior knowledge from children’s everyday experiences

• What are the broader ecological challenges
  • Standards/ assessments/ accountability measures
  • Preparing an infrastructure to support practice on the ground
Recommendations
Five Key Highlights of This Report

These highlights are drawn from an extensive set of recommendations outlined in the conclusion chapter of the report.
Five Key Highlights of This Report

(1)

Learning the complex demands of civic reasoning and discourse should be grounded in research on how learning entails students’ identity development, cognitive development, as well as moral and ethical development.
Civic learning should occur in environments that are conducive to student discussion, utilize project-based and inquiry-oriented approaches, and provide opportunities for developmentally responsive democratic decision making. All students should have access to these kinds of learning opportunities and approaches.
Civic education should not be siloed in civics classes – All of the core subject areas should contribute to the range of knowledge, skills, and dispositions that students need to develop to investigate problems that emerge in the public domain.
Learning to engage in civic reasoning and discourse should explicitly include strategies to help students **gather, analyze, and thoughtfully circulate information in digital and other media**, including identifying and combating misinformation.
Research infrastructures and other collaborative partnerships should be developed to (1) generate up-to-date data on teaching and learning in the area of civic reasoning and discourse and (2) encourage the uptake of a K-12 focus across curriculum areas that facilitates this multi-dimensional understanding of the complexities of learning to engage in civic reasoning and discourse.
Building Partnerships

- **Host additional webinars with key stakeholder communities**
  - Organizations that have developed reports related to these same challenges
  - Practitioner organizations working in the content areas – literacy, mathematics, science, history/social studies, the arts
  - Research organizations focusing on education and youth development
  - Educational policy makers and leaders at the federal, state, and district levels
  - Assessment community

- **Outreach to media outlets in hopes of sparking public discussion**

- **Developing shorter, more practice-oriented products for key stakeholders**
Thank You!

Full report and Executive Summary available at naeducation.org
CIVIC REASONING AND
MATHEMATICS

GRAPHS,
NUMBERS, AND
SOCIAL JUSTICE
DURING THE PANDEMIC

Judit Moschkovich, Professor, Math Education, June 17, 2021
Tales from three countries: reflections during COVID-19 for mathematical education in the future

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Memo 1: Why am I constantly looking at graphs?

Not arithmetic or computation but the meaning of graphs:
• What do graphs do (for me)?
• “Flatten the curve”
• “The curve is growing exponentially.”
Memo 2: Which numbers do I watch? What math concepts am I using?

- **Total numbers misleading:** proportional reasoning, multiplicative thinking (not additive), rates

- **Understanding graphs:**
  How do scales change curve?
  Logarithmic and linear scales?

How to lie with statistics, Huff (1954)
Memo 3: Not just math, science (and a very social science). How is my math reasoning informed by social justice?

- Medical science is observational and depends on questions we ask and lens that we use. Those questions are political. Who is dying? What ages? What gender? What co-morbidity factors? What zip codes in NY? Which social classes? Which ethnic groups?
- What questions do I ask to understand why these are hot spots?
- Where and when in school does one learn to ask these questions?
Memo 4: Modeling, Informal Statistical Inference

- **Modeling is based on imperfect data**, numbers only reflect what we can or do count (no tests available, deaths that are not recorded as due to COVID, etc.).
- **Any model needs to specify the conditions**: i.e. testing, how much, sheltering, what kind, etc.
- **Intuition and statistics are not good friends**: “There are no cases where I live.” “The virus is not in our town.”
RECOMMENDATIONS: Math education to support civic reasoning informed by social justice lens

1. Separating mathematics from its applications is foolish
2. Learn what questions to ask and what data to collect, not just how to interpret graphs, proportional reasoning, or what answers to trust.
3. Learn to reason with open minds, so that our intuitions both guide us and teach us what to question and when to question our intuitions.
4. Most importantly: develop compassion.
   • Compassion for ourselves: we cannot possibly understand a pandemic all at once.
   • Compassion for science and scientists: it and they have their limits.
   • And compassion for others who are not like me: so we can think well about the collective (and not only the individual)........embrace a social justice lens.

QUESTION: What course currently supports students in developing compassion and using a social justice lens?
TEACHING? DO NOT REINVENT WHEEL! THREE EXAMPLES


2. LESSON: Flint water catastrophe

3. FEELINGS: Teachers need support learning to lead difficult conversations
THANK YOU!
Civics and STEM learning are baked into my life story

- Sepehr Vakil, Assistant Prof, Learning Sciences, Northwestern University, B.S/M.S Electrical Engineering, UCLA
- Born in Iran (1983), immigrated to the US (1986)
  - My parents left Iran, to escape the war, pursue US citizenship via aspirations to pursue STEM
- What is your relationship to STEM/STEM Education?
Anchoring STEM in civics important for racial equity

- Let's take the case of computer science education...
- Political contexts of learning matter, and students are paying attention
- Civic and political identities in STEM (Vakil, 2018)

“Bay Prep will be a resource for Silicon Valley... We will stop the killing. We will stop the violence. We can. We will. We must... the goal is Intel. The goal is Google. The goal is Facebook!”
Towards a more ethical, civic-engaged STEM

- The profound responsibility of STEM education
- More empirical and theoretical research is necessary
  - Designing for ethical STEM learning in undergraduate education (NSF CAREER)
  - Historical and global view of STEM education can inform our own effort (Spencer large grant to study history of Sharif University in Iran)
Thank you

Please continue the conversation on chat, during the social networking session, and on social media.