A cultural framing of the ‘learning of scientific practices’ from an everyday cognition perspective

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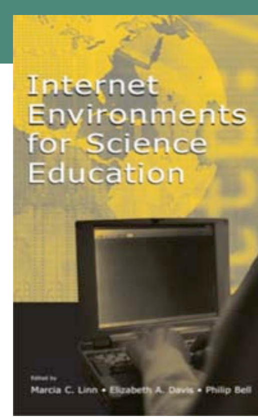
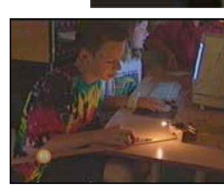
However, all opinions are strictly our own.

Prior classroom learning studies…

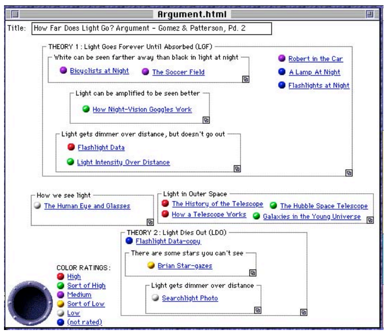


- Promote integrated understanding through scaffolded scientific inquiry (Linn, Davis & Bell; Linn & Hsi)
- WISE, Computer as Learning Partner



Argumentation and collaborative debate as a spanning, synthesizing context

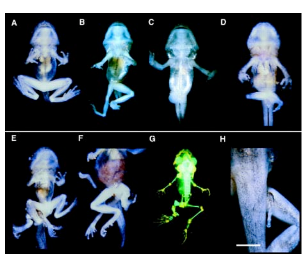
- Support students in building theoretical arguments that span a corpus of evidence (lab results, scientific evidence, life experiences, thought experiments)
- Students collaboratively refine their conceptual understanding and epistemological sophistication (to some degree)

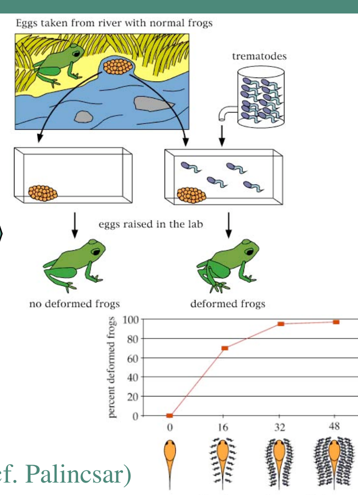


Bell, P. (2004). Promoting students' argument construction and collaborative debate in the science classroom. In Linn, M. C., Davis, E. A. & Bell, P., *Internet environments for science education*. Erlbaum.

Engaging students in the interpretation of current research

Primary Source:
P. Johnson, K. Lunde, E. Ritchie, A. Launer, in *Science*. (1999 April 30), vol. 284, pp. 802-4.





Students engage in "second-hand investigations" (cf. Palincsar)

Bell, P. (2004). The educational opportunities of contemporary controversies in science. In Linn, M. C., Davis, E. A. & Bell, P., *Internet environments for science education*. Erlbaum.

Cultural studies of science as a possible frame

Cultural studies of science…do not reduce science to culture, as if these were discrete and separable in the first place, nor do they programmatically challenge the cultural authority accrued by the natural sciences. Cultural studies instead focus critically upon *how and why science matters*, *to whom*, and *how people's possibilities for meaningful action and understanding are reconfigured* in part through the development of scientific practices. This emphasis upon *reshaping people's situation*, or what Wartenburg calls their 'action-environment,' is characteristic of cultural studies.

— Rouse, 1994, *PSA*, p. 400 (emphasis added)

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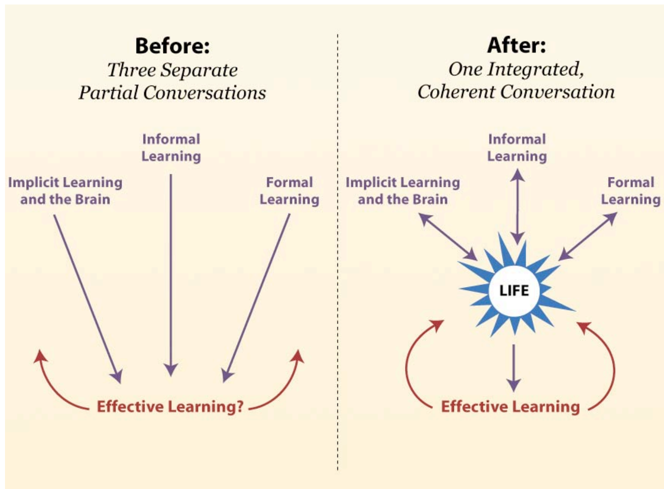
LIFE's Purpose: To transform the sciences of learning by identifying & investigating key research questions that draw on neurobiological, cognitive, developmental and socio-cultural theories & their related methodologies to collectively guide the design of effective learning environments.



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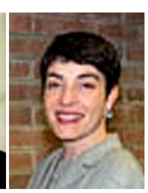
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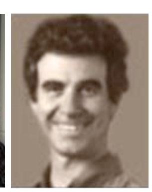
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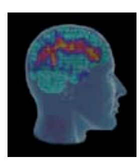
LIFE Graduate Students and Post Doctoral Scholars

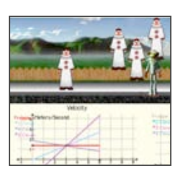
Each research strand has its own language, theory, and methods—need sustained conversation across

Implicit: social cognition, neural commitment, imitation, early learning, representation



Informal: context, distributed participation, interaction, appropriation of tools, culture, improvisation

Formal: transfer, preparation for future learning, adaptability, efficiency, design of tools



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everydaycognition.org

ESTG studies how culture and experience shape the patterns of activity that children and families engage in around science and technology, the meanings they attach to such events, and how it influences who they become.

Research methods:

- ethnographic fieldwork; videorecording of everyday life activities across settings
- clinical & ethnographic interviewing
- self-documentation by participants
- classroom and afterschool intervention studies

Members:

- Philip Bell
- Leah Bricker
- Tiffany Lee
- Maisy McGaughey
- Suzanne Reeve
- Carrie Tzou
- Heather Toomey Zimmerman

Four Conceptual Themes

Personally Consequential Biology

How do children learn about the living world across social settings and apply that understanding in their own lives?

Focus is on consequential topics: *personal health*, *nutrition*, and *local environmental conditions*.

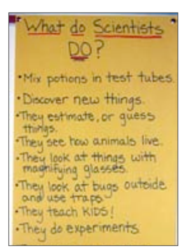
Technological Fluencies

How do children learn with and about digital technologies?

Everyday Argumentation

What are the forms of argument children engage with and construct across settings? How do they learn about and through argumentation?

Images of Science & Self



Based on the various images they encounter, what do children count as ‘science’ and why?

How do these images influence identity formation?

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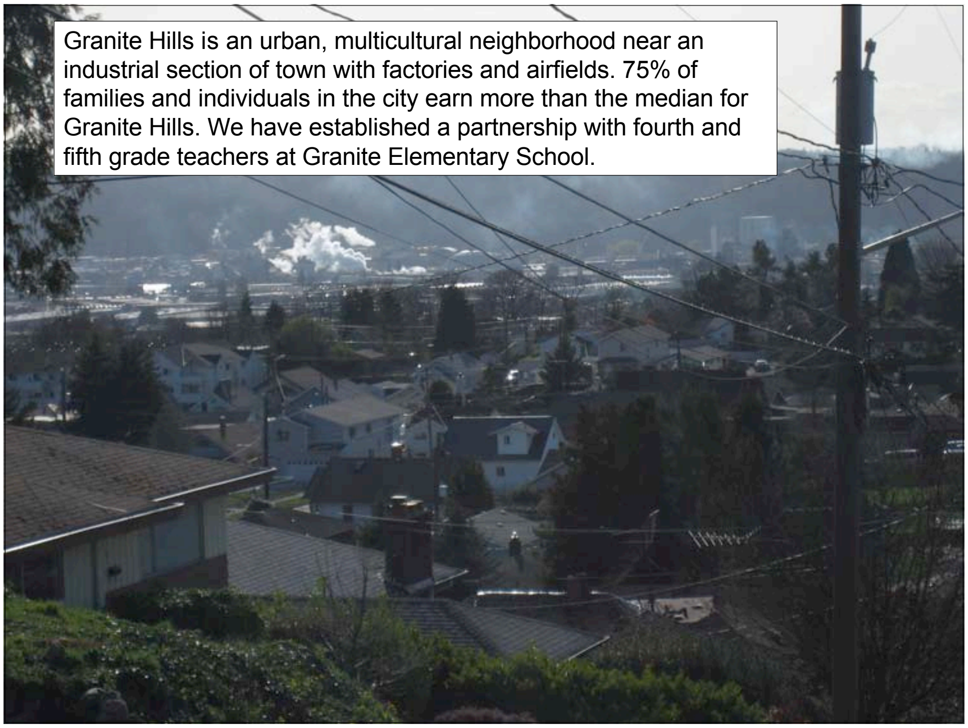
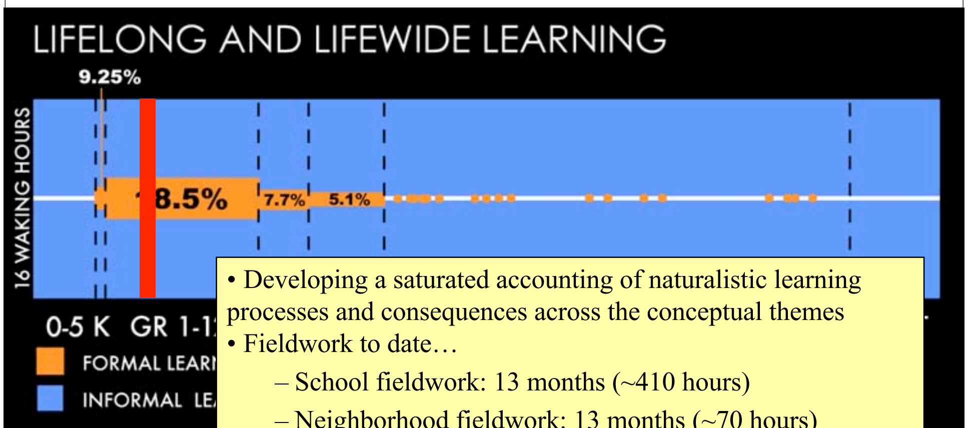


4th & 5th Grade Ethnicity	% Repr
Chinese •	31%
Filipino	16%
Vietnamese •	15%
Latino/a •	12%
African American	8%
East African: Tigrinya •, Amharic •, Oromo, Somali •	5%
Caucasian	5%
Cambodian •	5%
Native American	1%
Japanese	1%
Pacific Islander	1%
N=130	
School ESL	40%
Low Income (FRL)	60-65%

Research focus: A more saturated accounting of everyday cognition across settings



- Developing a saturated accounting of naturalistic learning processes and consequences across the conceptual themes
- Fieldwork to date…
  - School fieldwork: 13 months (~410 hours)
  - Neighborhood fieldwork: 13 months (~70 hours)
  - Child & Family fieldwork: 6 months (~180 hours)
- Conducting ~100-120 hours of fieldwork each month
- Anticipate a minimum of 100 hours of fieldwork per child

My Orientation to Scientific Practices: Two touchstones, a worry, and a wish

- Two Touchstones:
  - Follow the accomplishment of everyday work within contemporary, *professional fields of inquiry*: social, material, technical practices within specific sub-fields affiliated with the natural sciences (academic [e.g., disciplines, interdisciplinary efforts] and otherwise [e.g., medical workers, federal agencies involved in regulation])
  - Follow *the everyday relevance of science* for just plain folks (JPFs): involves striving to understand the many forms and arrangements of scientific 'literacy' in the consequential moments of people's lives
- The worry: (e.g. Rick's "How normative should we be?")
  - Do we need to push back against the homogenizing forces that define 'successful learning?' — which derive from idealized, universal accounts of expertise; some curriculum renderings; some technology designs; and many assessments of cognition and achievement
- The wish:
  - To more fully document, through naturalistic research in diverse real world settings, the organization and consequences of everyday science learning for JPFs (e.g., families making complex health decisions, scientists engaged in social and material practices); learning progressions to where?

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How are you defining "scientific practice" in your design and empirical work? What is the model of the specific scientific practice you are investigating?

Analytical stance on 'scientific practices'

- Document and analyze, in a grounded theoretic manner, more 'comprehensive' accounts of naturalistic learning processes and consequences of everyday scientific practice
- Try to orient to both…
  - member meanings and relevant displays of activity to understand 'what counts as science' to the JPFs (*emic view, experience-near*)
  - analyze cases from the everyday cognitive perspective of relevant professional fields of inquiry in order to understand unrecognized scientific (or proto-scientific) practices or associated gaps (*etic view, experience-distant*)
- Play *professed accounts* off of *enacted practices* in order to push for theoretical progress
  - I.e., this is the classic Say / Do distinction
  - There would be great analytical and pedagogical benefit associated with ecologically grounding what people *say they do* to what *they actually do* in moments of their lives
    - e.g., the Nature of Science research program is in need of grounding

Brenda: A disconnect in scientific practice between formal and informal settings

- Fourth-grader at Granite Elementary
- Family structure & history:
  - Brenda is the only daughter of a single mom (Stella) and was adopted from Haiti when 10 mo. old
  - Mother emigrated to the U.S. from Haiti at 19; she works as a manager at a large health provider
- Brenda's routine activity systems & interests:
  - homework, family interaction, schooling, peer conflict management, tetherball, swimming, viola, computer and board game playing, peer play, caring for animals, perfuming

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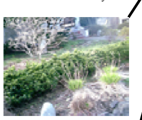
Brenda's understanding of health, related activity systems & everyday influences

Brenda: Understanding of Pleasing Natural Scents as Healthy

Self-Documentation

Flowering Bush in front of house: Healthy



Shrubs, grasses, plants: Healthy

Rose & Baby's Breath: Healthy

3 pictures of 6
—
4 healthy
2 healthy & unhealthy

Member Meanings for Healthy

A **Pleasing Natural Scents:** Plants that smell good are healthy and good for you.

B **Thriving Foliage:** Plants that are naturally green and thriving are healthy.

Member Meanings for Unhealthy

C **Physiologically Harmful:** Some substances are harmful to your body.

Associated Situated Activity Systems

Systematic Mixing: purposeful and careful mixing of perfumes (fragrances, solvents, lotions); everyday chemistry; instrumental use of products
(Observed & Member Reported)
Setting: Home
Participants: Brenda & Stella

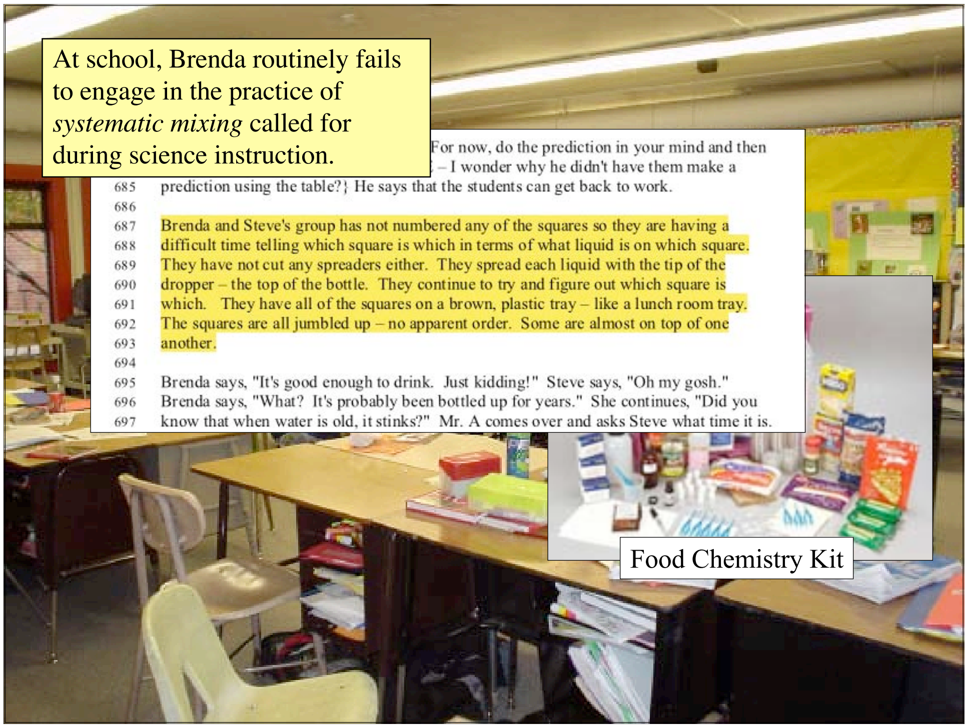
Gift Giving: gifting between focal participant and parents sometimes focus on items with pleasant scents
(Member Reported)
Setting: Home
Participants: Brenda, Stella, others

Known Everyday Influences

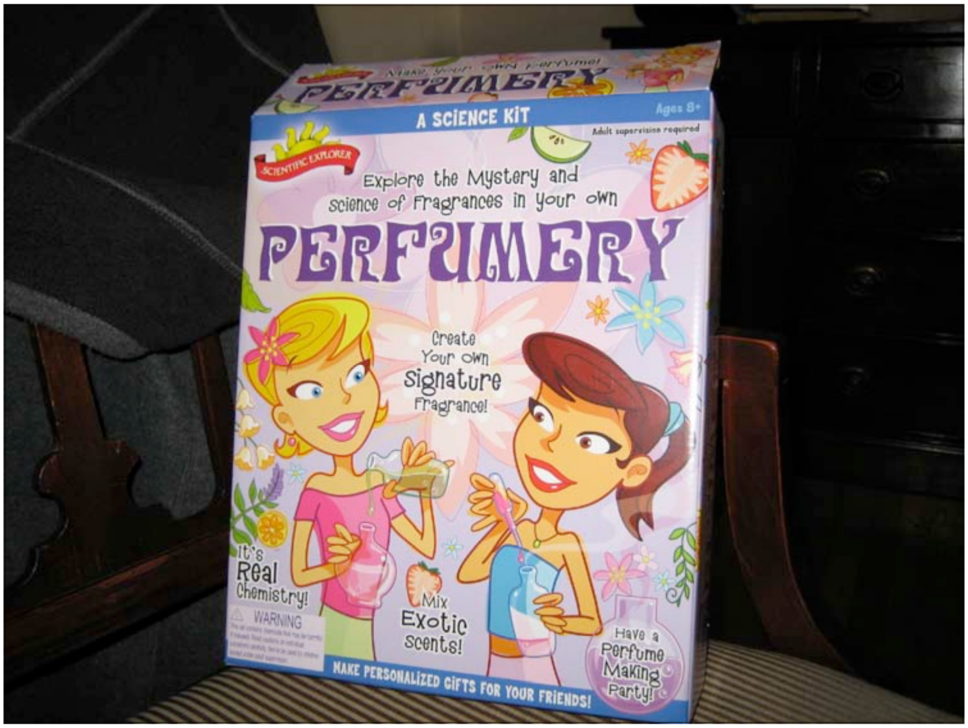
Potion-Making as Child & Haitian Cooking
(Member Reported)
Setting: Grandmother's home

Perfumery Science Kit
(Member Reported & Observed)
Setting: Home

Mother's Teaching of Organization
(Observed)
Setting: Home



But she routinely engages in that practice at home.



Situated Activity System: Systematic Mixing
Involves…
• Control for contamination with the apparatus
• Careful measurement of materials when mixing
• Tracking / labeling of samples
• Systematic journaling of results

Brenda's everyday chemistry practice serves a functional role for the family—weekly production of perfume (for approx. six months), mother's use, grandmother's use, as gift for second parent, scented misting in the home.

developmental history and cultural influences on Brenda's systematic mixing

- Brenda defines science as 'mixing' and 'doing chemistry'
- Stella provides a historical reconstruction of B's learning
- Both associate Perfumery activities with Brenda's long-held interest in potion-making
  - Brenda started making potions with her cousin when 3 at her grandmother's home
- Stella associates the potion-making activity with Haitian cooking

Brenda's systematic mixing, potion-making & Haitian cooking

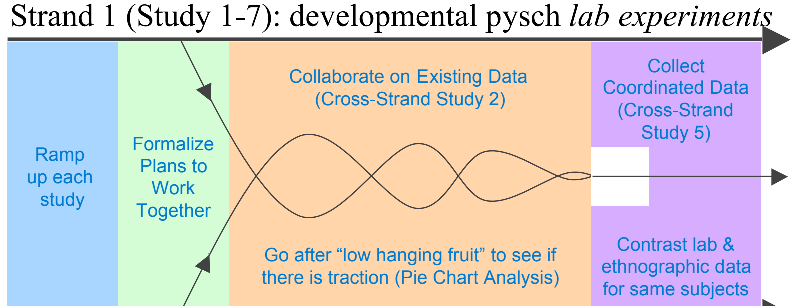
- Brenda's systematic mixing is enabled by elements of…
  - Her long-held interest in a potion-making activity system
  - A Haitian Cooking activity system at the grandmother's (most likely)
  - The Perfumery Kit— as an element in the cultural toolkit
  - A likely pedagogical influence from Stella
- Everyday chemistry is a fixture of the Joseph home, but Brenda does not bring her established practice to school
  - school science underrepresents her expertise
  - violates commonly held assumption that children are most "scientific" in moments of formal instruction

Everyday Expertise Framework

Analytical Plane	*Conceptual Focus*	*Learning Phenomena*
individual	*Cognitive ecology* consequential conceptual, epistemological & motivational resources	Range of knowledge, strategies, and motives developed and deployed by individuals
social	*Situated activity systems* social and material actions performed within and across ideocultures; cognition often distributed	Social / material practices used within and across settings; social network development and use
cultural	*Cultural toolkits* learning resources and tools available at a particular historical moment that allow for specific strategies of action	Awareness and localized use of pervasive cultural equipment (artifacts, habits, skills) for motivated purposes

Going after Say vs. Do: Tracing the social influences on children's development of metacognitive knowledge about thinking

Strand 1 (Study 1-7): developmental pysch *lab experiments*



Strand 2 (Study 2-2): everyday cognitive *ethnography*

Testing the ecological validity of their protocol while also informing the developmental influences.

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Now, to pop up a level.

And I apologize in advance for the text density associated with these philosophy of science quotations…

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Defining 'practice' and 'culture'

Since terms like 'practice' and 'culture' enjoy a rich and varied range of associations that differ from audience to audience, some preliminary clarification may be useful here. Centrally at issue is the constructivist insight that *doing science is real work and that real work requires resources for its accomplishment*. Throughout this essay, 'culture' denotes *the field of resources* that scientists draw upon in their work and 'practice' refers to the acts of making (and unmaking) that they perform in that field. 'Practice' thus has a temporal aspect that 'culture' lacks, and the two terms should not be understood as synonyms for one another: a hammer, nails, and some planks of wood are not the same as the act of building a dog kennel—though a completed dog kennel might well function as a resource for future practice (training a dog, say).

— Pickering, *Science as Practice and Culture*, p. 3

- This resource-driven notion of 'culture' can be viewed as being contingent upon a *disciplined way of seeing* (cf. Goodwin, Hutchins).

Broadening the frame on scientific practices…

Scientific practices obviously include experimental and instrumental practices that make things newly or more reliably manifest and available for interaction and manipulation, and the practices of theorizing, modeling, and calculating that offer alternative ways of understanding and interrelating such phenomena. Yet I also want to conceive scientific practices more expansively, as *encompassing the institutional, communicative, pedagogical, economic, industrial, political, and other practices* that interact with, enable, constrain, enforce, utilize, and otherwise influence or even constitute the more narrowly 'scientific' practices that preoccupy most philosophers of science. We cannot fully understand the significance of scientific practices without considering them in their full concreteness.

— Rouse, 1994, *PSA*, p. 397

- How narrowly or broadly should we bound 'scientific practices' for the purposes of science education (I.e., how much of the 'full concreteness' do we bring when? Many cognitive models in the literature are typically quite narrow. What about connections to policy, economics, communication, industry, learning?

Scientific practices are patterns of activity in response to a situation

I understand practices as patterns of situated activity [in response to a situation]. Part of the point of this formulation is to include *the material setting of activities* within the conception of a practice....Practices respond over time to the affordances and recalcitrance of their surroundings, while those surroundings are meaningfully configured by the practices through which they become manifest." — Rouse, 1994, *PSA*, p. 397

Highlights a distributed cognition image of practice.

It is next to impossible to efficiently organize *the field of material resources* in schools for science learning. How much progress would scientists make in their inquiry if they had to tear down their equipment each and every day?

Scientific practices are dynamic, sustained, communal; 'knowing' is accomplished through 'social alignments'

More importantly, however, practices on my account are *dynamic* and *temporally extended*, since their patterns only exist through *continuing reenactment*. Their coherence and continuity depend both upon coordination among *multiple participants and things*, and upon *the maintenance of that coordination over time*...Furthermore, practices are intrinsically open to the continuation or extension in multiple ways, because the enactment of patterns in the practice *cannot be determined by rules*. [R, 397]

Knowing…is similarly mediated by and dispersed across '*epistemic alignments*'; just as actions are only effective when appropriately aligned, skills, models, concepts, and statements only become informative about their objects when *other people and things interact in constructive alignment with them*. [R, 398]

Highlights the duration, materiality, and peer ownership of practices in classrooms, and figuring out how to focus on & bootstrap 'epistemic aligning' among students and 'things.'

Scientific practices are both stable & unstable

Scientific practices therefore embody a continual tension between intelligibility and incoherence. Dispersion and openness to multiple interpretation *continually threaten their coherence*, but since *any specific research only becomes intelligible and significant as a contribution to a project shared with others*, there is also *a relentless pressure to adjust one's work to fit in with what others are doing*. This ongoing tension is manifest in what I call the *narrative reconstruction of science*…Scientists share not background beliefs, but a situation, which they may understand in partially divergent ways. —Rouse, 397-8

Highlights the need to establish shared projects of inquiry & orient to how student's focus on shaping their scientific practices based on those of others (peers, scientists) —perhaps in contrast to accomplishing one 'idealized practice.'

What is the model for the pedagogical support of the practice? What kinds of designs put this model into effect?

We're not really there yet.

We are learning how scientific practices are supported in everyday settings…

- There appear to be multiple models for supporting the development of everyday expertise in science (different "species')
- A (preliminary) image of everyday science learning might include…
  - Heterogeneous resources—of narrative, material, visual, and technological varieties—are strategically brought into play…
  - with fidelity to a deep understanding of both the learner's interests and more professional fields of inquiry…
  - in tandem with a supportive, sustained social interaction…
  - often contingent upon an envelope of shared cultural experience with others (cf. Buhler's shared semantic fields; Edwards & Mercer's common knowledge)…
  - and frequently connected to activities and consequences valued by the participants.

Supporting everyday scientific practices

- In terms of formal instructional models, we're just now crossing that bridge into design experimentation with the teachers—much is still yet to be determined.
  - We will be working within the context of the existing elementary science kits and the health curricula.
  - And an afterschool science program.
- They will likely be a more 'whole cloth' scaffolded construals of a specific configuration of scientific work (i.e., a scientific community writ small focused on everyday consequence).
  - Think of FCL meets CiP with a focus on science

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How are you defining success in having learners engage in the practice? How do you assess it in your empirical work?

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Locating success in the world…

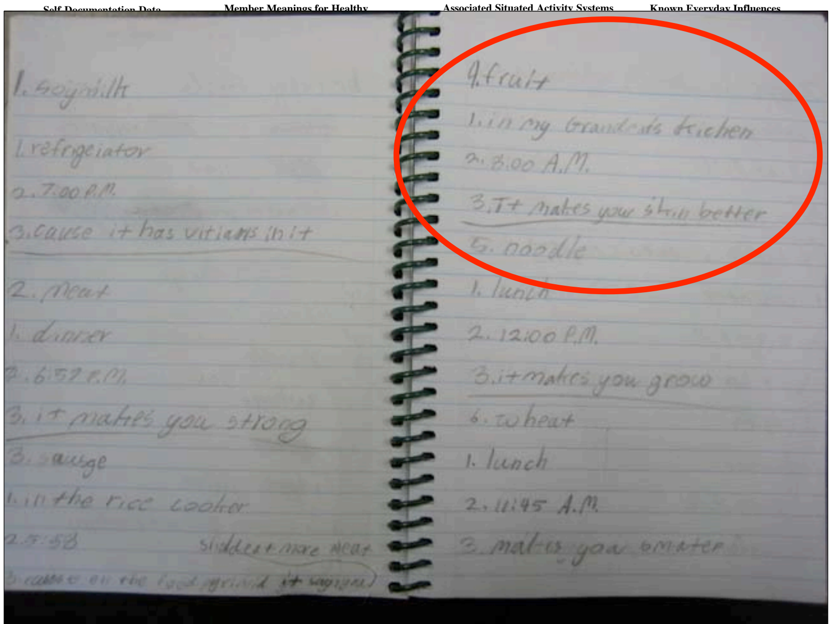
- ‘Success’ is operationalized around *personal relevance and significance*—as defined by JPFs and by us—when we observe the ‘doing of scientific practices’ in their lives
  - Focusing on consequential STEM topics:
    - in terms of the thinking associated with everyday life (e.g., personal health, family finances / projects) & possible social futures (e.g., associated with school math, technology design)
  - One way to understand our science work:
    - We are trying to connect conceptual change to behavioral change / action.

case 1: Steve Lee

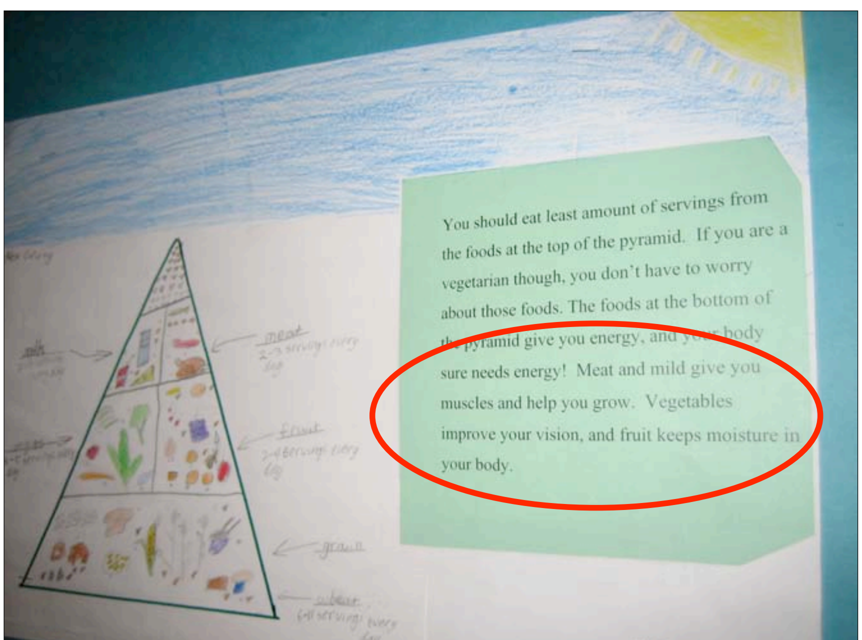
- **4th grader** at Granite Elementary
- **Chinese heritage** – both grandmothers are Chinese, one grandfather is Caucasian
- **Routine activity systems**: gaming, chess, school/homework, family/friends, swimming, pets
- **Health issues**
  - *food allergies* (dairy, seafood, nuts)
  - asthma (inhaler once/twice a day)
  - *skin condition* (Steve says it makes his skin “scratchy”)

Steve: Understanding of Foods as Healthy or Unhealthy & How Food Affects the Human Body

Self Documentation Data | Member Meanings for Healthy | Associated Situated Activity Systems | Known Everyday Influences



1 healthy & unhealthy



2 unhealthy
1 healthy & unhealthy

Steve pieces together and deploys his understanding of health across settings & purposes

- Ideas about health ‘travel’ within and across the activity systems at home and school
- Understanding is influenced by both family members and instruction
  - Parceling out the various everyday influences on Steve’s network of ideas is important for fully understanding his knowledge of health and its instrumental use in his life
  - Accounts of prior knowledge are often characterized as disembodied
    - can overlook people’s everyday expertise in which knowledge is interconnected and utilized in everyday life

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What have you learned about (a) challenges and (b) how to support students in this practice?

Challenges…

- There are ‘artifact of method’ issues associated with our single-site empirical accounts which underrepresent children’s reasoning.
  - We need more complete developmental accounts of learning.
  - We need to connect our accounts of learning to the everyday lives of children (i.e., after they leave the classroom).

Challenges…

- My sense is that we have made significant progress although we still have very coarse ways of knowing how to scaffold learning and development with respect to the significant individual variation in what learners bring to a particular instructional moment (i.e., with respect to competencies rooted in ethnicity, language, and class).
  - We either ignore large portions of this individual variation, leave it to local adaptation to manage, or let it live in our error terms.
  - There is a strong tension between the design of learning environments and the heterogeneity of many contemporary classrooms.
  - Some general principles summarized in:

    Nasir, N. S., Rosebery, A. S., Warren, B., & Lee, C. D. (2006). Learning as a cultural process. In K. Sawyer (Ed.), *The Cambridge Handbook of the Learning Sciences (1st ed.)* (pp. 489-504). Cambridge: Cambridge University Press.

Challenges…

- We live with historical images of scientific work that are now embedded in the structures of science ed—which makes it difficult to infuse new models of scientific work.
- It is also difficult to promote innovation in the system under ‘resource poor’ conditions.
- But as children sort out their interests and futures, I have come to increasingly worry about the images of science we hold up and reinforce through instruction.
  - The images seem far afield from some accounts of everyday scientific work we have from science studies (e.g., use of narrative and visual resources when theorizing).
  - They may filter out the very underserved children we want to bring into the STEM pipeline.

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Thanks!

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