Does social constructivism translate from history to education?

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I'm a high school physics teacher. I majored in Physics at Cornell University with a concentration in the history of physics, back in the heyday of constructionism. A highlight was co-authoring a paper on the difference between four pioneers of quantum in their patterns of citation, giving and receiving.

Today's presentation is less about recent discoveries and more about realizing how history has helped me think about my teaching, and how much more I should work on the following ideas.

How do we know the histories of physics?

Turn to the person next to you and tell a one- or two-sentence story from the history of physics or natural philosophy...What sort of historiography informed that story?

Consuming history

- History of a field may be useful to future practitioners.
- Teachers are inspired by history.
- Students may be inspired by history.
- Students see the myriad factors of action in science.

What is it that physicists do? How do they make decisions? How do they find success? Historians help answer these questions; so, historians should be able help us answer these questions with students. But teachers and students also struggle with the same problems which vex historians, those concerning agency, priority, motivation, and interactions. Knowledge doesn't exist outside of us, nor does it reside solely in individuals, but it messily travels in society. We are better teachers when we coach students through the classroom and through society with tools that let students consider themselves a part of physics and physics a part of their society.

From sidebar stories to descriptions of working systems

Type of history	Lesson learned
Dates and names	Physicists existed
Delicious anecdotes	Physicists are interesting
Constructed from resources	A glimpse of how physicists work (together) to re-shape their field

History in physics class is ready to move forward from dates and names, passing biographies and delicious anecdotes, onward into the fray of the complicated and specific historiographies of recent decades. In a sort of hierarchy, students of physics may learn from its history first that physicists are people, second that they have interesting lives, but what might be a much more useful third level is a glimpse of how physicists work together in a field to continuously re-shape that field.

Keep in mind that our story of how Einstein knew what he knew about special relativity has changed as historiography has changed. (See Clocks, Maps).

Constructivist approaches

- Social constructivists and historiography
- Constructivist education

We will discuss some constructivist approaches, then how history's successes and struggles can help us teach physics.

One may pooh-pooh constructivism in either field, science education or historiography, as a fad that had its run for a couple decades after the sixties, but perhaps it has just become part of the landscape.

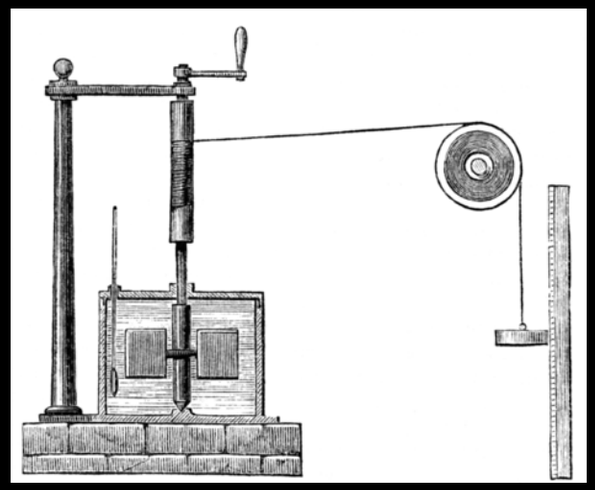
Some features of intentionally constructivist histories of science

- Scientific subcultures
- Models and methods
- Open-ended nature of work
- The field is maintained by pedagogical authority and social control.

Golinski, p. 26

Energy in Victorian Britain

- Energy science constructed, not discovered
- Energists were creating and thriving in a network of cultural resources.



Joule's paddle wheel

Harper's New Monthly Magazine, No. 231, August, 1869.

Crosbie Smith, pp2-3, the science of energy was constructed, not discovered, from pieces of philosophy and industry to wield power in British society. He seizes on the process of an upward 'spiral of credibility' that garnered acceptance, really celebration, of energetics.

Joule drew on his skills and tools from his family of brewers.

[Scottish Presbyterians took over from Anglican Royal Society.]

[See top of p12 for a succinct quote and citation.]

Constructivism in education

- The teacher must be aware of how the student constructs a framework of skills, facts, and understandings.
- Then the teacher must nurture additions to that building.

Perhaps more tortured than constructivism in history, going from psychological to social, back to the individual, then maturing to today's accepted form.

Extreme constructivism is unnecessary

- Let's avoid the straw man of absolute relativism, that every student's mental universe is their own isolated construction.
- Constructivism rather is interested in the links between the student's thinking and the resources surrounding them.

Blind heuristics, that students need to learn everything by themselves, and our link to constructivist historiography clarifies our distance from such extreme constructivism—Constructivist historiography shows that scientists draw on the resources around them, not draw science out of the air.
See below on extreme c. Learning.

Traditional Classroom	Constructivist Classroom
Curriculum begins with the parts of the whole. Emphasizes basic skills.	Curriculum emphasizes big concepts, beginning with the whole and expanding to include the parts.
Strict adherence to fixed curriculum is highly valued.	Pursuit of student questions and interests is valued.
Materials are primarily textbooks and workbooks.	Materials include primary sources of material and manipulative materials.
Learning is based on repetition.	Learning is interactive, building on what the student already knows.
Teachers disseminate information to students; students are recipients of knowledge.	Teachers have a dialogue with students, helping students construct their own knowledge.
Teacher's role is directive, rooted in authority.	Teacher's role is interactive, rooted in negotiation.
Assessment is through testing, correct answers.	Assessment includes student works, observations, and points of view, as well as tests. Process is as important as product.
Knowledge is seen as inert.	Knowledge is seen as dynamic, ever changing with our experiences.
Students work primarily alone.	Students work primarily in groups.

Educational Broadcasting Corporation, 2004.
http://www.thirteen.org/edonline/concept2class/constructivism/

Here's a document showing the multidimensional vector pointing towards constructivist teaching. I've put lines around my favorite parts.

Balance preparation and presentation

- To prepare to be productive scientists, students need to experience inquiry.
- But, to take advantage of scientific progress, students also deserve to know results of previous inquiries.

The problem with radical educational constructivism is that most people in society, including most of the students, want largely to know what science has already been constructed, without time to construct it as it had been done by the scientists. Our job, in educating students who will be creators and consumers of science decades hence, lies in the balance between depicting known science and preparing for unknown science. So, we must not tarry forever in "making sense of science," nor should we linger too long in a swill of regurgitation. (Matthews 1998)

As selecting resources

- Seeing historical scientists as selecting resources can be:
  - Humanizing the findings.
  - Providing a model for the student.

SCIENTISTS/STUDENTS SELECTING RESOURCES

Constructivist historians write from the position that what one brings to the table, and what one finds there, determines what gets done. Can this help us with our gender issue? (Nurture over nature.)

Rather than merely being sideline coaches, we need to provide our students with resources like knowledge and skills, but when they need them, or most radically, when they figure out when and how to ask for them.

Table 1 Constructivist Learning Environment Survey (CLES): preferred and perceived forms

Component	Description	Sample item (preferred form)	Sample item (perceived form)
Personal relevance (PR)	Relevance of school science to student out-of-school life	In this class, I wish that students learned about the world outside of school	In this class, students learn about the world outside of school
Scientific uncertainty (SU)	The nature of scientific knowledge	In this class, I wish that students learn that science has changed over time	In this class, students learn that science has changed over time
Critical voice (CV)	Student ability to have a voice about the quality of learning activities	In this class, I wish that it's OK for students to ask me "why do I have to learn this?"	In this class, it's OK for students to ask me "why do I have to learn this?"
Shared control (SC)	Students share control of the learning environment, including selection of learning activities, assessment criteria, and negotiation of social norms	In this class, I wish that students help me to plan what they're going to learn	In this class, students help me to plan what they're going to learn
Student negotiation (SN)	Students verbally interact with other students to build their scientific knowledge	In this class, I wish that students get the chance to talk to other students	In this class, students get the chance to talk to other students

Funda Savasci and Donna F. Berlin. 2012. Science Teacher Beliefs and Classroom Practice Related to Constructivism in Different School Settings. Published online: 20 January 2012
The Association for Science Teacher Education

Implementation

- Teachers as consumers of history
  - Preservice
- Students as consumers of history
  - Students of humanities
  - Students of science

See History in the Teaching of Physics: Proceedings of the International Working Seminar on The Role of the History of Physics in Physics Education, edited by Stephen G. Brush and Allen L. King, published in 1972 by Dartmouth.
According to Brush, case studies will be useful. (p.95) While to others in the Proceedings attention must be given to the histories of the main topics of any course lest the teacher feel we don’t care about their topical choices.(p. 74, 79, 80)

More implementation

- Preserve apparatus
- Preserve evidence of selection, influence
- Analyze original papers

See Allen L. King's letter on preserving apparatus in Brush and King (editors), Proceedings…p.105-106

See Roger H. Stuewer's letter on analyzing original documents. p. 106

Even more implementation

- Expect creativity

Perhaps the most important lesson from constructivist history for our students is that scientists are productive when they draw on resources in their environs to create fields, theories, paradigms, instruments, schools, policies—What have you. Then, when we ask our students to investigate their physical world in a constructive way, they'll see we're not asking them to passively consume science but to follow in the methods of great scientists.

Important reading

- **Golinski, Jan. 2005.** *Making Natural Knowledge*. **Chicago:University of Chicago Press.**
- **Smith, Crosbie. 1998.** *The Science of Energy*. **Chicago:University of Chicago Press.**
- **Matthews, Michael, editor. 1998.** *Constructivism in Science Education: A philosophical examination*. **The Netherlands: Kluwer Academic.**
- **Von Glaserfeld, Ernst, "Cognition, Construction of Knowledge, and Teaching" pp 11-30 in in Matthews 1998.**