Learning Sciences Reading Log

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Introduction

This collection of notes from readings and class discussions was first constructed using LaTeX in the Fall semester of 2019. The Notes and Glossary files organize and chronicle the thoughts and summaries from the reading involved in this program.

Contents

List of Figures

0 Summer 2019

Math and Science Education Journal Club

- The group and I read about Learning Trajectories/Progression (LT/P), and we differentiated LT/P, where trajectories are for mathematics, and progression is for science (Duncan & Rivet, 2018; Lobato & Walters, 2017; Schwarz et al., 2009).
- Role of neuro in learning sciences (Jacobson et al., 2016).
- The group read about gender and identity in learning (Darragh, 2016; Liben & Coyle, 2014).
- The group and I read about maker spaces (Blikstein et al., 2017; Halverson & Peppler, 2018).
- The group and I read about transfer of math knowledge into sciences (Britton et al., 2005; Roberts et al., 2007; Tariq, 2008).

Learning Trajectories and Progressions: Week 1

Very initial thoughts on Learning Trajectories:

1.1 Learning Trajectories and Progressions

In order to give a proper definition of learning trajectories and progressions, we must first begin with preliminary definitions.
Given an academic discipline, there exist ways to describe the paths to student growth and mastery. Researchers and teachers conduct this theoretical work with variety of intentions and focus, leading to a corniucopia of styles and approaches to the study and creation of learning trajectories and progressions. In (Duncan & Rivet, 2018), Duncan and Rivet give a general definition of Learning Trajectories or Progressions (abbrev: LT/P). In (Lobato & Walters, 2017), Lobato and Walters give a detailed description of seven different types of intentions/perspective on LT/P.
First, knowledge in an academic field beckons organization, and the first operation we do is to separate out knowledge into *constructs*, which are defined as follows:

Definition 0.1 (Construct)**.** *Constructs* are large ideas in an academic discipline, usually defined in a way to partition a subject in order to understand cognition and learning. One can consider this defining subsets of the knowledge of a discipline.

Note that constructs are subjectively defined, and the ways they are defined reveal the researcher's intention. Furthermore, constructs may contain other constructs; I.e., If A is some construct, then there may exist $A_1, A_2, \ldots, A_n \subset A$. Note that in this description, we consider finite n, as most applications of hypothetical models of learning in the form LT/P contain finitely many constructs.

Example 0.1. Suppose we have a topic $A =$ "Functions in Precalculus", and we wish to use a disciplinary-logic approach (defined in 1.11) to describe a set of constructs that may

be defined using skills and definitions. For a rudimentary example:

$$A_1 = \text{"Use of variables"},\ A_2 = \text{"Mapping / Relations"},$$
$$A_3 = \text{"Graphs of equations in } \mathbb{R}^2\text{"},\ A_4 = \text{"One to one"},$$
$$A_5 = \text{"Inverse functions"}, \cdots$$

by construction: $A_1, \cdots, A_5 \subset A$

Note here that for some arbitrary i, j, $A_i \cap A_j \stackrel{?}{=} \emptyset$.

Definition 0.2 (Pathway between constructs)**.** A pathway between constructs shows a connection between ideas, usually for pedagogical reasons or disciplinary expertise. A pathway between constructs may contain intermediate steps, with a diverse set of pathways.

Remark. I wonder if creating LT/P with disjoint constructs is useful or not? Or acknowledging the overlaps can create better "knowledge webs"? Can one define the pathways and the constructs the edges and nodes of knowledge countable? discrete?

In essence, once constructs are separated out and defined using some rule (this may be based on education research or academic expertise), one is imposing some partial order on these constructs, where the this order may be defined in multiple ways, depending on the academic field.

Definition 0.3 (Learning trajectories and progression)**.** A *learning trajectory* (LT) or *learning progression* (LP) is a hypothetical model used describe student growth and mastery in an academic subject, usually with intermediate *levels* and *pathways*. Usually, mathematics educators use "trajectories" and science educators use "progressions". We call a LT/P *linear* when the LT/P models a *well ordered set*.

1.2 Common Properties of LT/P

As researchers have finite time and resources, one must define a limitation on the scope of an LT/P:

Definition 0.4 (Scope of LT/P)**.** LT/P have a defined *scope*, which consists of
- a particular slice of knowledge (domain of study),
- and a specific age-group (span).

Conventionally, the starting point of an LT/P is called the *lower anchor*, represented with a beginner or novice level of understanding within the scope, and the ending point of an LT/P is called the *upper anchor*, which represents the proficiency level within the scope.

LT/P, by its nature, describe student mastery and progress over a given scope. Naturally, this gives rise to another component of LT/P:

Definition 0.5 (Levels of LT/P)**.** A LT/P usually contain definitions of levels, which are types of construct that are categorized by (Duncan & Rivet, 2018) (Lobato & Walters, 2017):

(i) Content ideas or cognative conceptions,
(ii) Practice and discourse patterns
(iii) A mix of (i) and (ii)
(iv) Observable strategies
(v) Textbook tasks

A way to study and compare two different LT/P in the same field is to consider how many constructs are spread over a particular length of time. This gives rise to the following definition:

Definition 0.6 (Grain Size of LT/P)**.** The "size" of the jump between each level or construct. Usually can be viewed the following: Let c be the number of constructs, and t be the amount of time in the scope of the LT. Then the grain size is defined as $g = \frac{c}{t}$. Furthermore, given g_1, g_2 are two grain sizes, suppose $g_1 < g_2$, then we say g_1 is "coarser" and g_2 is "finer". (This is the same language as the descriptors for the partition of an interval.)

Remark. The grain-size and the number of paths given differ based on the intention of the researcher as well as the targeted audience.

Given that LT/P describe "growth", this implies that there is some order that can be imposed on the models of student mastery over knowledge, either in terms of content, dialogue or both. Thus, the language of partially ordered sets is appropriate here, where each level or construct is an element, and the pathways between the levels is an edge or order relation. Thus LT/P may be considered as a directed graph.
Since LT/P describe growth from point A to point B, we may impose an *order* on the set of knowledge, once constructs and levels are defined. Some common types of ways to characterize and measure "progress" (Duncan & Rivet, 2018):

Definition 0.7 (Individual progress along a LT/P)**.** Individual progress can be defined as "major re-conceptualizations of knowledge and beliefs because students' naïve understandings are often incommensurate with canonical scientific ideas." - Idea is that students have a network of knowledge that becomes better approximations of the expert knowledge as students progress along the levels.

Individual progress has been the center of study for most subjects, while in mathematics education there's been another perspective on viewing progress:

Definition 0.8 (Community progress along a LT/P)**.** Communal progress can be measured as changes in the discourse and practice from the community perspective. Duncan cites Cobb and colleagues LT/P, which "captures the changes in classroom norms and mathematical practices." Tasks and tools to help achieve the goal of community learning are often included.

Remark. Given a particular discipline, (the pure mathematician in me asks) can we partition a given scope into infinitely many levels, with LT/P that has infinitely-fine grain size? Perhaps this is the difficulty;t we're using discrete abstractions that hope to closely model the learning process from the instructor or the student perspective, while the experience of learning is one of flow and students experience learning as a continuum of experiences.

1.3 Claims about LT/P

While the constructs is connected to many paths, there seems to be a boundary in which these paths can be drawn effectively. While the number of paths may be infinite, the area which they cover are not. Effective models of descriptive paths is an optimization problem, where there exists finite amount of space and time to describe paths between constructs; and at best, we have some hypothetical model to describe the space of paths between two constructs. These educated conjectures based on research that must be continued to be refined.

Conjecture 0.1 (Directed graph conceptualization of LT/P)**.** Suppose we impose some order (type of progression) and define constructs associated with the order. Then suppose $A < B$ in some LT/P. First, there exists at least one path between A and B, and there *likely* exists intermediate constructs or levels $\{C_1, C_2, \cdots, C_k\}$. We then define the vertex set to be $\{A, B, C_1, \ldots, C_k\}$ and edges as the pathways between these constructs. This give rise to finitely many paths due to the constraints described above.

Remark. Math nerd side note: An LT/P with this must be some sub-graph of the complete $(k+2)$-directed-graph. This means that the number of pathways, or edges, in an LT/P with k constructs connecting A and B has the following bounds:

$$k+1 < (\text{Number of pathways}) < 2\sum_{n=0}^{k+1} n = (k+1)(k+2)$$

This way of describing LT/P gives rise to two quick corollaries:

Corollary 0.1. LT/P are not necessarily linear.

Proof. Given we use the language of posets and directed graphs, this is a linear LT/P is a special case of the general LT/P. Literature review reveals that "learning is multi-dimensional, context-dependent and therefore likely not linear" (Duncan & Rivet, 2018) ❖

Corollary 0.2. A LT/P may contain cycles.

Proof. In these models, we have directed graphs to indicate progress in maturity of dialogue or to record technical dependencies. Then note that the directed graph that models a particular LT/P may contain cycles. Duncan and Rivet (Duncan & Rivet, 2018) referred to Battista's research, that students may use more rudimentary ways of reasoning when tackling more complex questions, even though they may have shown proficiency in more sophisticated techniques. ❖

1.4 Development and Refinement of LT/P

LT/P are by definition hypothetical constructs, and their development involves a few usual phases, similar to the engineering design cycle:

(1) A well formed hypothesis usually begins with a throughout literature review:
   (a) if (1) yields sufficient existing research: design a well-specified LT/P and go to refinement.
   (b) else, use these following techniques (Duncan & Rivet, 2018):
      - Assessment-driven cross-sectional studies of student thinking using interviews and written assessments.
        Pro: When interviews are done under status quo setting, the study has the benefit of reflecting what students can do under less than ideal learning environments. Written-assessments[1] are used to help scale to larger sample of students.
        Con: Written assessments are difficult to design, especially to elicit responses that can demonstrate the full range of the progression. Optimization problem between the number of assessments and the discrete nature of assessments in a continuum of learning.
      - short and long (i.e., longitudinal) teaching experiments using design-based research to characterize the development of students' ideas under specified instructional conditions
        Pro: Development of instructional interventions modified based on observed student performance allows for a more grass-roots, bottom up approach to validating LT/P.
        Con: LT/P that is written and designed for a specific condition leads to a question of whether generalizing this is easy. **Open research question:** Whether learning paths would look different under dissimilar instructional conditions is unknown.

1.5 Seven approaches to LT/P

Lobato and Walters (Lobato & Walters, 2017) gave a detailed taxonomy of approaches to LT/P in state-of-the-art research. In their taxonomy, they classify the different approaches into seven categories; however, note that a given LT/P may be born of a melange of a few perspectives.

[1] Commonly used statistical models: Rasch models, latent class analyses, Bayesian networks)

1.6 Cognitive levels

In the cognitive levels perspective, cognitive milestones are ranked in order of sophistication but hierarchies may be weak or strong. Similar to the language used in mathematical induction, strong assumes all steps before are mastered. Mostly linear in nature, but students may enter at a variety of levels and may fall back or climb forward.

- Features: Levels or constructs may be organized using mental actions, fine-grained progression or clustering meanings by observing different types of abstraction. For LT/P written in this approach, emphasis is placed on the quality of the narrative, or group discussions rather than the content.
- Methods: Created using cross-sectional interviews over multiple grade levels.
- Purpose: Diagnostic assessment
- Benefits: In the example cited by Lobato and Walters, Teachers can access reports of their students' thinking, given that assessments are written to associate particular responses with facets, giving rise to facet-driven instructional resources.
- Trade-offs: Learning mechanisms on how students morph their understanding by shaping their thoughts from one level to the next is hidden. Progression of understanding of innovative teaching techniques is limited. Important scientific habits of explaining or conjecturing is not emphasized.

1.7 Levels of discourse

Progress is described as increasingly sophisicated ways of communicating in use of language, of thinking and of acting. Lower anchor is the informal primary discourse. This type of LT/P tends to have coarser grain size.

- Features: Progress along levels of discourse has been defined in a variety of ways. Levels might represent using secondary discourse. Some use Toulmin's [2] model of argumentation.
- Methods: Constructed and evaluated using written data collected across multiple grade levels, as well as an example of research inside the classroom to account for differences in instruction.
- Purpose: "Literacy is characterized as the mastery of a particular discourse that is acquired through increased participation in communities where that discourse is common and valued."
- Benefits: This research provides a tool by which instruction can be aligned with state standards.
- Trade-offs: This is currently more biased towards science education than mathematics education researchers.

1.8 Schemes and operations

Generate a model of students' initial schemes and mental operations and infer the modifications of students' schemes over time, where schemes are defined by Piaget. Piaget is famous for the stages of development in cogitative science.

[2] Who is Toulmin?

Definition 0.9 (Scheme)**.** A scheme is conceived as a researcher's construct used to model students' concepts. According to von Glasersfeld, a scheme consists of three parts

(1) Trigger conditions - Set of internal conditions, such that when satisfied will activate the scheme;
(2) way of operating mentally and physically;
(3) anticipation of the outcome of the activity.

According to Norton and McCloskey (2008), schemes are activated holistically rather than sequentially like a strategy.

- Features: In an demonstrative example, the centerpiece of the trajectory is the construction and evolution of schemes. Focus tends to be on mental operations, with an emphasis on student's mental coordination and reflective abstraction. Less variety because of the shared theoretical perspective of "Piagetian constructivism." Common assumption is that students respond to particular activities and instruction based on their current conceptual structures.
- Methods: Teaching experiment where research-teacher working in parallel.
- Purpose: Micro-analysis of the evolution of individual understanding, with a focus on students' learning rather than the logic of a mature mathematician
- Benefits: Provides useful constructs to other researchers
- Trade-offs: Small n limits researchers ability to generalize, and $\exists$ few efforts to extend this approach by codifying the instructional moves that support the construction of students' ideas.

Remark. What is the difference between schemes and schema which is "a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning."?

1.9 Hypothetical learning trajectories

Captures the ways teachers posits a conjecture regarding their students' current understanding and develops activities that they think will support their students in constructing more sophisticated ways of reasoning. This approach commonly consists of three components: learning goal, levels of thinking, instructional tasks.

- Features: Ongoing modification of LT/P, "to offer a conceptualization of teaching as being informed by a constructionist perspective on learning."
- Methods: Data on students' initial concepts is collected using interviews + assessments.
- Purpose: Used mainly as teaching resource, and is very dynamic. Instructional tasks aim to inspire and help students to reach the next level of sophistication in their learning.
- Benefits: (Perhaps) a good tool for improving mathematics instruction.
- Trade-offs: Goals focused on standards documents, so LT/P do not

speak to what is possible when teachers focus on mathematical goals not in the standards.

1.10 Collective mathematical practices

Focus on *emergent perspective* which :individual constructs are coordinated with collective constructs, such as social norms and classroom practices."

Remark. In an ancestral way, each class is a different community, and has a different norm for communicating. Personally, I've observed this while teaching precalculus courses in a few semester at SFSU.

- Features: Researchers have begun with observable actions/strategies, and progressed towards observing what can function "as-if-shared" in the framework of cognitive sciences. The communal nature of the description of levels causes most of this type of LT/P to also include descriptions of collective constructs such as social norms and sociomathematical norms.
- Methods: Documenting Collective Activity (DCA) method, a three phased method:
  (i) generate a log of student argumentation and record structure of statements
  (ii) record when students accept a previously disputed claim as truth or when a previous claim/-conjecture becomes supporting data in another argument, or when an idea is repeatedly used as data.
  (iii) researchers then cluster mathematically related, normative ways of reasoning and provide a LT/P
- Purpose: inform "instructional theory and design"
- Benefits: Embraces the way teachers experience a classroom - as a community.
- Trade-offs: In order to have discussions, the class social norms must be conducive to student sharing before argumentation can occur.

1.11 Disciplinary logic and curricular coherence

Generated and reflected upon experts' knowledge of the domain, synthesizing research from studies of student knowledge and learning. Structure of the disciplinary knowledge is strongly emphasized, and provides a macro view of how student proficiency in a domain may develop over a long span of time.

- Features: "Most make explicit the intertwining of content and inquiry-oriented practices." Because of their intended audience and purpose, all LT/P written from this approach will contain "learning performances and assessment tasks aligned with the progressions."
- Methods: Existing research and discipline logic inspire these types LT/P.
- Purpose: Inform curricular organization and textbook content towards coherency and cohesion. Provides "horizon knowledge" for teachers.
- Benefits: Accessible for a wide audience!

- Trade-offs: Lack consistency due to drawing from a large variety of research conducted with different goals/settings; trajectories aligned with standards are inflexible and limit growth. These types of LT/P can be very skill focused.

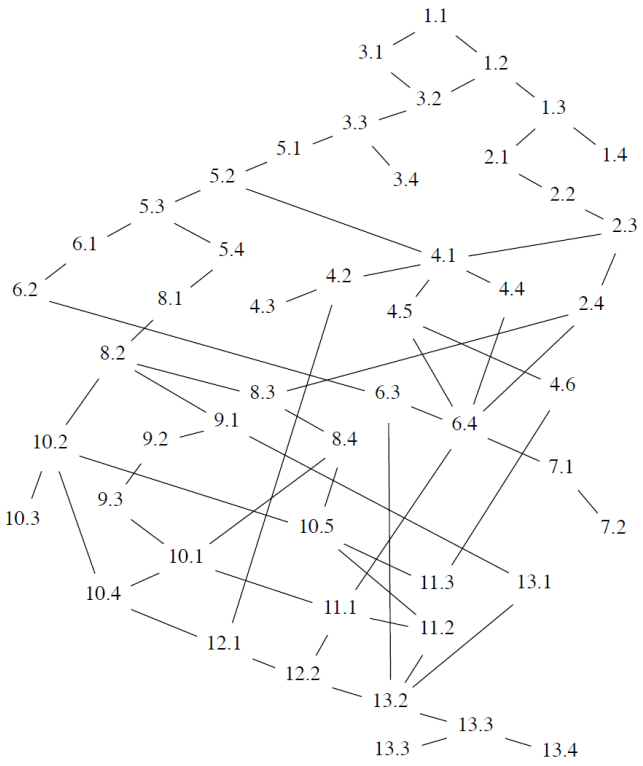

Figure 1: "The partially ordered set of section dependencies" (Beck & Sinai, 2016)

Remark. Figure 1 is an example that is self-contained and was not intended as an LT/P (since it was presented without instructional guides). Since the image is from a book on proofs meant to describe the logical, mathematical dependencies, this is genuinely a technical extreme version of a disciplinary-logic-and-cirricular-coherence approach to LT/P.

1.12 Observable strategies and learning performances

Progress is described using observable behaviors, strategies or other learning performances, and each level is described using action verbs instead of mental conceptions.

- Features: Levels are organized using observable strategies or behaviors. There are differing assumptions in examples of LT/P written in this perspective about the connections between cognition and behavior.
- Methods: Could be a product of research or informed by research.

- Purpose: Communicating with teachers and teacher professional development.
- Benefits: Increase the precision and explicitness of LT/P, and help provide diagnostic or formative assessment information to teachers.
- Trade-offs: Can miss out on details about conception/cognition.

1.13 Critiques of LT/P Research

Diagnosing students and placing them in the appropriate level in an LT/P is not trivial. There are students who may appear to be on two different levels at the same time. Currently, the research in LT/P do adequately address the pressing issues of equity, diversity, race, language.

1 Fall 2019

Aug 26th—Aug 30th: Week 1

1.1 LSRC 501: Introduction to the Course

Introduction: Emergence and development of the Learning Sciences
Read the work published in American Educational Research Association (AERA) meant to give insight to the need for quality empirical research ("Standards for Reporting on Empirical Social Science Research in AERA Publications," 2006). Basically report all thinking, assume nothing - and be honest about particular methods used and any "massaging" the data.

1.2 LSRC 500: Introduction: Emergence and development of the Learning Sciences

Reading about the pre-history and history of Learning Sciences. How did the field came to be separate from cognitive psychology, education, and other fields?
Made a timeline in class and spoke of the politics related to the founding of the young academic field of Learning Sciences (Hoadley, 2018; Kolodner, 2018; Pea, 2016). Some organizations, conferences and interests of note with respect to my interests:

- International Conference of the Learning Sciences (ICLS)
- computer support for collaborative learning (CSCL)
- Association for Computing Machinery (ACM)
- Association for the Advancement of Computing in Education (AACE)
- Computer-Supported Cooperative Work conference (CSCW)
- The Institute for Research on Learning (IRL)

1.3 DHD 510: An Introduction to Disability Studies Research Methodology

DHD 510: Got an intro to the field Disability Studies, defining the boundaries of the field with the relevant historical progression of the different conceptions of disability (Edwards & Imrie, 2003; Goodley, 2011; Linton, 1998).

Sept 2nd—Sept 6th: Week 2

2.1 LSRC 500: Theoretical perspectives and Frameworks on How People Learn: Cognitive, Cultural, Sociocultural, Communities of Practice.

Theoretical perspectives and Frameworks on How People Learn: Cognitive, Cultural, Sociocultural, Communities of Practice.
Examined the texts How People Learn 1 & 2 and practiced comparing the two texts in more detail. Got an introduction to the differences between the cognitive and socio-culture perspectives on learning and transfer (**national_research_council_design_1999**; **national_research_council_learning:_1999**; Greeno & Engeström, 2014; National Academies of Sciences, Engineering, and Medicine, 2018a, 2018b; Satyam, 2018). Of particular interest is the diagram on perspectives on learning environments 2.

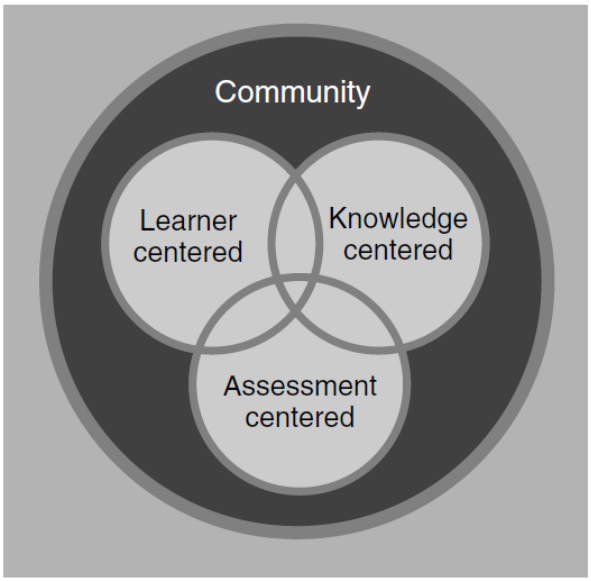

Figure 2: Perspectives on learning enviornments (**national_research_council_design_1999**).

2.2 DHD 510: Conducting Research Overview

DHD 510: Conducting Research Overview
Basically read about the nature of scientific progress and revolutions, and what methodologies groups (quantitative and qualitative) are associated with particular epistemologies (Hahn, 1993; Kuhn, 1996; Sprague, 2005; Titchkosky, 2007).

2.3 LSSA: GSC rep

Joined LSSA and volunteered to become one of the GSC representative.

Sept 9th—Sept 13th: Week 3

3.1 LSRC 501: The Ongoing Debate about "Scientific" Research in Education

Snapshot of the current state of educational research, and what qualifies as scientific educational research?
"Debate" - can Educational Research be scientific? What is scientific?
Nice quotes: "All models are wrong, some are useful" — George Box
"Better an approximate answer to the right question than an accurate answer to the wrong question" — John Tukey Main Ideas and Takeaways on Feuer et al. ER Paper (Feuer et al., 2002):

- Developmental level of Education Research and its reputation - is this caused by funding, or the age of the field (immaturity)
- Science $\neq$ Methods
- Role of Government in Educational Research

- Culture relate to Education Research Quality; Self-Regulation
- Empiricism
- Similarity and difference between Education Research and other disciplines
- Multiple players $\implies$ multiple disciplines/bias/techniques
- Quantitative versus Qualitative Methods - $\exists$ tensions between folks who comes in with different "epidemiological baggage", and the inherent biases, leading to narrow views of what research is considered rigorous. "Educational research has a long history of struggling to become—or to ward off—science.
- Becomes a work on definition of *rigor*.
- Educational research became a bit of a political
- Science is often about measurement, and is dependent on the tools used to measure things. This means both physical tools as well as mathematics/statistics.
- Science is not free from culture & politics.
- contentions with the public opinion (inference: perhaps a harsher view Education due to personal experience, etc?)

We also read the first 5 chapters of the NRC Report, and got some current understanding of the landscape of scientific educational research (National Research Council, 2002a, 2002b, 2002c, 2002d, 2002e).

CH 1: Report Intro,
CH 2: Accumulation of Knowledge,
CH 3: Guiding Principles for Scientific Inquiry,
CH 4: Features of Education and Educational Research,
CH 5: Designs for the Conduct of Scientific Research in Education

- Science is never finished, but improves warrants for knowledge over time
- Nature of progress is the same across fields = zigzagging paths. Progress is a function of time, money, and public support.
- Research-based knowledge in education has accumulated in this way, but Education = slower.
- 6 principles of Inquiry:
  1. Significant questions that can be investigated empirically,
  2. Link research to relevant theory,
  3. Use methods that permit direct investigation of the question,
  4. Provide a coherent and explicit chain of reasoning,
  5. Replicate and generalize across studies,
  6. Disclose research to encourage professional scrutiny and critique.
- Features of Education and the implications for inquiry
- Shelf life $\implies$ persistence?
- Ethics and designs for conducting research
- Three types of Education Research questions:
  1. What's happening;
  2. Is there a systemic effect (casual effects?)
  3. How does it happen? (What is the underlying mechanism?)

(??) Moderator vs Mediator definition between Treatments and Outcome.
(!!) Scientific $\subset$ Educational Research, but note that there exists valid scholarship that is $(\text{scientific})^c$.

(!!) Consider *who* wrote the literature, the *intent* of the writer and people who commissioned the writing (be it publisher or government entity), and the *audience* of the writer.

3.2 LSRC 500: Cognitive and Sociocultural Perspectives on Learning and Transfer, Part 1

Went more into detail into cognitive and socioculture perspectives, and analyzed data from Dr. Allison Hall's work. Had a discussion on what we observed through the socio-cutulral lens and what we observed through the cognitive lens (J. Pellegrino & Hilton, 2012). *(Feedback: My paper needs more operational definition with proper cititations, so that the critera used to determine what is cognitive and what is sociocultural will be more clear. Like Gubeladze said, papers need to be self-contained as much as possible!)*

3.3 DHD 510: Knowledge Produced About Disability vs. Disability Studies

Knowledge Produced About Disability vs. Disability Studies
Examined the growth and change in philosophy in methodologies, especially towards transdisciplinary ideals and emancipatory research (Barnes, 2003; Goodley & Runswick-Cole, 2012; Kitchin, 2000; Tregaskis & Goodley, 2005).
When interviewing, especially with an intermediary, it's important to conduct member checking.
$\exists$ many instances of unethical and exploitative research where the researchers objectify those with disabilities and ignore the agency or boundaries of those with disabilities.

Definition 1.1 (Reliability)**.** Quantitative: Can be repeated, and is *consistent*, with generalization in mind

- Inter-rater or Inter-Observer: multiple observers to extract data or evaluate information, to make sure that the measure is objective by consensus. ($n \geq 3$ and n should be odd).
- Test-Retest: Give the test multiple times, it should give same results.
- Parallel-Form: Same content, but different versions of the same test.
- Internal Consistency: Same question at different points to make sure that the response is consistent.

Definition 1.2 (Validity)**.** How valid one's research is. *Accurate* and reflects the real-world

- Internal Validity: The degree to which the results are associated with the independent variable; make sure that no other factors are affecting the outcomes
- External Validity: Generalizability of the test across different studies
- Construct Validity: The degree to which a test is actually measuring what it is intended to
- Criterion-Related Validity: Is the research fitting pre-determined criterion?
- Content Validity: Are the tests fitting the purpose of the research?
- Ecological Validity: Is the research reflecting the world? (The setting chosen)

$$\text{Reliability} \equiv \text{Consistency (how far spread)} \quad \text{Validity} \equiv \text{Accuracy (how on target)}$$

Bias Goal is to minimize bias (increase reliability/validity), and to do so one should learn to spot such bias in one's own and others' research.

- Sampling Bias: issues with choosing a sample that is not representative of the target population.
- Selection Bias: Not randomly assigning folks between control/test groups. (Self-selection bias, where individuals choose to participate.)
- Response Bias: People may give inaccurate answers because they are trying to give answers that they think the researcher wants to hear. (Yea-saying) Sometimes the researcher push until they get the answer they're looking for, or sometimes limit the research questions.
- Hawthorne Effect: Some times the interaction with researchers can change the subjects' lifestyle; like if they have to keep track of their food/exercise, they may be a bit more "accountable". This can be moderated by control groups.
- Performance Bias: Researcher / participants are going to be changing their behavior based on their preconceived associations. Can be mediated by "blind" or "double blind" trials.
- Measurement Bias: people measuring or assessing the outcomes in a study should not know which individuals are in a test group or a control group.

Disability studies should benefit the people with disabilities and focus on removal of barriers in society. Power should be given to people with disability in creation of knowledge in disability studies. Research should include multitude of methods, so that we can give a more complete and complex view.
Internalized ableism can be an influence on whether people identify as a disabled person. Not everyone who is disabled would identify as such, and this can introduce selection bias.
Researchers have a platform, and thus a responsibility to collaborate with people with disabilities in giving voice to a marginalized community.

$$\text{Inclusive research} = \text{Emancipatory} \cup \text{participatory research}$$

co-production is the outcome of1 participatory research.
Emancipatory research has the goal of empowerment, though transformation of the social dynamics of research; use the privilege of being a researcher to help remove barriers.
Intersectional feminism and Queer/Crip approaches
Participatory research: Empirical research that involves the participants in the decision making process.
Action research: there should be an actionable outcome.
Participatory Action Research (PAR): participation at each step of the research. Community Based Participatory Research (CBPR): Ecologically valid!
$CBPR \subset PAR$.

Sept 16th—Sept 20th: Week 4

4.1 LSRC 501: Connecting Philosophy, Epistemology & Methodology

Reading start to get a bit philosophical (Bredo, 2006).

- The author gave four ways of "getting to the bottom" of an idea :
  1. "Method of tenacity": just hold your opinion really hard, which fails when your opponent is equally tenacious;
  2. "Method of authority": appeal to authority in a particular community, which fails when the authorities are not in agreement;
  3. "Method of a priori reasoning": finding underlying beliefs or assumptions that are common, which fails when the beliefs come from differently epistemologies,
  4. "Method of experiment": different epistemologies should be adopted as hypothetical and fallible, and tested in terms of their consequences.
- The author discussed the distinctions between externalist and internalist views, and the third, interactionism, which is in between the two mentioned here.
- The thoughts leading up to post-positivism, post-modernism and critical theory.
- Externalist thoughts $\implies$ empiricism $\implies$ classical positivism and logical positivism. Critiques of positivism that follow in succession of this line of externalist school of thought thought are together taken as post positivism—though those who subscribe to postpositivism tend to still believe a model of research based on natural sciences, with the goals of searching for universal laws. This is in the left branch of Figure 3.
- Kantian rationalism is a critique of previous rationalism on that it focuses too much on the mind (like Descartes, Spinoza and Leibniz) and also denounces the approach of empiricism as focusing too little on the mind.
- A tool that arose during the time of the development of these Romantic responses to Enlightenment empiricism is hermeneutics, which Dilthey (1833-1911) suggests that this methodological foundation provides a framework for cultural sciences distinct from natural sciences.
- Internalist thoughts $\implies$ subjective idealism $\implies$ structuralism. Critiques of these eventually lead to postmodernism; even structuralism has a given, where $\exists$ a structure at all. This is in the middle branch of Figure 3.
- Dialectical/Transactional Relation $\implies$ absolute idealism $\implies$ dialectical materialism $\implies$ critical theory This is in the right-most branch of Figure 3.
- Critical theory arose as a response to instrumental rationality
- And finally, standing on its own ispragmatism, where local progress is possible without a notion of progress towards ultimate ends or directions. Truth is a matter of an idea's usefulness in guiding action.

(???) What did the author mean when they said "Newton's explanation of planetary motion based on the law of gravitation really is correct, then empiricism *must* be wrong because it cannot not account for such universal and necessary generalizations."?

(!!!) The text is indeed dense, but written in a way that is not conducive for reading by non-philosophers. In particular, the author chose to use words before they are well defined, and I believe the author did not do a good job at defining subjective

idealism.
(!!!) Similarly, transcendentalism was in the title of a section without once being defined.
(!!!) "knowing is primarily for the sake of action, and action changes what is known"

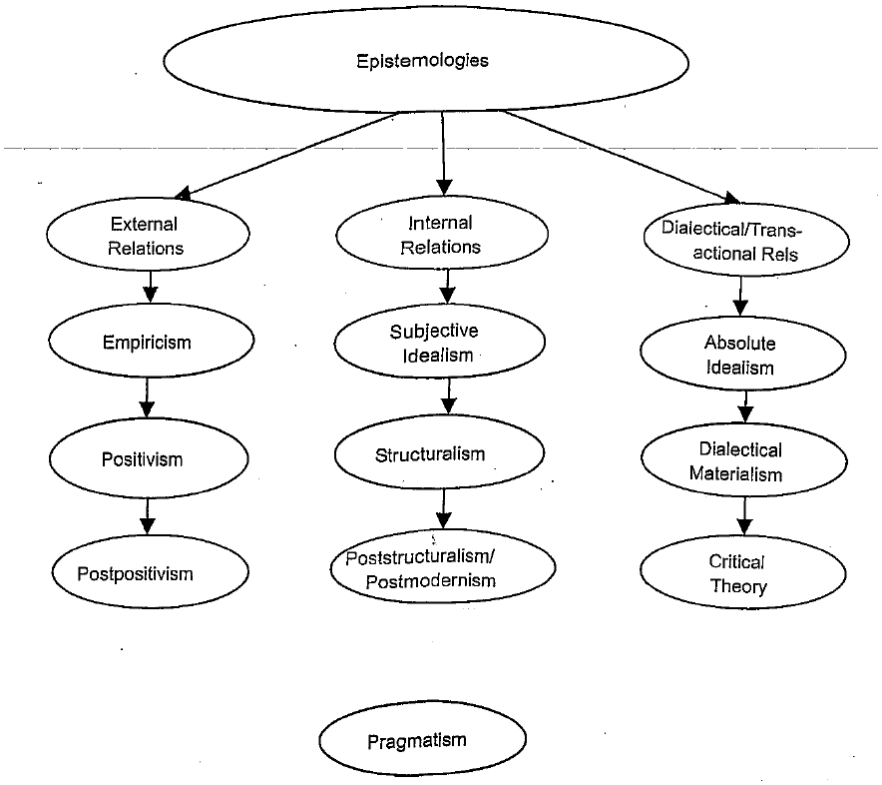

Figure 3: Arrangement of philosophies (**green_philosophies_2006**)

4.2 LSRC 500: Cognitive and Sociocultural Perspectives on Learning and Transfer, Part 2

Discussed what makes an expert, how to become an expert, how to assist someone else to become an expert, and how to evaluate someone's expertise
Had a discussion on Discussed what is Legitimate Peripheral Participation (LPP)
Discourse of Gee:
Supplementary Readings, presented by Meerok and Erin:

- Primary discourse is what you grow up with at home and in families.
- Secondary discourse arises when one leaves the primary discourse - and secondary first discusses those that involve print, but this also applies to film, TV, etc.
- Acquisition vs Learning —

Epistemic Cognition (EC) How people think about knowledge, what their beliefs are and how it manifests in their way of seeking knowledge. practices are a way to make beliefs about epistimic commitments visible - example, scientist will interrogate data. this way of studying actions reveal the beliefs underneath (**fischer_epistemic_2018**):

- Features of LS research on EC

- emphasizing multidisciplinary research
- broadening the range of questions
- challenging normative assumptions
- a focus on practices
- the throroughly social nature of EC,
- its situativity.

Definition 1.3 (Epistemic practices)**.** Socially normed activites that people carry out accomplish epistemic aims such as developing evidence, arguments, theories and so on.

C

4.3 DHD 510: Asking Research Questions from a Disability Studies Perspective

DHD 510: Research Questions
What makes good *research* questions?

- Answerable
- Significant (statistically)
- Relevant to the disability community

Commitments:

- reflecting views & experiences of those who are on the receiving end of policy & practice
- implication for to change
- anti-ablist, anti-racist and anti-sexist

Criterons for a Good Research Question: Feasible, Interesting, Novel, Ethical and Relevant (FINER)(Cummings et al., 2007)

1. Feasible
   - # of participants
   - technical expertise
   - affordable (time & $$)
   - Manageable in scope
2. Interesting
   - Investigator
   - Peers
   - Community
3. Novel: Confirms/refutes or extends current research
4. Ethical: Make sure that study is amendable to review boards.
5. Relevant to
   - scientific knowledge
   - policy, practice and the real world
   - future research

Components of a research question: Population, Investigation, Comparison Group, Outcome of Interest and Time (PICOT) (Riva et al., 2012)

1. Population: What specific population are you interested in learning about?
2. Investigation: What is your investigation? What will you be doing? Will you be surveying, observing, using video diaries? (Indicates methodologies)
3. Comparison Group: What is the main alternative group in contrast with the research population? (Some might not have one, if so you need to explain why.)
4. Outcome of Interest: What do you intend to accomplish, measure, improve or affect?
5. Time: What is the time-span that you will be looking at for your research?

4.4 Attended LSGSC

Attended the LSGSC of 2019 at Northwestern University on Sept 21st—22nd, and volunteered for food preparation and I hope to become involved in the planning committee for next semester. I attended a paper presentation session called "Embodied Technology in Science Learning", and a talk that really stood out for me was by Erin Riesland from University of Washington, and her email is erinsage@uw.edu. She mixed social sciences and VR!! How innovative and what a great perspective.

Sept 23th—Sept 27th: Week 5

5.1 LSRC 501: Multiple Methods and a View on the History and Evolution of Learning Research

Then on the next chapter, it's a tiny bit more readable but still pretty dense, almost math textbook dense (**green_epistemology_2006**).

- Pages on critiques of positivist focus, boiled down to...
  1. Strong theory-dependence; i.e., observations, choices of procedures, and inferences made from data are dependent on the beliefs one holds about the world. Observations are not independent of the intellectual apparatus brought to bear on the objects of concern; finding observations that are truly indubitable was formidable, given variation in observer knowledge and perspective.
  2. Data seem to underdetermine theory choice- there are instances in the history of science to suggest that multiple theories are equally supported by empirical evidence in a given instance.
  3. Any hypothesis is tested empirically, a number of auxiliary hypotheses are assumed at least provisionally true, and so that when a main hypothesis is tested and seemingly refuted, it may be due to an auxiliary hypothesis was mistakenly taken to be true when it was in fact false.
  4. Continual discovery of the social basis of disciplinary knowledge is in contradiction to the formalism of logical positivist epistemologies
  5. Plurality of knowledge systems is derived thru the work of particular epistemic communities.
- $\exists$ multiple challenges to educational research:
  1. Frustration with the degree and usefulness of knowledge relevant to education currently available
  2. Plurality has its advantages and should be encouraged, with a distinction between claims to validity (moral reasoning) and claims to truth (scientific reasoning).
- One may address the above critiques and challenges through critical discourse, within group, regarding public reason and hermaneutical conversations across groups.
  1. Within group — Developmental and definitional work regarding the creation/specification/extension of research $\rightarrow$ theories, assumptions, ontological commitments. (include socialization of new members)

2. With public reason — Development of epistemological commitments to asses value of educational research across traditions → internal consistency, empricial adequacy, usefulness for practitioners
3. Hermaneutics —

(??) Is this a version of pragmatism spoken of in Chapter 1?

Smith Chapter on mixed methodologies (**green_multiple_2006**):

- Complex scenarios require mixed methodologies
- ∃ different types and ways to use mixed methodologies
  1. sequential design
  2. concurrent design
  3. confirmational
- Institute of Education Sciences (IES) goal structure

Goal 1 Exploratory
Goal 2 Development, usually uses Design Based Research (DBR)
Goal 3 Efficacy, usually uses Randomized Controlled Trials (RCT) to demonstrate that under optimal conditions that ∃ effect
Goal 4 Effectiveness: It worked, but can it be scaled? This is super expensive, typically over 10 million dollars, and most intervention inventions may end here.

Greeno Chapter in the same book (**green_theoretical_2006**):

- many discussions on the different types of methodologies, with some examples from the progress in math education.
- Greeno defined design-based research as:

  Definition 1.4 (design-based research)**.** A view on research that understands fundamental research as a resource for design and development, includes attention to a body of design principles that can be developed in a field of engineering. See Figure 4 for the pathways involved.

5.2 LaTeX workshop for LSSA

Discussed with the Laura and Rubia about the creation of a workshop for LaTeX. This means I'll begin writing material for an introductary course!

5.3 LSRC 500: Motivation, Self-regulation, and Metacognition

Chapter on Motivation, Engagement and Interest (**fischer_motivation_2018**):

- Motivation is defined as follows

  Definition 1.5 (Motivation)**.** (Engagement, Interest) ∈ Motivation. Furthermore, ∃ more elements in this idea:

  - perceptions/beliefs WRT achievement/ capability/competence
  - expectancy
  - value
  - choice
  - goals (short/long term)
  - performance goal
  - mastery goal

- Engagement

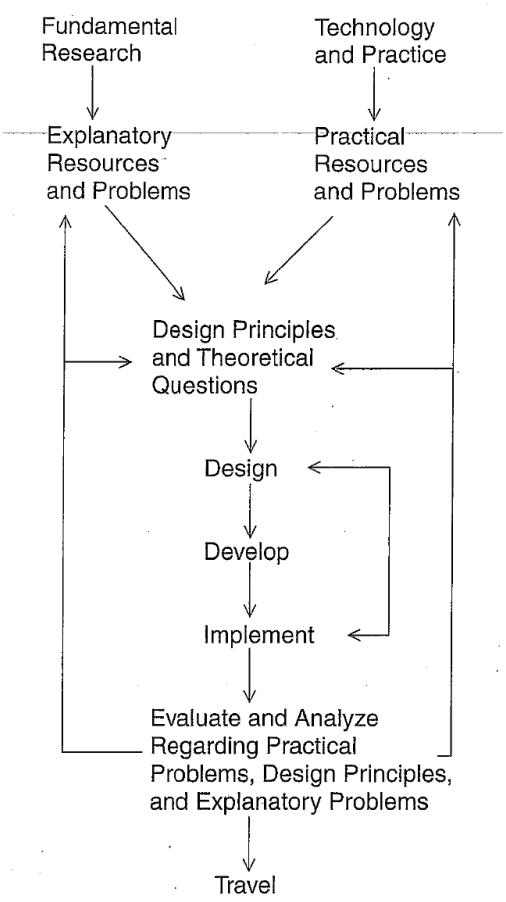

Figure 4: Model of Problem Solving R & D (**green_theoretical_2006**)

- Interest

Chapter on Metacognition (**sawyer_metacognition_2014**):

- Types of knowledge:
  -

Chapter on Regulated Learning in Collaboration (**fischer_contemporary_2018**):

5.4 DHD 510: Reviewing Literature: Adding Disabled Voices

Conducting a Literature Review (Alderman, 2014):

- Benefits of a literature review
  - Assess current state of research
  - Identify experts
  - Identify key questions for further research
  - Determine methodologies used in past studies of similar topics
- Steps to conduct a literature review
  1. Selecting databases: use library discovery tools.
     - ⚠ Some database materials might not be included in discovery tool search
     - ⚠ No one tool does it all, "not even Google scholar"

- ⚠ book collections might be excluded
- ⚠ Features available in a particular database might not be available in a discovery tool.
- ⚠ Some discovery tools limit results to what is available through a particular library's collections
- ⚠ Review which databases have been included in the search, and which have not been included.
- ⚠ Go *backwards* by examining the articles in the bibliography to seek past articles, and go *forward* by looking at the "Web of Science" and "Social Sciences Citation Index" to identify article citing the key articles identified in the previous steps (Webster & Watson, 2002).

2. Formulate an effective search strategy: know the field of that the database, as psychology terms may not work in a human resources management database. Use abstracts of relevant articles to build this list of search terms.
3. Locate *the actual items* and compose the review. End result should be to discuss the central themes in research and overview of significant studies.
4. If the dissertation/thesis takes a long time to write, review the literature periodically.

Table 3. Concept Matrix Augmented with Units of Analysis

Articles	Concepts														
	A			B			C			D			…		
Unit of analysis	O	G	I	O	G	I	O	G	I	O	G	I	O	G	I
1					✖				✖						✖
2	✖				✖	✖		✖							
…								✖	✖			✖			

Legend: O (organizational), G (group), I (individual)

Figure 5: Tool to move from author to concept centric organization (Webster & Watson, 2002).

Writing a Literature Review (Webster & Watson, 2002):

- Types of literature review:
  1. Mature topic where an accumulated body of research exists and require analysis and synthesis
  2. Emerging issue that would benefit from exposure to potential theoretical foundations.
- Writing a Review Article

1. Beginning:
   - Hook your readers
   - Provide working definition of key variables

  - Articulate the paper's contributions such as:
    * New theory to analyze or synthesize the existing literature
    * Point out that little research currently exist
    * Bring together previously-disparate streams of work
    * Implications for practice
  - Identify the contexts in which the theory applies
  - Support the scope of the search
2. Organize your literature: Move from author centric to concept centric. ⚠Sometimes certain concepts are defined differently by different authors based on context or unit of analysis. See Figure 5 for a tool to do such organization.
3. Stylistics:
  - Tone: summary, so don't be overly critical
  - Tense: since this is about the state of the art, choose present tense. Unless you're attributing a concept to a specific person because that may change.
4. Guiding questions while writing:
  (a) What's new? (contribution)
  (b) So what? (impact)
  (c) Why so? (logic)
  (d) Well done? (thoroughness)

Lecture Notes: Types of literature review:

- Scoping (breadth): examining larger field of information.
- Rapid Evidence (depth): pick one issue of a part of an area.
- Systemic (breadth + depth): EVERYTHING that has been published on the topic. Usually begins with scoping, then identifies areas of focus and do a rapid evidence review on each focus.
  - Narrative: Describe the data that is out there, usually as a first step to research projects.
  - Analytic: Not just review, but also gives interpretation/theory. A good example is the "Who's Not Yet Here" article (Burch, 2006).

Parts of a literature review:

- Purpose
- Structure for searching.
  - Inclusion Criteria: "search parameters" to help structure the search and limit it to just relevant articles
    * Location
    * Time span
    * Types of journals
    * Databases
    * Methodologies
  - Keywords: most helpful words that are helpful, often the operational definitions; sometimes keywords differ based on time/location. (learning difficulties = UK; whereas intellectual disability = US after 2004, etc.)
- Search Strategy: have one, and know why you're doing this way.
  - Boolean:
    * uses logical operators `AND`, `OR`, `NOT`.
    * Use quotes to define text phrases
    * use asterisk (*) to search for the root of a word.
    * Advanced search features help *narrow* the search.
  - "Going backwards", look at the

citations until *point of saturation*, i.e., when you keep finding the same articles.

- "Go to the source" Begin with an expert -

GUIDELINES

1. Introduction
2. Search structure
3. Findings
4. Discussion
5. Conclusion

Tips

- Pick a reference manager
- Choose a citation format
- Set up macro/keyboard shortcuts

Theoretical / Conceptual Frameworks

- Theoretical framework explains how theory that is being used works with the research
- Helps organize ideas and explain *how* particular frameworks are used.
- Operational definition sometimes come with a theoretical/conceptional framework
- Uusally in the background section, conception framework might come in during methods also
- Disciplinary background may lead to your theoretical framework

Sept 30th—Oct 4th: Week 6

6.1 LSRC 500: Design and Support for Learning

Scaffolding (**sawyer_scaffolding_2014**; **fischer_research_2018**) and Technology (**sawyer_knowledge_20**

- Work is shared between the learner and some more knowledgeable other or agent
- Scaffolding enables the performance of a task more complex than the learner could handle alone, and enables learning from that experience.
- Zone of Proximal Development (ZPD): A range of tasks that are outside of the learners' independent ability but are achievable with appropriate help, thereby extending their range of indpendent activity (Reiser & Tabak, 2014)
- prolepsis: A mechanism that helps explain how learning occurs through scaffolding, where the learner imitates the modeled actions and associates them with the directive and definition of the task (Reiser & Tabak, 2014)
- As the learner appropriates this guidance and begin to regulate their own actions as the tutor gradually reduces guidance resulting in *fading* of scaffolding
- Scaffolding is more than just breaking down a problem into smaller sub-tasks (*decomposition*); scaffolding is using a complex (expert level) task, which motivate developing subskills and requisite knowledge, applying knowledge and skill as they are constructed.
- scaffolding these aspects of work can make tasks tasks more productive for learning:
  1. Sense-making: helping learners make sens of problems or data.
  2. Articulation & reflection: helping learners articulate their thinking as they progress on problems

3. Managing investigation & problem-solving processes: helping learners with strategic choices and executing

- Possible benefits of scaffolding according to (**sawyer_scaffolding_2014**):
  - Simplifies elements of tasks so they are within reach of learners,
  - Manage the process so learners can engage in elements of the disciplinary work in real problem contexts,
  - Offset frustration and risk and maintain interest,
  - Focus learners' attention on aspects of the problem they may take for granted,
  - Prompt learners to explain and reflect,
  - Enable learning by doing in context.
- According to there are three types of distributed scaffolding:
  - Differentiated scaffolding
  - Redundant scaffolding
  - Synergistic scaffolding

Game based learning

Oct 7th—Oct 11th: Week 7

7.1 LSRC 501: Discourse I

Notes from Goldman Article:

- Discourse analysis of written text provides a method for systematically describing texts that students read as well as those they write.

  Definition 1.6 (Readability)**.** Reading difficulty of a passage, where traditional formulas fail to consider the familiarity of the concepts in the passage.

  Definition 1.7 (Proposition (literacy research analysis))**.** Proposition is a theoretical unit of analysis that corresponds roughly to the meaning of a clause. Propositions can be organized with propositional schemes and semantic networks.

  Definition 1.8 (Predicate (literacy research analysis))**.** Main verbs of clauses or connectives between clauses.

  Definition 1.9 (Arguments (literacy research analysis))**.** Arguments have functional roles WRT the predicate or can be embedded propositional schemes.

7.2 DHD 510: Understanding and Evaluating Different Types of Research

Different disciplines have different established types of methods.

- Natural Sciences
  - Usually a quantitative approach
- Humanities
  - Art, art history, music, philosophy, etc.
  - Contrast with social sciences
  - Significant overlap between social sciences & humanities.
  - Not necessarily seeking to make claims -

  - "What something is vs. the meaning we attach to it".
    - How disability has come to mean what it means,
    - How those meanings come to be,
    - How have the ways meaning been contested.
  - Critical & Analytical
  - "What does it mean to be human"?
  - more *philosophical* than social sciences
  - within disabilities studies, the humanities perspective focuses on intersections with other critical fields with the purpose of social activism
  - Struggle with the meaning of words—the way they are defined and recognize that words can be in flux and they are contextual.
  - text can be data, where one can analyze the text itself.
  - Some methods:
    - Content Analysis
    - Critical Discourse Analysis (CDA) — this can be different between Humanities and Social Sciences!
    - Media
    - LIteracy
    - Art History, Art Production, etc.
- Social Sciences

types of research

- Cross-sectional research: snapshot
- Longitudinal research - over a length of time
- Comparative research - comparison in the data, within group vs between group
- intervention research - pre-post test design
- Instrument development: new measure or adapting an existing one.
- Evalutation research: formative vs summative

Oct 14th—Oct 18th: Week 8

8.1 LSRC 501: Discourse II

8.2 LSRC 500: Technology in support of learning

Guest Speakers: Tom Moher, Joe Michaelis
$\exists$ long list of possible educational technology, from paper/pencil $\rightarrow$ XR and machine learning tools.
Is a technology (method) in search of a problem, or problem in search of a technology(method)? (Should be the ladder).
Three articles:

- Classroom Orchestration: The Third Circle of Usability (Dillenbourg et al., 2011)
  -
- Collective Inquiry in Communities of Learners (**fischer_collective_2018**)
- Reading socially: Transforming the in-home reading experience with a learning-companion robot (Michaelis & Mutlu, 2018)

- Why is the comparison to a paper based activity? What about other existing tech that can have that social element?
- Deep Understanding + Interest Development + Social Robotics

8.3 DHD 510

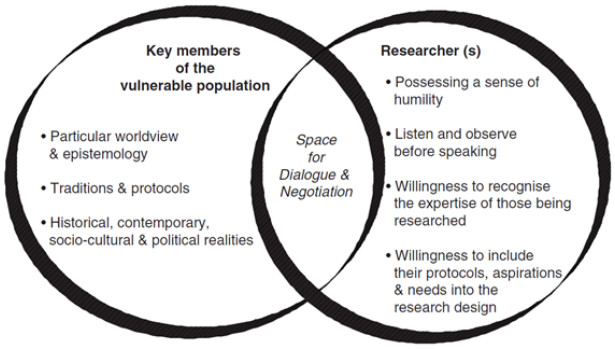

Figure 6: Creating the space for dialogue and negotiation

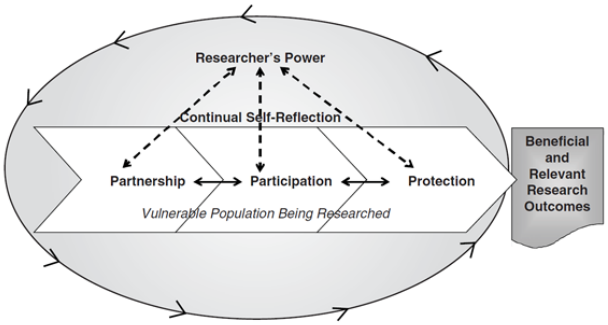

Figure 7: Power in Research with Vulnerable Populations

Activity: Prisoners w/ mental illness - Perception of Authority "Authority" - Remove CO's if possible

- Consent/Assent from guardian/CO/Wardens
- Needs assessment: Medication, resource
- Compensation?
- create space to speak to prisoner alone if possible
- remove identifiers from research if possible to avoid negative consequences for the participant
- have a plan for crisis
- have a plan for lack of medicine or being forced to take medicine
- have a plan for signs of retaliation from CO's and peers

8.4 LSRC 540: Tissenbaum

Divergent Collaboration Learning Mechanisms (DCLM) framework: understanding collaboration in open-ended tabletop learning environments

- Contrasts with shared-goal collaboration, in an informal setting where participants walk in with different goals and get different things out of the environment.
- Contrast with CLM / CCC where the state of communication $\equiv$ progress, where divergence is "poor collaboration"
-

Oct 21st—Oct 25th: Week 9

9.1 LSRC 500: Mathematics Education

Ball paper: Mathematical Knowledge for Teachers (MKT)

- Common Content Knowledge (CCK)
- Specific Content Knowledge (SCK)
- Horizon
- Knowledge of Content and Teaching (KCT)
- Knowledge of Content and Students (KCS)
- Curriculum

9.2 DHD 510: Research Methods, Quantitative

Types of Variables

- Independent / Dependent / Controlled
- Examples of statistical data: SPSS, SAS, STATA
- Continuous vs Discrete: Uncountable vs Countable
- Types of Experimental & Quasi-experimental design
  - Post Test Only
  - Pre-post test
  - Soloman Four: Usually used when one is not certain if pretest influences treatment.

	Pretest	Treatment	Posttest
Treatment	1	1	1
Control	1	0	1
Treatment	0	1	1
Control	0	0	1

Oct 28th—Nov 1st: Week 10

10.1 DHD 510: Research Methods, Qualitative

Qualitative Research Traditions:

- Narrative Inquiry: Biography, autobiography, life history and oral history. Mainly uses interviews and primary documents. Looking for epiphanies, and examines context. *Outcome: Detailed picture of an individual's life.*
- Phenomenology: "Pre-sociology" often used by philosophy. Long interviews with ≈ 10 people. Examines statements, meanings, meaning themes, general descriptions of the experience. *Outcome: "Essence" of the experience.*
- Grounded Theory: produce a theory/model (Very structured) Interview with 20-30 people. Uses the techniques: Open coding, Axial coding, Selective coding, Conditional matrix. *Outcome: theory & theoretical model*
- Ethnography: comes from anthropology - describing a culture and social group. Examines observations, interviews and other artifacts and often immersion over a

long time. Analysis done using description and interpretation. *Outcome: description of the culture behavior of a group or an individual.*
- Case Study: In-depth study of a particular "case". Multiple sources - documents, archival records, interviews, observations, physical artifacts. Analysis: Description, themes, assertions.

Qualitative Methods:
- Document and Archival Analysis: document = data.
- Observation: systematically taking notes & recording in naturalistic setting.
- Interview: interaction based, one-on-one.
- Focus Groups: group interviews. Used when one-on-one is limiting.

Qualitative Sampling Strategies (instead of random...):
- Maximal variation sampling (every category represented)
- Extreme case sampling (get outlier; extreme characteristics)
- Theory/concept sampling (fits operational definition)
- Homogeneous sampling (something in common)
- Critical Sampling (challenging a phenomenon)
- Opportunistic/emergent sampling (due to unfolding events) *This is different from Convenient sampling!*
- Snowball Sampling (ask participants to refer others)

$$(\textbf{Trustworthiness, Rigor}) \simeq (\textbf{Reliability, Validity})$$

Trustworthiness:
1. Credibility
2. Transfer-ability
3. Dependability
4. Confirm-ability

TRIANGULATION & MEMBER CHECKING are gold standards, because they theoretically should increase the

Nov 4th—Nov 8th: Week 11

11.1 DHD 510: Observation

Definition 1.10 (thick description)**.** A description that includes not only immediate behaviors but also contextual and experimental understandings

Definition 1.11 (naturalistic observation)**.** Non-experimental method where people/-groups/organization/cultures are observed in their "natural" setting. (Quotes because by being in it you might change the setting somewhat.)

	Participant	Non-participant
Overt (participant aware)	Living as a member of a community	Researcher not mingling (like in a classroom) Challenging to be a "fly on the wall"
Covert (participant not aware)	IRB needs to know why you're not making it overt	

]

EMIC Insider perspective (local) - observes behavior within a group, culture, or organization.

	Pros	Cons
EMIC	• Understand the POV from other cultures • What is important and meaning to those within group • in depth, rich and holistic knowledge	• Difficult to make comparison • Researcher subjective bias • Research can take more resources
ETIC	• Allows comparison between cultures • Researcher decides what is important before hand • Multiple cultures can be observed at once	•

Nov 11th—Nov 15th: Week 12

Nov 18—Nov 22nd: Week 13

13.1 DHD 510: Data Analysis

- Statistical Analysis
  - Descriptive statistics are not analysis
  - Parametric VS. Nonparametric
    - Parametric analysis to test group *means*; assumes normality, homogeneity of variances, and independence.
    - Nonparametric analysis to test medians: Used when data does not meet the assumptions required for parametric tests - usually when mean and median do not line up.
  - Variance Analysis
    - t-tests
    - One-way ANOVA
    - One way repeated measures ANOVA
    - Factorial ANOVA
    - ANCOVA: Analysis of co-variance.

    - MANOVA: Multiple dependent variables
  - Correlational Analysis
    - Pearson Correlation—tests for strength of the association of two continuous variables
    - Spearman Correlation—Tests for the strength of the association between two ordinal variables.
    - Chi-Squared—Tests for the strength of the association between two categorical variables
  - Regression Analysis
    - Simple Linear Regression—Tests how change in the predictor variable predicts
    - Multiple Regression—Linear but high dimensional.
- Qualitative Coding & Codebooks
  - Codebook for analysis:
    - In qualitative research, a codebook is a set of codes and definitions used as a guide to help when doing analysis
    - Codes are used to categorize verbatim quations from research participants
  - Software for qualitative analysis includes ATLAS.ti and NVivo
    - Software = more efficient when collaborating
    - ppl still do this by hand tho cuz it's more "involved"
    - coding becomes a way to become immersed in the data
  - Index coding: develop an index of code a priori.
  - Thematic Coding: create codes that capture core themes that emerge in the research
  - Grounded Theory:
    1. Open Coding—form initial categories about the phenomenon
    2. Axial Coding—Assemble data in new ways after open coding
    3. Selective Coding—identify a storyline and write a story that integrates categories from axial coding
- Quantitative Analysis: Deductive (theory driven) and inductive (emerges through data)
  - Content analysis—conceptual/relational analysis to understand the actual content and internal features of media
  - Discourse analysis—linguistic analysis of ongoing flow of communication, looking at verbal and non-verbal communications.
  - Constant comparison/Grounded Theory—Each interpretation/finding is compared with existing findings as they emerge
  - Thematic analysis—looks for themes
  - Narrative Analysis—Focuses on the way people make/use stories to interpret the world around them (structural/functional approach or sociology of stories)
  - Hermaneutical Analysis—Methodology of interpretation; problems that arise when dealing with meaningful human actions and the products of such actions, most importantly texts.
  - Phenomenological/Heuristic Analysis===The study of how individuals experience the world.

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Acronyms

AACE Association for the Advancement of Computing in Education. 15
ACM Association for Computing Machinery. 15
AERA American Educational Research Association. 15

CCK Common Content Knowledge. 32
CDA Critical Discourse Analysis. 30
CSCL computer support for collaborative learning. 15
CSCW Computer-Supported Cooperative Work conference. 15

DBR Design Based Research. 24
DCLM Divergent Collaboration Learning Mechanisms. 31

EC Epistemic Cognition. 21, 22

FINER Criterons for a Good Research Question: Feasible, Interesting, Novel, Ethical and Relevant. 22

GSC Graduate Student Council. 2, 16

ICLS International Conference of the Learning Sciences. 15
IES Institute of Education Sciences. 24
IRL The Institute for Research on Learning. 15

KCS Knowledge of Content and Students. 32
KCT Knowledge of Content and Teaching. 32

LPP Legitimate Peripheral Participation. 21
LSGSC Learning Sciences Graduate Student Conference. 2, 23
LSSA Learning Sciences Student Association. 2, 3, 16, 24
LT/P Learning Trajectories/Progression. 5

MKT Mathematical Knowledge for Teachers. 32

PICOT Components of a research question: Population, Investigation, Comparison Group, Outcome of Interest and Time. 22

RCT Randomized Controlled Trials. 24

SCK Specific Content Knowledge. 32

ZPD Zone of Proximal Development. 28

Glossary

absolute idealism Hegel (1830-1991) philosophy, where he believes that inquiry functions best when conducted with an awareness that it is just a "moment" in a collective, evolutionary process. This is a type of anti-dogmatism. (Bredo, 2006). 20

classical positivism The view that knowledge should be based on what is "positively" and directly observed rather than on unobserved entities, forces, or causes thought to lie behind things (Bredo, 2006). 20

critical theory Response to instrumental rationality, where a researcher may accept a supposedly universal conception of things that in practice serves only limited private interests. This line of thought by Habermas further claims that the validity of an assertion can only be determined in free and unforced argument in an "ideal speech situation" with "no external constraints preventing participants from assessing evidence and argument, and ...each participant has an equal and open chance of entering into discussion". (Bredo, 2006). 20

dialectic logical argument in collective thought (Bredo, 2006). 20

dialectical materialism NOT WELL DEFINED (Marx??) (Bredo, 2006). 20

differentiated scaffolding Use different means to support different aspect of performance. 29

distributed scaffolding A concept that describes those cases in which scaffolding is embedded productively in multiple aspects of a learning environment. (Reiser & Tabak, 2014) Three types:

1. differentiated scaffolding
2. redundant scaffolding
3. synergistic scaffolding

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empiricism Empiricist philosophies of knowledge generally argue that knowledge is based in experience of concrete objects or events; the philosophy that all knowledge comes from "experience". (Primary vs secondary qualities: primary = objective; e.g., solidity/shape/size/velocity and secondary = subjective; e.g., taste/color) (Bredo, 2006). 20

externalist External accounts view the properties of the environment as the principal factors explaining the properties of the mind (Bredo, 2006). 20

hermeneutics The science of textual interpretation origially develped as a systemic method of interpretation to resolve disputes over religious texts. Modern interpretation of this is that the author of an act or utterance does not have privileged access to its meaning and must rely on the responses of others to clarify it. (Bredo, 2006). 20

instrumental rationality This is an applied form of utilitarism in Education and other social sciences, where one approaches everything in terms of efficiency towards some stated goals by assuming that they're shared by all, and thereby hiding or displacing the discussion on the conception of said goals. (Bredo, 2006). 20

interactionism Thinking alters action, which subsequently affects the external world, thereby affecting one's future sensory input; i.e., "internal" and "external" factors affect one another (Bredo, 2006). 20

intermediary Intermediary is a "gatekeeper" who are often guardians, and acts as a link between the researcher and the participant. 18

internalist Internalist accounts suggest that the most important determinants of thought or knowledge arise from the "inner" constraints of the mind or distinctions built into language or culture (Bredo, 2006). 20

logical positivism A descendant philosophy to classical positivism, where the use of general form of logic is adopted, and sensitivity to analyzing the language in which scientific propositions (Bredo, 2006). 20

member checking The act of verifying with the interviewee that the data is accurate. 18

naturalistic observation Non-experimental method where people/groups/organization/cultures are observed in their "natural" setting. (Quotes because by being in it you might change the setting somewhat.)

	Participant	Non-participant
Overt (participant aware)	Living as a member of a community	Researcher not mingling (like in a classroom) Challenging to be a "fly on the wall"
Covert (participant not aware)	IRB needs to know why you're not making it overt	

. 33

post positivism Critiques of logical positivism:

- the notion that observational facts are logically independent of the theories they test;
- the notion that scientific thought can be "verified" is questionable (This has been called "critical rationalism"),
- positivist conception of science can be overly individualistic,
- the attempts to separate facts from values has failed, in that there is no value-neutral language, and one's purposes or aims are effectively built into the way one conceives things.

This is not necessarily a comprehensive list of critiques of positivist thoughts (Bredo, 2006) 20

postmodernism Lyotard defined this as "incredulity toward meta-narratives", which are any account that attempts to encompass other accounts to become *the* way things are. In this, the postmodernists reject any attempt to give a unifying theory or totalizing accounts of the human condition. (Bredo, 2006). 20

pragmatism This line of thought do not believe that there is an ultimate "ideal" or "goal", and rebelled against all deterministic schemes and fixed schemes and foundations(Bredo, 2006). 20

prolepsis A mechanism that helps explain how learning occurs through scaffolding, where the learner imitates the modeled actions and associates them with the directive and definition of the task (Reiser & Tabak, 2014). 28

rationalism Rationalists view knowledge as primarily determined by reason, or the mind, rather than by sensory experience. 20

redundant scaffolding the same aspect of performance is supported through different means. 29

reliability Quantitative: Can be repeated, and is *consistent*, with generalization in mind. 18

structuralism Per Roman Jacobson, "any set of phenomena examined by contemporary science [which are] treated not as a mechanical agglomeration but as a structural whole (in which) the mechanical conception of processes yields to the question of their function". The elements or objects figuring in the analysis of behavior are defined by the rules constituting the activity of which that behavior is a part. (Bredo, 2006). 20

subjective idealism NOT WELL DEFINED Rationalism? Hermaneutics? (Bredo, 2006). 20

synergistic scaffolding providing different concurrent means of support for the same performance that are synergistic in scaffolding learners. In the design strategy, some of the supports help the learners make use of the other concurrent supports . 29

thick description A description that includes not only immediate behaviors but also contextual and experimental understandings. 33

validity How valid one's research is. *Accurate* and reflects the real-world. 18

Zone of Proximal Development A range of tasks that are outside of the learners' independent ability but are achievable with appropriate help, thereby extending their range of indpendent activity (Reiser & Tabak, 2014). 28