

HS 525: Cognitive, Sociocultural and Critical Foundations of the Learning Sciences

Lecture 3: August 12, 2025

Aditi Kothiyal



What and why did we do in the first week?

One thing I learned last week...

- Pasteur's quadrant
- People learn for many reasons

One thing I found challenging last week...

- Making concept maps - too dense
- Reflecting on your own learning journey
- Designing contextualized learning environments
- How to study learning without intervening



Trends in the LS

1. Learning as a complex systems phenomenon
2. Precision in explication of the longitudinal expectation from learners in terms of knowing and doing, tighter coupling between assessment and design
3. Adaptive Learning, selection of scaffolds
4. Mixed methods
5. Designing *with*, rather than *for*, acting *with* rather than acting *on*.
6. Increased attention to social justice and equity

Vote: Which trend do you think is the least important and why? (Individual, 2 min)

—

VOTE count with reasons:

- 1) 5 - if others are taken for, 1 will be taken care of; others seem more important
- 2) 1 - rigid rules get taken out of context, other things are way more funda; this can emerge when its relevant
 - a) Alignment between assessment and design is important
- 3) 0
- 4) 4 - methods are least important, because theory is necessary; if we do everything else right this will happen
- 5) 0 - 5 is most important without it we are shooting in the dark; 6 is most important because we have to consider perspectives of the marginalized students
- 6) 5 - by product of 5 and 3



Consolidation

1. LS emerged as a response to the “frustration” with the disconnection between the predictions of models of thinking and what is relevant in real-world educational contexts.
2. LS centers design of effective learning environments and reflective development of theories of how learning happens.
3. **Ecologically valid** settings of research, **pragmatically adopting** mixed methods, **researcher-practitioner partnerships** and **sensitivity to context** are core philosophical ideas of the research field => “scruffy”.
4. LS is constantly evolving as seen by the emerging trends, adopting new technologies and methods to support new purposes of learning



Evolution of an LS research project

1. Design-implement-evaluate-redesign -> engineering ethos
 - a. “Highly responsive, evidence-based course corrections”
2. Iterations of evaluations in real-world settings
3. Document effectiveness in a carefully chosen test site
4. Scale-up beyond the test site and change
 - a. Pedagogical practices
 - b. Design principles
 - c. Education policies
5. Contextualization of innovations during scale-up



Influential Theories of Cognition

1. Cognitivism

- “Cognition as computation” - physical symbol systems - internal mental representations (symbols) **about** the world
- Goal is to develop theories of cognition
 - Attention, perception, memory, language development, concepts, decision making and reasoning, problem solving, procedural and conceptual understanding, consciousness

2. Situated Cognition

- “Cognition as a result of direct perception of the action possibilities of our interaction with the environment”
- “Perception and representation as grounded interaction **with** the world”
- Contextualized activity of people, resources and environment
- Cognition is embodied, embedded and extended



Influential Theories of Learning (cognitive development)

1. Constructivism

- a. Creation of mental structures
- b. Schemas or categories
- c. Concrete to abstract
- d. Radical vs social constructivists
- e. Constructionism

2. Sociocultural Theories

- “All intelligent behaviour realized in a complex environment”
- Learning also occurs in a complex environment and not in the head of an isolated learner
- Importance of social interaction and scaffolding



Influential Theories of Learning (cognitive development)

3. Dewey

- a. Learning emerges through authentic inquiry
- b. Driven by child's interest and experience
- c. Thought emerges through interaction with reality
- d. Communication and language begin as concrete gestures and become abstract

Think: (INDIVIDUAL, 4 min) <SKIPPED>

A group of 12-year old girls start working in a makerspace in their school because they are interested in fashion and love making costumes for the school plays and dance performances. When they began they believed they couldn't do science and so they chose an e-textiles project, instead of robotics or STEM lab. They began without knowing what e-textiles were and at the end of a year they know how to design and program an appropriate circuit to make the textiles glow, flash or anything they can imagine! They now think electrical engineering is fun.

According to you, which of the theories of cognition or learning explain this change?

- 1) Cognition as computation 2) Situated cognition 3) Constructivism**
- 4) Sociocultural theories 5) Dewey**

Vote: (INDIVIDUAL, 30 sec) <SKIPPED>

Raise your hand with the number of the trend you selected - 1, 2, 3, 4, 5.

Find a partner who has a different number than you.

—

Pair: (PAIRS, 5 min) <SKIPPED>

Discuss with your partner and agree on one theory - you convince them or they convince you!

Share your choice and reasons: <SKIPPED>

Scope of Learning Behaviours

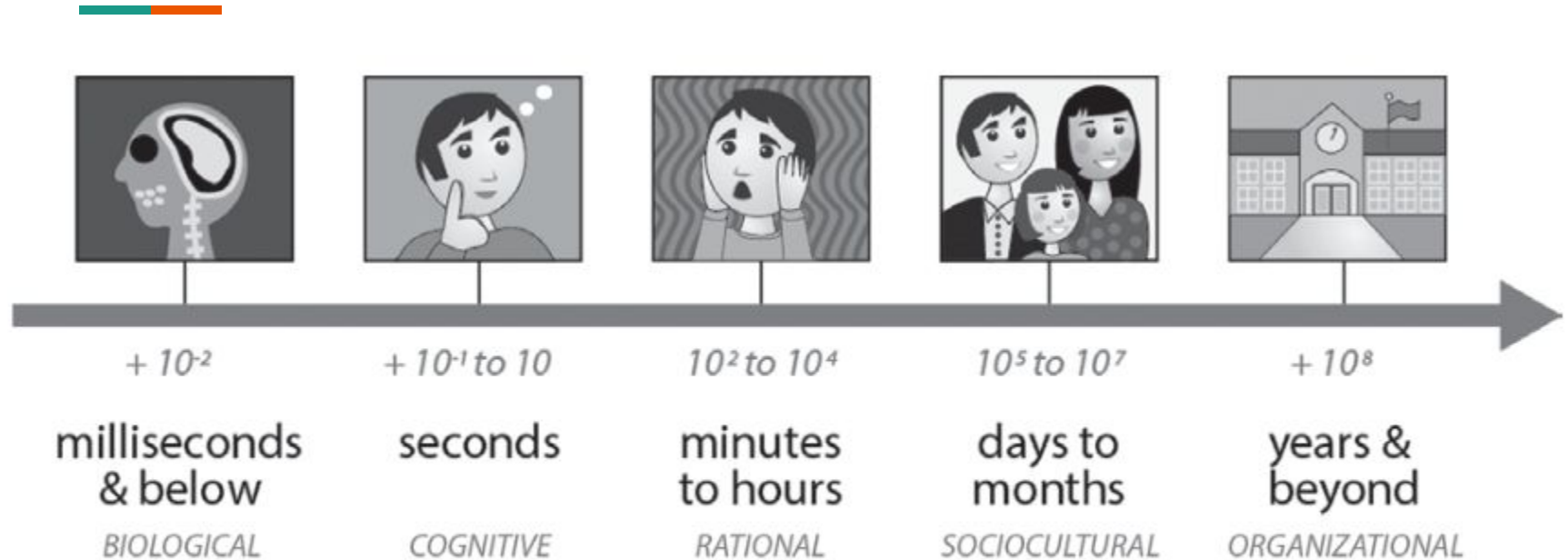


Figure 2.1. *Log₁₀ time scale of human learning. Adapted from Nathan and Alibali (2010).*



Levels of Analysis and Research Approaches

- Time scales of learning: Mental processes vs. designed learning environments
- Elemental vs. Systemic research
 - Quantitative vs qualitative research is a false dichotomy
 - Important to understand the purpose of the research
- Levels of analysis: Complete system (supervenience) vs. component elements (reductionist)
- Approach determined by the nature of the phenomenon
- Complex systems -> emergence -> factoring not possible



Evidence-based principles from elemental approaches

1. Spaced repetition, practice, feedback: block vs interleaved
2. Managing cognitive demands
 - a. reducing cognitive load through structure
3. Active meaning making
 - a. grounding experiences in perception and action, language, prior knowledge
 - b. Provide activities that ground meaning
 - i. Progressive formalization
4. Metacognition: monitor one's understanding and reflect on one's own learning process



Evidence-based principles from systemic approaches

- Cognition as “stretched over, not divided among”.
 - Document holistic learning practices, complex system phenomenon
 - Focus on the group, or the socio-technical system
1. Collaborative discourse and argumentation
 - Collaboration improves learning
 - Quality of discourse influences subsequent performance
 - Generating and listening to explanations
 - Make knowledge explicit, reveal knowledge gaps
 - Reflect on reasoning process -> conceptual change
 - Co-constructions of ideas and representations
 - Learners need support - modeling, scripting

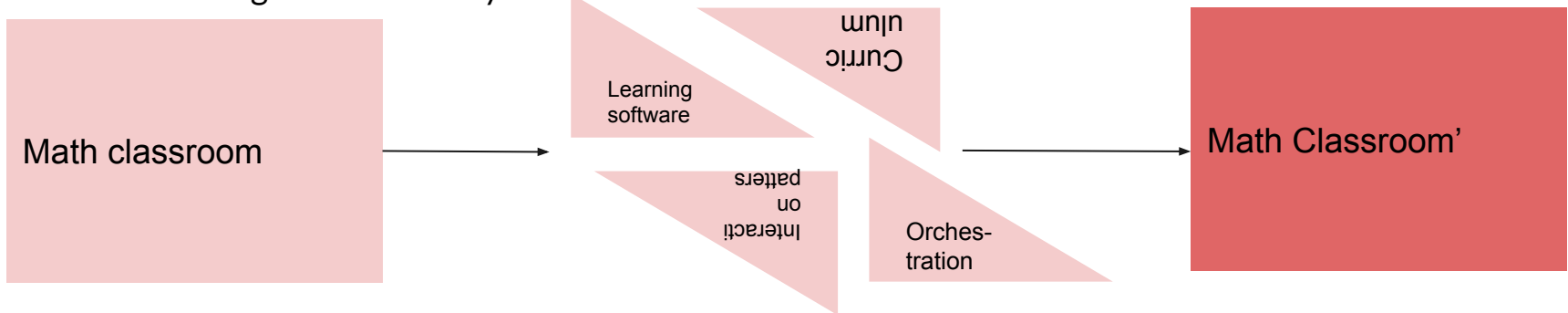


Evidence-based principles from systemic approaches

1. Engage in authentic disciplinary practices
 - a. Meaningful context, anchor students understanding
 - b. Support future application
 - c. Increase student motivation
 - d. Understanding epistemology
 - e. Careful design of LE required - structure and support - learning and autonomy
 - f. Socio-technical system - distributed cognition
 - g. Cognitive apprenticeship - guided participation - make tacit knowledge explicit
2. Guided Inquiry and project based learning
 - a. Doing, generating and articulating knowledge, asking questions, self-explanation, justification
 - b. Generating and applying ideas to solve meaningful problems
 - c. Support to discover, connect prior knowledge, monitor and reflect

Scale down approach

- Observe System and develop Hypotheses
- Potential subsystems within nearly decomposable systems
- Modify design and performance of these subsystems
- Reintegrating modified subsystems into the system
 - Capture interactions of the participants and context with the functioning of the components in the system
- Observing behaviour of system as whole



Think: (INDIVIDUAL, 4 min) <SKIPPED>

A school district discovers during an ASER assessment that their fifth grade students do not understand 2 and 3 digit numbers at the level of third graders. They call in you, a learning scientist, to redo their math classrooms to improve the understanding of numbers.

1) How would you go about redesigning the classrooms? Explain your process.

2) Articulate which elemental and which systemic learning principles you would put in place. Justify your choices.

Pair: (PAIRS, 6 min) <SKIPPED>

Discuss with your partner and flesh out the details of your redesign plan and the learning principles used.

Share your redesigns:

<SKIPPED>

—



Next Class

- Metaphors of learning
 - 2 readings only