Issues of Learning and Cognition as Complex Systems

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– Summary Handout for Discussion –

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FUNDAMENTAL QUESTIONS
(and Index to Handout)

1. **Is learning a complex system (and how is it a complex system)?**
   - → Characteristics of complex systems
   - → Questions related to learning and learning as a complex system:
     - ◆ What is the purpose of learning?
     - ◆ What are the patterns of learning?
     - ◆ What are the processes of learning?
     - ◆ What is the driving "force" of learning?
     - ◆ What are the underlying assumptions of particular learning theories?
   - → Overview of learning theories and their compatibility with complexity

2. **What would teaching, curriculum, and schooling "look like," if they were consistent with learning as a complex system?**

3. **How do current practices of teaching, curriculum, and schooling undermine learning as a complex system?**

Features of Complexity

➔ ***As criteria for learning as a complex system?***

Core Features of Complex Systems

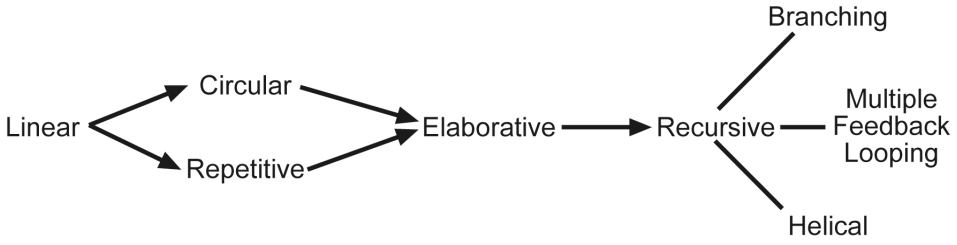
Non-Linear	Circular or more complex causal, relational, and/or interactive loops or recursions
Autopoietic	Self-generating, self-maintaining, self-organizing, self-renewing, self-amplifying, self-transcending
Far from Equilibrium	System does not function as a steady-state, but from state of imbalance

Other Features

Energy (Driving "Force")	Some "thing(s)" provide(s) energy or force for system
Amplification	Small initial factors or events may have large effects on system
Whole > Σ Parts	The whole is greater than the sum of its parts (holist – not reductionist)
Central Organizing Factor(s)	Some features act as organizing center for the system and subsystems
Emergence	Complex systems provide for possibility of new, emergent features, qualities, effects, or products
Unpredictable	Direction or course and results are not entirely predictable

Ramifications and Implications

Continuum of Non-Linearity:

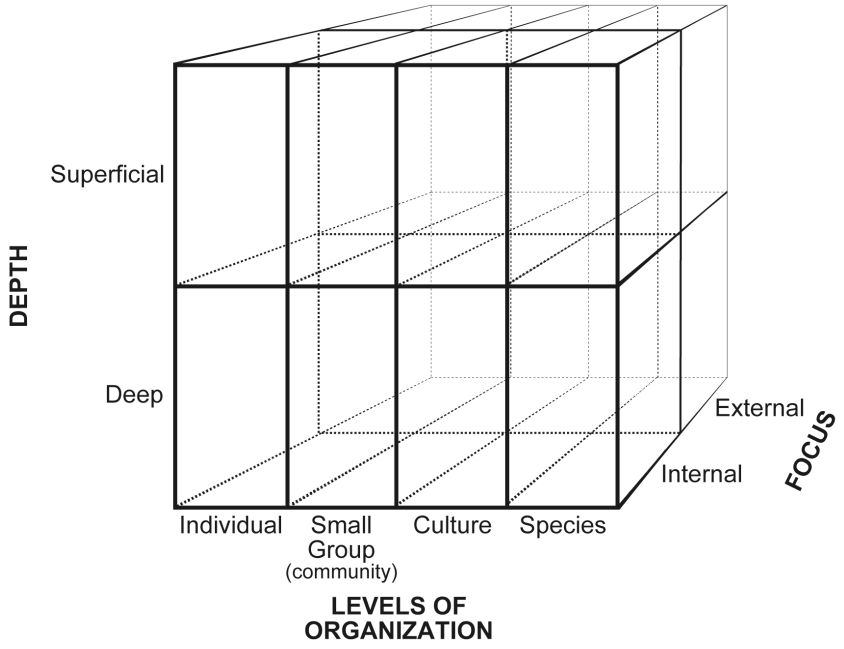


Patterns of Organization	Fundamental patterns within system and its organization and products
Relational Complexity	Relationships among parts, whole, and external "things" and contexts are characterized by complex interactions
Contexts are Important	Systems operate within contexts and are inextricably interconnected. Systems and contexts affect one another.

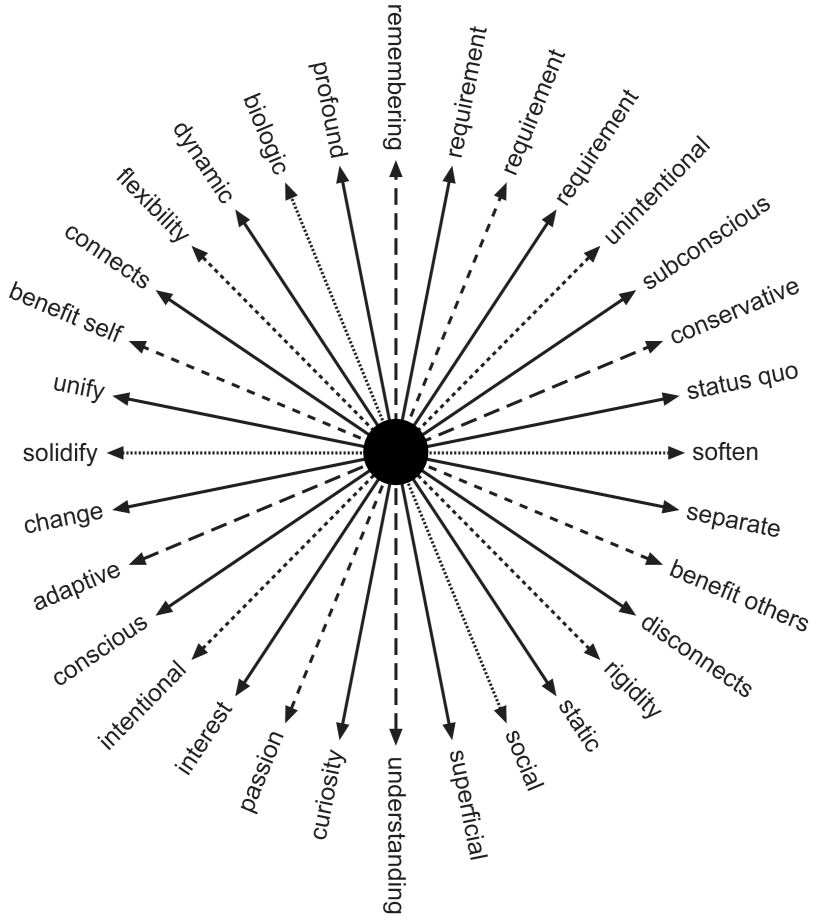
Some Major Learning Theories

Theory	Summary	Orientations	Complexified?	Theorists
Activity Theory	Learning is based on tool-mediated activity in contexts and through cycles of transformation and creation of objective knowledge of reality.	• Functionalist • Goal–directed • Objectivist • Partly mechanistic • Partly positivist	• Non–linear // recursive • Disequilibrium	→ Engström • Vygotsky • Leont'ev • Luria
Assimilation Theory	Learning based on assimilation into prior knowledge. Transfer of knowledge occurs because learning was meaningful.	• Metacognitive • Partly positivist	• Disequilibrium • Networks of relationships	→ Ausubel • Novak
Behaviorist Theories	Learning as change in behavior through: stimulus-response, automatic and reflexive, & simple connections. Ignores cognition, emotions, and consciousness.	• Positivist • Mechanistic • Reductionist • Objectivist • Deterministic • Thinking is irrelevant	⊗ linear ⊗ retrogressive	• Watson, J. B. • Guthrie, E. R. • Thorndike, E. • Skinner, B. F. • Black, E. • Cook, D. A.
Brain-based Theories	Meaning-making through patterning. Parallel processing. Learning involves whole body, focused and peripheral perception, and in conjunction with other brains (socially).	• Holistic • Multimodal • Multi-contextual • Emotions—important in patterning • Contextual	• Parts and wholes • Non-linear; complex recursiveness • Uniquely organized • Disequilibrium • Autopoietic • Flexible, adaptive	• Caine, R. • Caine, G. • Armstrong, T. • Pert, C. • Jensen, E.
Bateson's Cybernetic & Deutero-Learning	Learning as transformations through cybernetic feedback loops with mind extending beyond body.	• Holistic • Metacognitive • Mutli-contextual • Emotions—important • Metapatterns • Contextual	• Parts and wholes • Non-linear; complex recursiveness • Patterning • Autopoietic • Adaptive	• Gregory Bateson
Constructivist Theories	Learning as the construction of meaning through connections to prior knowledge.	• Holistic • Relativistic-subjective • Contextual	• Non-linear	→ Piaget → von Glasersfeld
Social Constructivist Theories	Learning as the construction of meaning through social interaction.	• Holistic • Social-communicative • Reciprocal	• Non-linear • Autopoietic • Adaptive	→ Bakhtin → Vygotsky → Leont'ev
Information Processing Theories	Learning as computational processing of information into various types of memory.	• Mechanistic • Reductionist • Deterministic	• Partially non-linear	• Atkinson • Bransford • Miller • Rummelhart
Neo-Schema Theories	Learning as active, transactional, and embodied processes of representation at various levels of abstraction.	• Holistic • Contextual • Evaluative • Mind-Body Connection	• Non-dualistic • Non-linear • Patterning • Autopoietic • Adaptive • Parts and wholes	• McVee • Dunsmore • Gavelek
Situated Learning, Apprenticeship, & Communities of Practice	Learning as (unintentional) induction into the practices of particular communities, such as apprenticeships, cultures, etc.	• Holistic • Contextual • Social-communicative • Multi-modal	• Non-linear • Adaptive • Autopoietic • Disequilibrium	→ Lave → Rogoff → Wenger
Distributed Cognition	Learning is a system that is distributed among people, tools, internal & external environments, artifacts, and time. Goals of learning tend to involve solving problems and acquiring expertise.	• Partly positivistic • Partly functionalist. • Holistic	• Non-linear • Autopoietic • Disequilibrium	• Salomon • Hutchins • Perkins • Pea • Norman

Purposes of Learning



Dimensions of the purposes of learning.



Intersecting dichotomous continua of learning purposes.

PURPOSES from the perspective of current *Learning Theories*

General View

- ⊙ as vague functionalist or mechanistic process
- ⊙ as goal directed at conscious level
- ⊙ as need-directed
- ⊙ as unintentional

Operational or Functional (tends to be circular → "purpose of learning is to learn")

- ⊙ for solving problems
- ⊙ for meaningful learning or meaning-making (→ circular argument)
- ⊙ for skill acquisition
- ⊙ for abstract representation
- ⊙ for pattern recognition
- ⊙ for evaluation of goodness of fit
- ⊙ for remembering
- ⊙ for understanding

Adaptation, Survival, Change, Maintenance

- ⊙ for self-correction
- ⊙ for adaptation
- ⊙ for behavioral change
- ⊙ for social survival (as perceived)
- ⊙ for individual survival (as perceived)
- ⊙ for solidification
- ⊙ for flexibility

Relationships, Communication, Participation

- ⊙ for participation in a particular community of practice
- ⊙ for communication
- ⊙ for relevant expertise

PURPOSES from the perspective of *Learning as a Complex System*

Many learning theories do not expressly discuss the purposes of learning. If they do discuss them, these purposes tend to be relatively superficial (e.g., to make meaning, to participate in a community, etc.). However, learning as a ***complex system*** will include most of the purposes listed above, as well as others, such as:

- ◈ for survival of species (as genetic "learning") – as genetically distributed learning
- ◈ for survival of individual(s) – self & socially distributed learning
- ◈ for maintaining individual system
- ◈ for maintaining social or cultural system

Other potentialities of learning from ***complexity perspective*** include:

- ◈ self-transcendence
- ◈ self-transformation (e.g., egolessness & enlightenment•)
- ◈ innovation and creativity
- ◈ insight

◈ From Buddhist psychological perspective learning can be geared towards:

1) development, maintenance, and extension of ego (as sense of solidity and dualistic separation)
2) development of intelligence (prajna) and wisdom (jnana) for cutting through ego and achieving state of egolessness
   → this sense of learning is associated with self-transformation, self-transcendence, and compassion, as well as with a sense of being "learned."

LEARNING AS COMPLEX SYSTEM
Characteristics & Implications

Characteristics	Description	Implications
Non-linearity	**RANGES FROM:** ***Repetitive → Elaborative → Recursive*** • Recursion seems to be qualitatively (and quantitatively) richer and more complex than elaboration and repetition **INCLUDES:** • *looping – multiple, interacting loops – helices – branching – divergences – convergences*	⦿ Teaching and curriculum need to incorporate recursive patterns of working with concepts. ⦿ Teaching and curriculum need to provide opportunities to support children's: • natural recursiveness. • recursively helical patterns of learning over time. • divergent thinking and new branches of inquisitiveness. ⦿ Assessment needs to: • move away from standardized tests. • focus on children's idiosyncratic understandings .
Stochastic elements & patterns	• Randomness both internal (ideas, emotions, etc.) and external (whatever arises from interactions with others, events etc.) elements and events.	⦿ Teaching and curriculum need to provide opportunities for the occurrence and use of random events, elements, and patterns. ⦿ Teaching and curriculum need to accommodate the incorporation of random thoughts, experiences, and patterns of thinking in the work and thinking of students. ⦿ There needs to be time for the unexpected to occur.
Predictably unpredictable	• Outcomes of cognition are not predictable. • We can predict this unpredictability.	⦿ We can predict that the unexpected or unpredictable will occur if schooling and curriculum are not solidified – actually the unexpected will occur anyway. ⦿ By de-solidifying schooling and curriculum, we can provide room for the unpredictable to develop into novel ideas and products.
Emergence as creativity & insight	• Not deterministic.	⦿ Emergence of the unpredictable is the manifestation of creativity and insight. ⦿ Real problem-solving is dependent upon such emergent creativity & insight.
Embodied & contextually distributed cognition	• Embodied cognition involves: • coordination of mind and body. • distribution of cognition throughout body. • Distributed cognition extends within and beyond body to tools, artifacts, materials, and others.	⦿ Teaching and curriculum needs to value and promote: • use of a variety of tools, artifacts, and materials for exploration, inquiry, and communication. • the idea of group cognition and learning. • the idea that cognition and learning involve interacting with the world and not just thinking and talking heads. ⦿ We need to "see" each child as a system with looping processes extending into their worlds, its objects, and other people.
Active & dynamic	• Cognition and learning are active and dynamic processes. • Understandings continue to change over time.	⦿ Student, while in classes, should be actively engaged with materials, tools, ideas, and other people – and should be stationary and quiet for as little as possible.
Situated in contexts	• Cognition and learning are situated in multiple contexts, including: • cognitive—emotional • sensory • theoretical—conceptual • physical—environmental • social—cultural	⦿ All learning must be situated in one or more relevant contexts, such as: • everyday lives of students and their individual interests & passions • political • cultural and social • theoretical (abstracted contexts within the world of ideas)

Socially & psychologically adjusting and modifying	• Learning involves continuum of changes that can range from simple emotional connections with content of learning TO major shifts in beliefs and orientations	⦿ If students are learning, then they are changing psychologically and socially – learning is not just creating compartmentalized areas for information storage ➔ learning involves changing the way we see and relate to the world.
Biologically adaptive	• Evolutionary processes of genetic change involve the transference of information at the genetic level (a Batesonian learning).	⦿ Learning also occurs at the level of genetics, where information is passed on to other generations; and this information is adaptive (re: Bateson, et al.)
Reflexive & purposeful	• Learning ranges from the unconscious and reflexive to the conscious, purposeful, and metacognitive.	⦿ Classroom and school environments need to: • be relaxed, safe, and open environments that support individuality and creativity • be stimulating and rich environments that promote curiosity and engagement • be communities that promote meaningful and respectful interactions, the development of identities, meaningful and relevant engagement and participation • promote reflexive to purposeful learning • promote thinking that is reflective, analytical, creative, insightful, and metacognitive
Driving "force" or "energy"	• Learning is driven by some sort of psychological "energy": • emotions (fear to joy) • curiosity • passions & interests • social & cultural acceptance • for spiritual growth • for ego enhancement	⦿ Teaching and curriculum need to avoid teacher-directed approaches where learning is driven by external factors, such as rewards, fear, etc. ⦿ Teachers need to provide opportunities for children to engage and learn driven by positive emotions, curiosity, passions, interests, and challenges of various kinds.
General Implications		⦿ Children need time to explore, make mistakes, and play with ideas and materials. ⦿ Children's individuality and children's social connectedness need to be valued. ⦿ Curriculum and planning need to focus on "planning for the unexpected" – i.e., on the emergent (questions, divergences, new events, etc.)

How do current views and practices of teaching, curriculum, and schooling undermine learning as a complex system?

Practices & Views	Assumptions
Classroom "Management"	• Children are to be controlled and manipulated. • Teachers are in control. • Learning requires that children are "in control."
Teacher-Proof Curriculum	• Teachers are not professionals • Learning is in the control of remote others. • Learning is static. • Learning is a standardized, linear process.
Curriculum Mapping	• Sequence and focus of curriculum needs to be predetermined. • Learning is determined by teacher and others. • The "map" is the "territory" (learning confuses representations with reality). • Learning is the same for all students.
Lesson Plans	• Sequence and focus of teaching is predetermined. • Learning is determined by teacher. • "Bits" of information can be taught as isolated segment.
Learning Objectives	• All learning can be measured. • All learning can be observed. • Learning is predictable.
Content Standards	• What is "good" for one student is "good" for all students. • Some "content" is more important than other "content" & this is determined by a relatively small group of people. • What is to be learned is age-dependent → learning capabilities are standardized, linear, and restrictive progressions.
Learning occurs from Concrete to Abstract	• Learning is a linear progression from simple to complex or abstract. • Learning simple, concrete ideas is "easier" than more complex and abstract ideas.
Testing & (most) Assessment Practices	• Learning is measurable. • Discrete bits of information about what has or has not been learned is indicative of a student's understanding. • Assessment of learning has to be done by someone other than the learner. • Students are incapable of self- and peer-evaluation. • Assumes students are not (and are probably incapable of being) aware of their own learning. • Learning is contained purely within an individual.
Grading	• The teacher is in control. • Learning is discretely measurable. • Learning can be evaluated on an abstract scale.
Homework (as typically practiced)	• Assumes learning is a process of simple repetition and practice. • Assumes learning is devoid of context.
Drill & Practice	• Assumes learning can be achieved by simple repetitive cycles. • Assumes learning is simple rote memory.
Student Achievement	• Learning is a level of performance that can be measured. • "Achievement" is confusing a piece of the "map" with the whole "map" and with the "territory." • Confuses "achievement" with learning (one can achieve without significant learning).

Student Achievement as Measure of Teacher Effectiveness	• Achievement is not necessarily learning. • Assumes student learning is entirely due to "effectiveness" of teacher. • Assumes that student learning is only affected by teacher and what takes place in classroom. • Assumes students have no responsibility for their own learning. • Assumes that other factors do not affect learning, such as family life, everyday life contexts that are outside of family and school, etc.
Time On Task	• Assumes that learning only occurs while focused on a task. • Assumes that children can be totally focused on a task, while no adult is ever totally "on task" while at work. • Assumes that "time off task" is a waste of time, even though creativity, insight, and solutions to problems often occur while "off task."
Time Limited Tasks (incl. tests)	• Assumes learning can be accomplished during discrete periods of time. • Assumes that all students can learn at the same rate. • Assumes that learning has discrete limits in depth, extent, and abstraction.
Adherence to State Standards	• Most literature have statements about adhering to state standards for all teaching activity & have statements about promoting connections to student prior knowledge, curiosity, and their everyday lives → these two statements are contradictory → if you truly promote connections to student prior knowledge, their lives, and their curiosity, you will have to deviate from state standards.
Teachers Teach	• Teachers are in control of student learning. • Assumes that someone "can teach" someone else and ignores learning as an integrative process that occurs within an individual and among individuals.
Learning Progressions	• Assumes learning is linear. • Assumes that learning progresses through the same sequence. • Assumes that learning processes are standardized across all individuals. • Assumes learning follows a linear pathway from simple to complex (abstract).
"Teachable Moments"	• Assumes that learning occurs around specific and discrete "meaningful" events, as opposed to learning that occurs as helices in time and space. • Assumes that someone other than the learner(s) must be responsible for recognizing opportunities to learn. • Does not recognize such moments as possible points of departure or emergence from existing learning helices (but are seen as discrete, fragmented, and disconnected moments).
Scaffolding	• Although seen as helical, scaffolding assumes a certain sequential linearity to conceptual learning.

Much of what we do in the name of schooling revolves around the notion of "*control*":
— controlling students, controlling teachers, controlling knowledge —

Linearity and working **towards equilibrium** are manifestations of our attempts to **solidify & control our worlds, our children, and ourselves.**
Positivism, mechanism, reductionism, functionalism, and egotism are traps of solidification & control.

Complexification of Learning

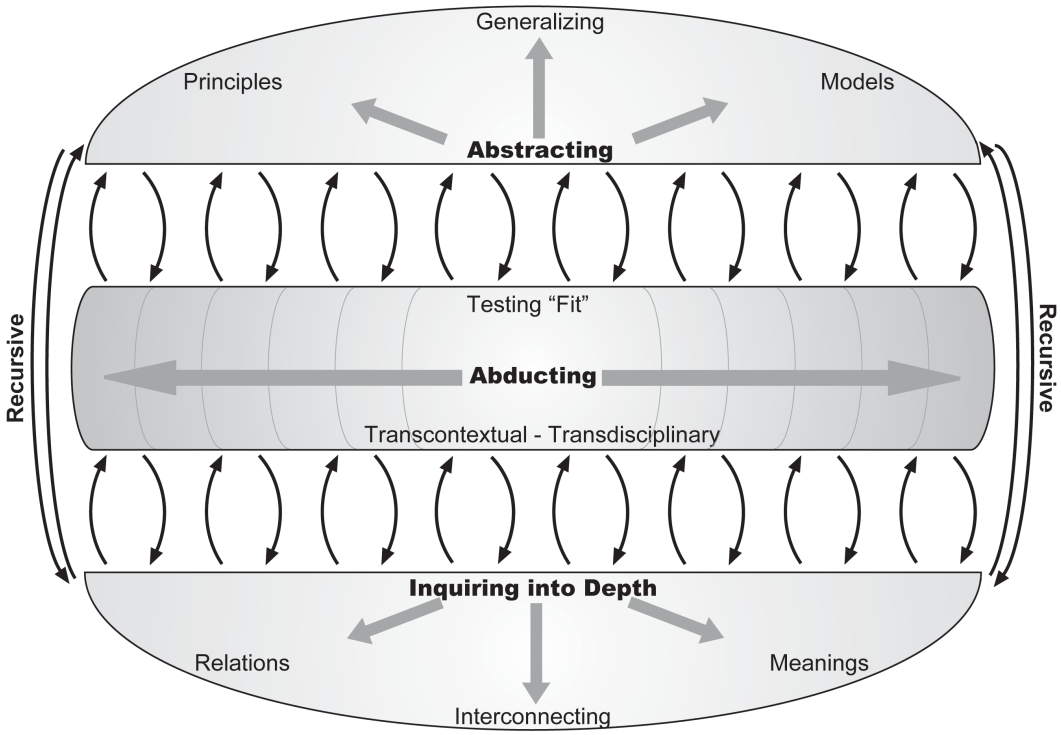
requires a shift in our worldview that sees learning as a continual process of engaging with a variety of "worlds" (our physical and biological worlds, our social worlds, our worlds of ideas and emotions) in ways where the barriers between self & others and self & worlds begin to dissolve and where control is distributed & shared.

What would teaching, curriculum, and schooling "look like," if they were consistent with learning as a complex system?

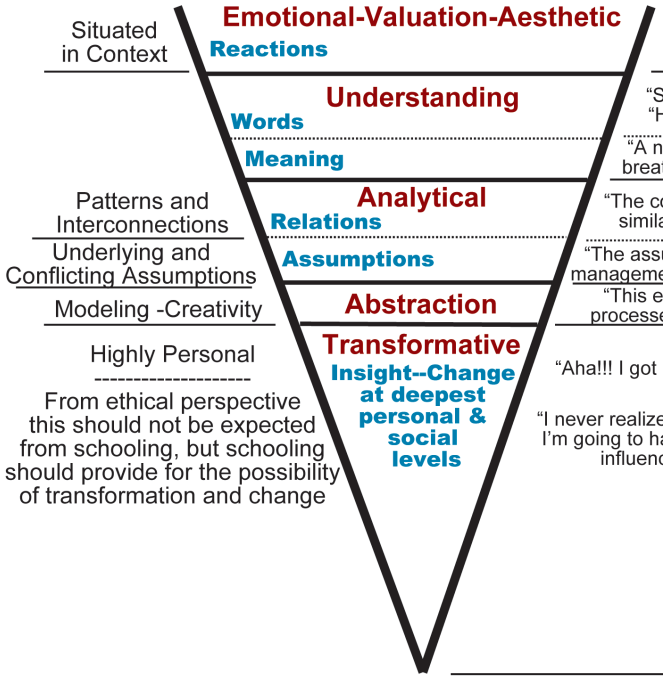
- Schools are ***vibrant communities*** of learning and knowledge production.
- Schools celebrate the ***diversity of individuality*** of its students and teachers.
- Schools provide "***down-time***" where students and teachers can interact in a variety of ways that stimulate creativity, insight, divergence, and innovation.
- Schools value ***emergence*** and provide opportunities for ***new questions and ideas to explore*** in-depth.
- Schools tend to be ***meeting places for sharing and arguing*** about ideas, ***communicating*** the results of knowledge production, ***analyzing data***, and ***working with other relevant and authentic tasks***.
- Students and teachers spend a great deal of time collecting various kinds of data and engaging in other learning activities ***outside of school***, and when in school they continue to engage in such activities.
- Student ***learning appears*** as:
  - ***Groups working together***.
  - ***Individuals working alone***.
  - ***Groups socializing***.
  - ***Individuals in "down-time".***
  - ***Teachers interact with students*** in ways that value and encourage student thinking, creativity, insight, innovation, and so forth.
  - ***Teachers act more as mentors and collaborators.***
- ***Assessment*** occurs as ***collaborative meta-evaluative processes*** that are an integral part of innovative and creative knowledge production communities.
- Students and teachers are involved in all kinds of ***activities that are multimodal*** -- recognizes value of physical activities, artistic expression (visual, dramatic, and musical), and so forth -- ***learning does not just occur in the head***.
- Students and teachers value ***curiosity***, ***emotions***, ***personal aesthetics***, ***intrigue***, ***wonder***, ***play***, ***exploration***, and other things that ***fuel the fire of learning and innovation***.
- ***Learning = Innovation***.
- ***Learning = Transformation***.

Some Relevant Models of Learning

Learning as Complexity

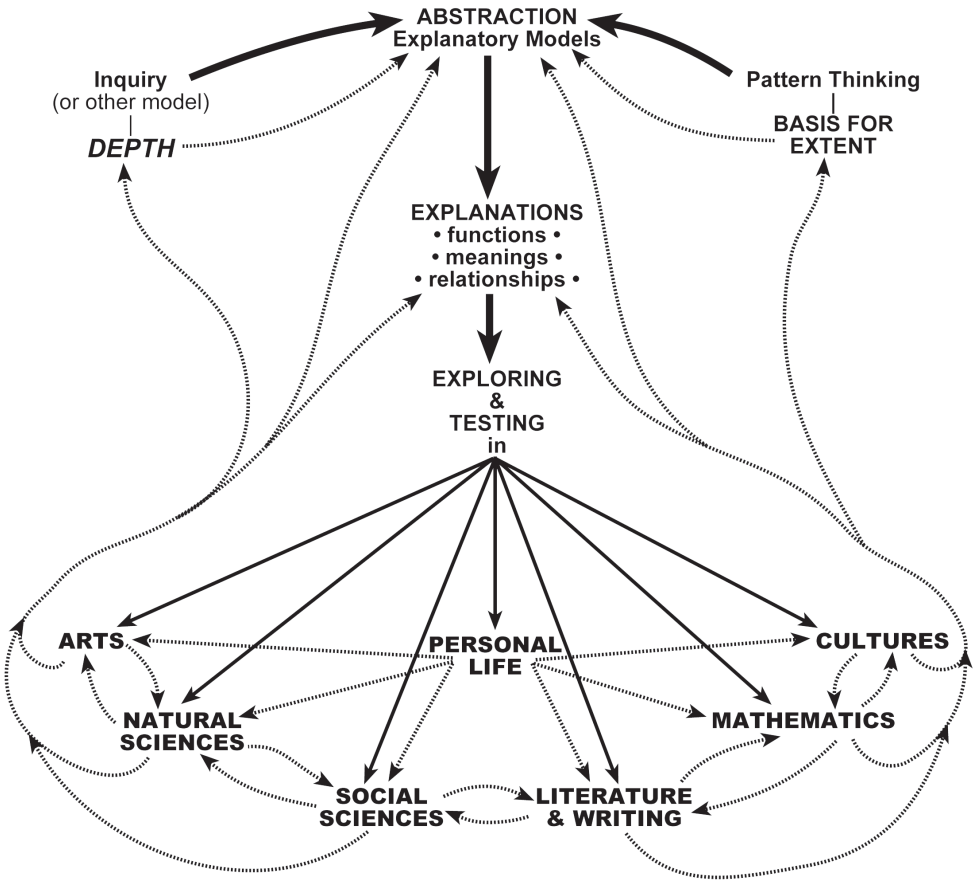


Levels of Cognition

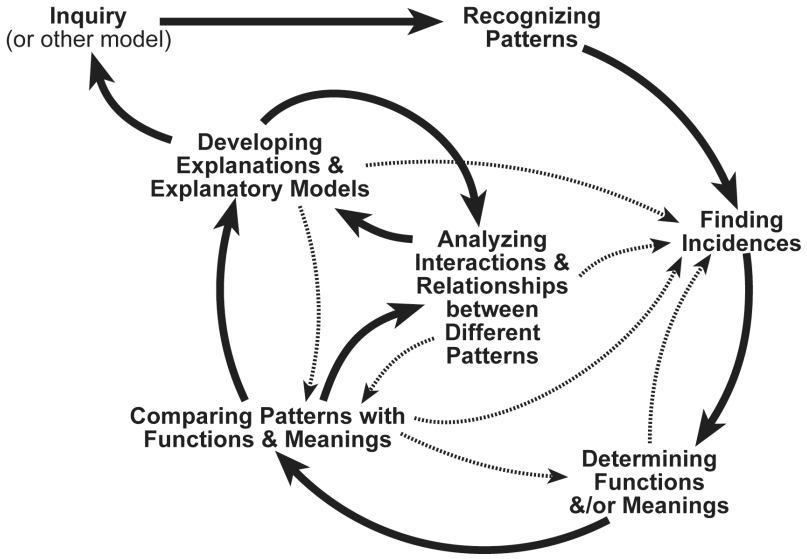


Levels of Cognition	Examples	Additional Commentary
Emotional-Valuation-Aesthetic Reactions	"I enjoyed it." "I hated it."	Superfiical, but is a significant aspect of meaning-making and personal relevance.
Understanding Words	"She said..." "He went..."	Understanding "words" involves minimal connection to context and relationships.
Meaning	"A nose is involved with smelling, breathing, etc."	Meaning involves understandings that are embedded in one or more contexts.
Analytical Relations	"The concept of management in schools is similar to management in corporations"	Understanding at this level sees complex sets of relationships and relations of relations.
Assumptions	"The assumption underlying the notion of management is a hierarchy of competence."	Understandings of underlying and implicit assumptions, presuppositions, etc.
Abstraction	"This event demonstrates how similar processes create these kinds of effects."	Abstraction involves developing models and creative connections between ideas.
Transformative Insight--Change at deepest personal & social levels	"Aha!!! I got it! It changes the way I see this..." "I never realized that I believed...., but I'm going to have to work on letting it influence my teaching."	At this level of transformation, our own and/or our particular social groups' assumptions are exposed and seen in terms of our practices, actions, speech, and contexts within which we function. It also can involve breakthroughs or insights at deeper levels. The result is a transformation or change in our fundamental beliefs, assumptions, goals, ideals, etc. Learning at this level is generally uncomfortable and sometimes even painful. Our basic patterns, assumptions, and beliefs may be challenged.

Recursive Learning for Transfer Instructional Plan Model



Pattern Thinking Instructional Plan Model



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