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Theory of Technology-Mediated Learning

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Overview

- Educational theories and key proponents
  - Behaviorism vs. constructivism
  - Instructionism vs. constructivism
- Cognitive constructivism vs. social constructivism
  - Child as active learner
  - Adaptation vs. Scaffolding
- Methods
  - From thinking-aloud to observation of verbal activity
- Role of digital technology (WISE)
- Activity theory

Goals for this lecture

- Basic understanding of key constructivist and sociocultural concepts
- How key ideas have been developed by researchers over long time
- Understand how these theories and ideas can be used in the analysis of *use* and *design* of digital learning technologies
- More about the latter part will follow Aug 30

Educational theories: schisms

- Behaviorism vs. constructivism
  - Basic dichotomy in psychology of education
  - Do we learn "in the world" or in the mind/brain by operating on conceptual representations?
  - Is knowledge objective or subjective?
- Instructionism vs. constructivism
  - Do we learn from teachers and assigned tasks or from ourselves and the goals we set to improve our current knowledge with new experiences?

Constructivist theories: Key proponents we address some of

- Piaget (father of constructivism)
- Vygotsky (father of social constructivism)
- Wertsch (sociocultural theory)
- Linn & Eylon (knowledge integration theory)
- Papert (constructionism)
- Engeström (activity theory)

Literature

- Vygotsky, L.S. (1978). Internalization of Higher Psychological Functions, ch. 4 (pp. 52-57) and Interaction between learning and development, ch. 6 (pp. 79– 91) in *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University.
- Wertsch, J. V. (1991). Prerequisites (pp. 6-17) and Mediation (pp. 28-46) in *Voices of the mind: A sociocultural approach to mediated action*. Cambridge, MA: Harvard University Press.
- Linn, M. C. & Eylon, B.-S. 2011. *Science Learning and Instruction: Taking Advantage of Technology to Promote Knowledge Integration*. New York: Routledge, pp. 100-147 (ch. 5-6)
- Verenikina, I. (2010). Vygotsky in twenty-first-century research. *Proc. World Conference on Educational Multimedia, Hypermedia and Telecommunications,* vol. 1, pp. 16-25.

Key concepts in Piaget's theory

- Adaptation (how children acquire knowledge)
  - Assimilation
  - Accommodation
- Children are active learners modeled after stages of cognitive development
  - Sensorimotor stage: birth to 2 years
  - Preoperational stage: ages 2 to 7
  - Concrete operational stage: ages 7 to 11
  - Formal operational stage: ages 12 and up

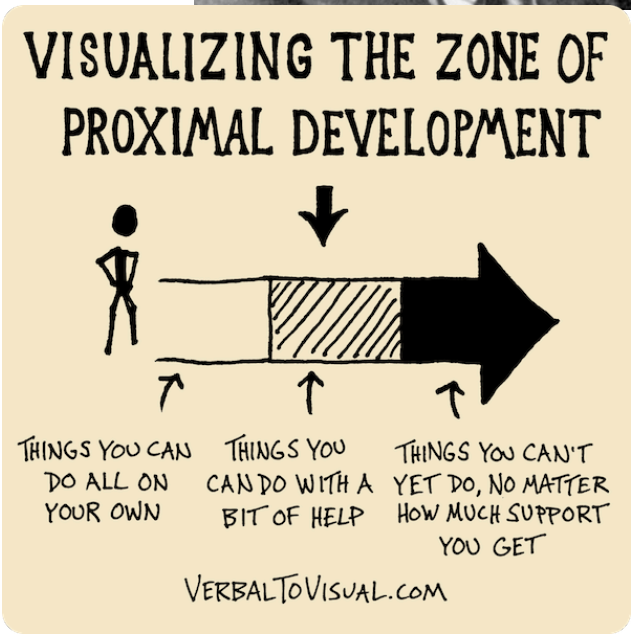
Piaget: adaptation

- *Assimilation*: Using existing knowledge structure (schema) to deal with a new object or information in the environment
- *Accommodation*: Altering existing knowledge structure to create a new named concept to deal with a new object or information in the environment
- E.g. Apple or pear?

Piaget: It depends on what you already know of apples and pears!!

Key concepts of Vygotsky

- Explain the relationship between human (mental) processes and cultural, historical, and institutional processes ("cultural recapitulation")
  - Two levels of change
- Zone of proximal development (referred to as scaffolding)
- Instruction help the learner achieve tasks that would be impossible without such guidance



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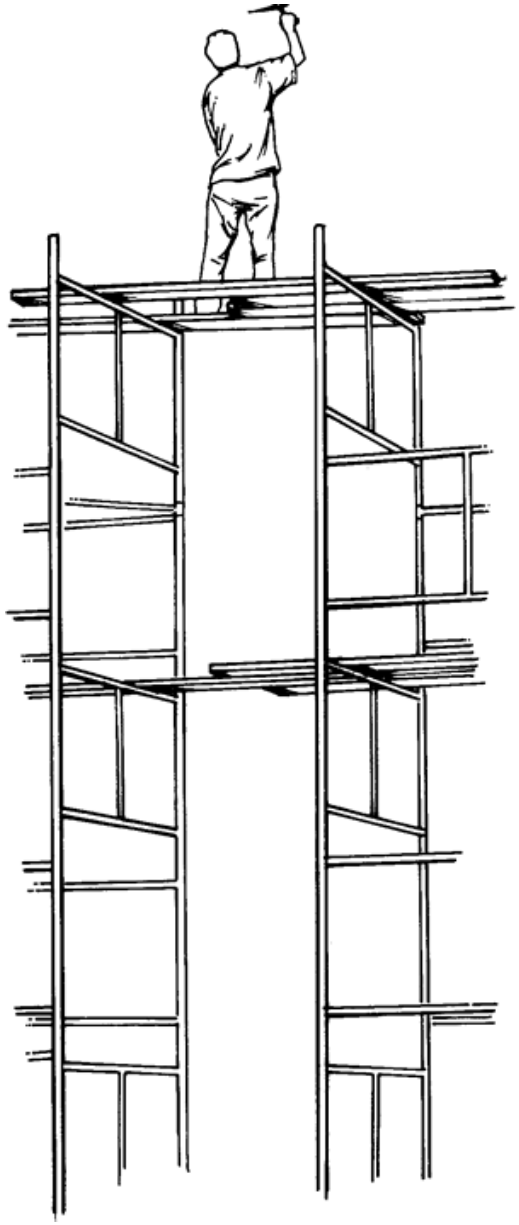
Scaffolding

- Initiatives to support the student to move from their current to their potential level of development.
  - Procedural initiatives: Tasks.
  - Conceptual initiatives: Dialogue emphasizing conceptual contexts
  - Social Initiatives: Guidelines for Talking, Group Breakdown.



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Interaction of learning and development

- Development is associated with (biological) maturity
- Teaching can speed up learning so that learning can lead development, according to V
- New representations can make tasks that at first seemed impossible become possible
- Therefore learning can lead development, which is contrary to what Piaget argued

Key concepts in sociocultural theory in English (Wertsch)

- Mediation
  - Actions and mental functions take place through cultural artifacts
  - Mediation was triggered by the short-comings stimulus-response theory of B.
- Two types of artifact can mediate:
  - Tool (physical) and sign (conceptual)
- Language is the most important cultural artifact, according to Vygotsky

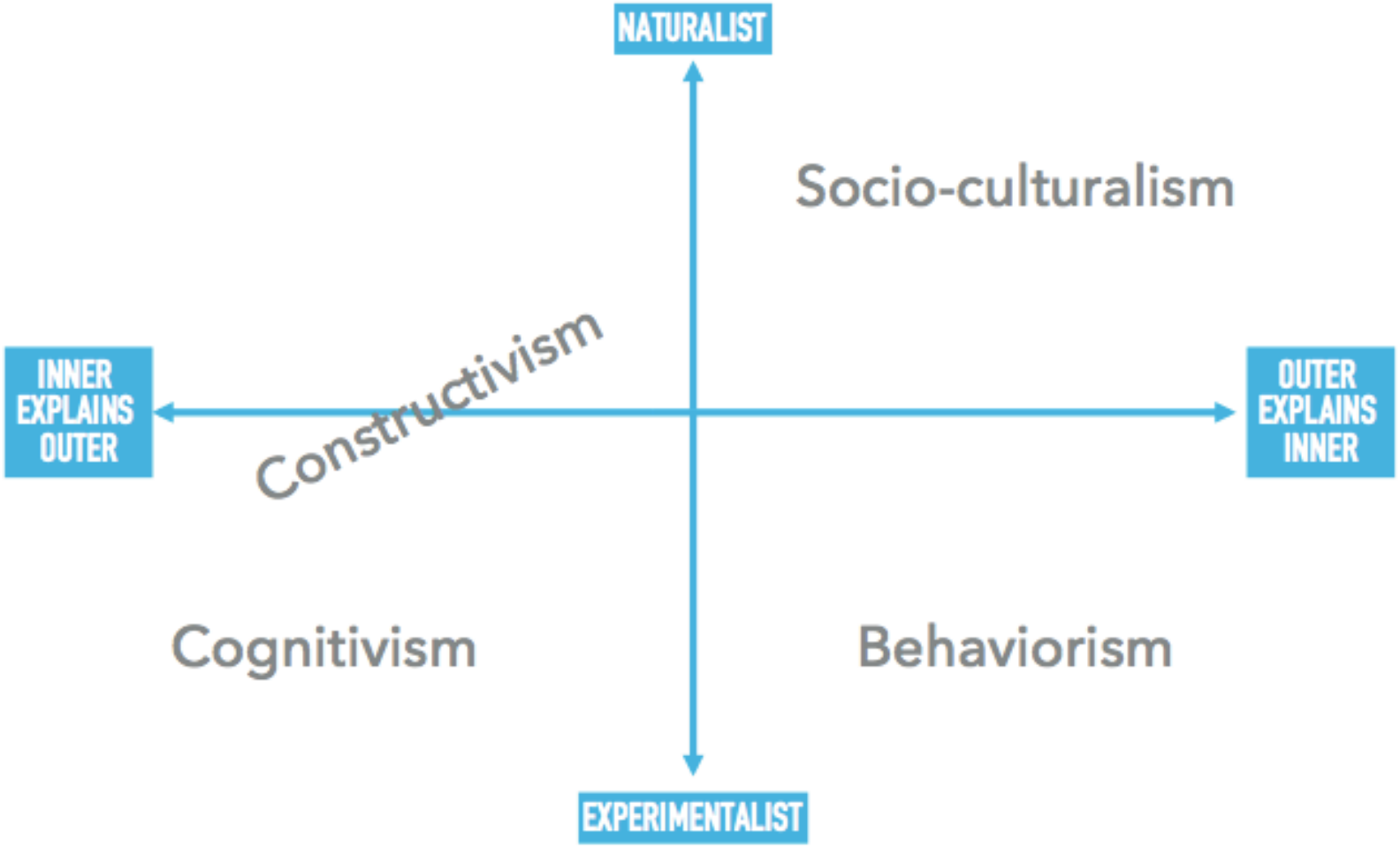
Tools and signs

- Tools
  - Hammer, computers, computer programs
  - Orients outwards, towards the object / nature
- Signs
  - Letters, symbols, words, expressions,
  - Orients inwards; towards the individual
- Language / dialogue
  - Used in communication, inward and outward

Developmental verbal learning

- Vygotsky, alongside Piaget, considered learning mainly a verbal process, passing through stages, starting in the social (external) environment and later appearing internally in the mind of the child as independent thought
  1. External social language (external speech)
  2. Ego-centric speech (thinking aloud)
  3. Inner speech (thought)
- The model is not linear; stages are interdependent (more like back and forth; partially cyclical)

THE SOCIO-CULTURAL POSITION



Knowledge integration theory

- Linn & Eylon combine ideas from Piaget and Vygotsky
- *From Piaget*: Encourage students to build on their ideas; learning starts with concrete experiences
- From Vygotsky: Instruction and scaffolding
- Suggest a set of principles to promote what they call "knowledge integration", which are supported by instructions and computer support

Knowledge integration (KI)

- Focuses on understanding instead of memory
- It is based on the student's own ideas (Linn used Piaget's "clinical method" in her early research)
- From empirical studies of KI, there emerged:
  - Principles of KI
  - Examples of design patterns that promote KI
- KI makes use of digital technology to support it
  - Web resources, simulations, visualizations
  - Investigations and experimentation faster ...

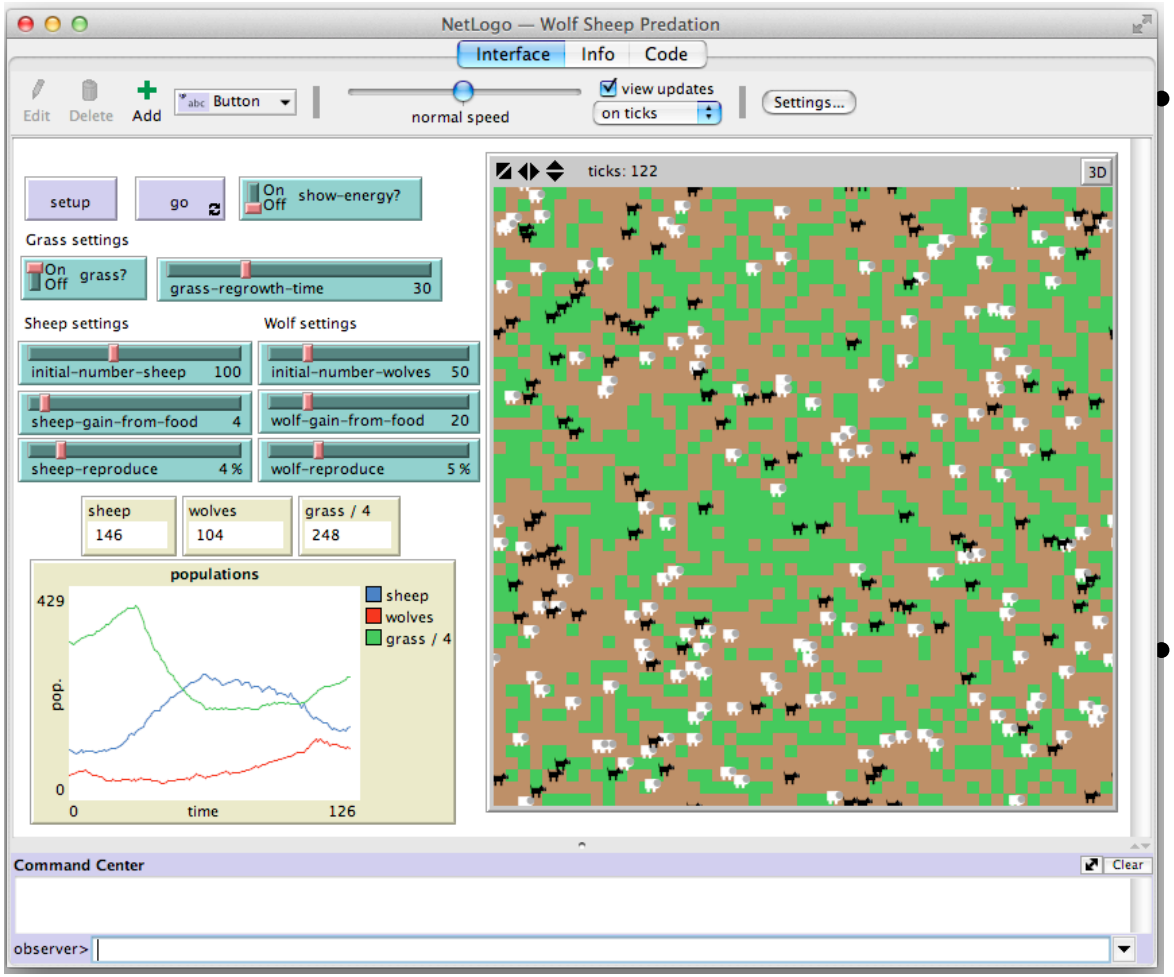
Principles of knowledge integration

- Making science available to all students (personal relevance)
  - Constructivist principle
- Make thoughts visible (internalization, externalization)
- Collaboration (internalization, externalization)
  - Social constructivist principle
- Promote lifelong methods for learning

Examples of patterns (instructional processes) that promote KI

- Explain existing ideas
  - teacher: "What do you think happens if ..."
  - learner: "I mean that ..."
- Add new, normative scientific ideas
  - Experiment, simulate what happens if …
  - Research shows that…
- Criteria
  - Valid conditions if the process is detected, arguments
- Sort the ideas
  - What ideas do you think are best given the criteria?
  - Why is not this idea good?

WISE: digital learning environment



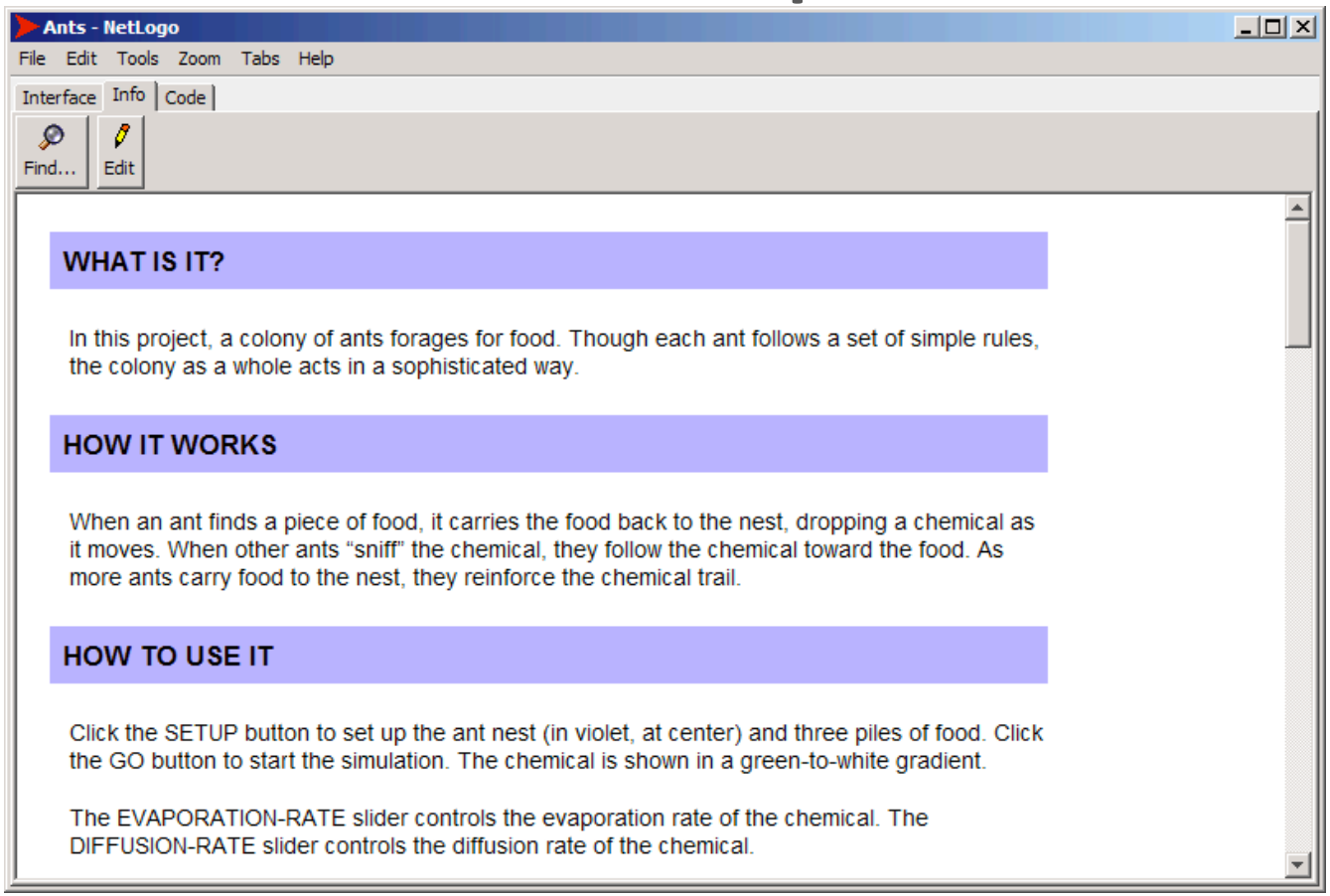
- WISE supports the KI collaborative learning process in terms of stages of activity, prompted by the patterns and principles
- Simulations are described in a scripting language

WISE: simulation language

Diagram | Procedures

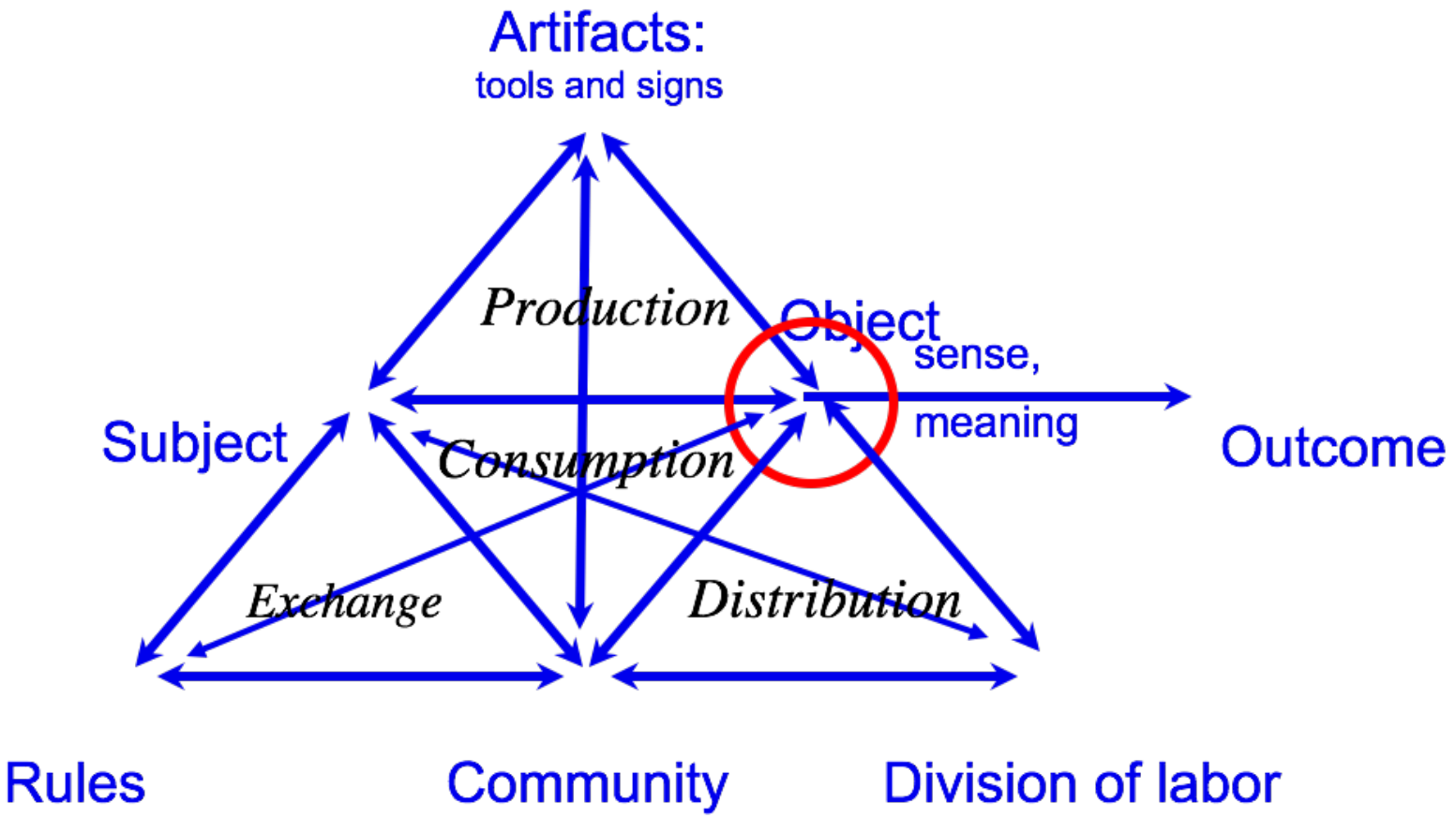
```
;; System dynamics model globals
globals [
  ;; constants
  sheep-birth-rate
  ;; stock values
  sheep
  ;; size of each step, see SYSTEM-DYNAMICS-GO
  dt
]

;; Initializes the system dynamics model.
;; Call this in your model's SETUP procedure.
to system-dynamics-setup
  reset-ticks
  set dt 0.1
  ;; initialize constant values
  set sheep-birth-rate .04
  ;; initialize stock values
  set sheep 100
end

;; Step through the system dynamics model by performing next iteration of Euler's method.
;; Call this in your model's GO procedure.
to system-dynamics-go

  ;; compute variable and flow values once per step
  let local-sheep-births sheep-births
```

WISE: Task description



WISE: Reflection prompts

Activity theory



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