Learning Theories and Education: Toward a Decade of Synergy

John Bransford et al.

The LIFE Center

The University of Washington, Stanford University & SRI International

Virginia Tech

About Me

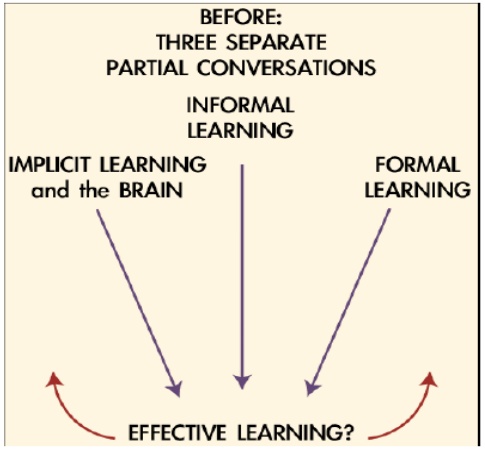
- Tung Dao, Ph.D. student in CS
- Work in software engineering with Dr. Edwards
- B.S, M.S. from Vietnam and Korea respectively
- From Vietnam

Motivation

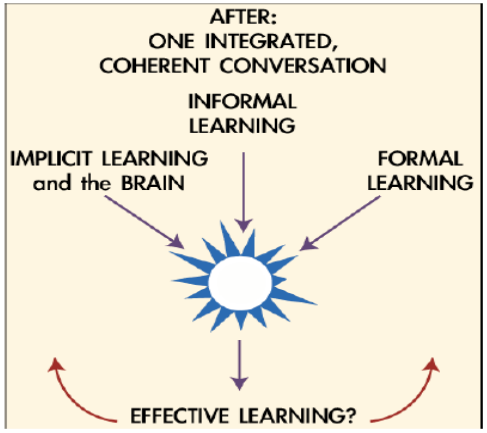
- Questions to answer in the paper:
  - Why do we need to understand or think about how people learn?
  - How do people learn? By which learning theories?
  - What are the problems with the existing learning theories?
  - How can we come up with better learning theories?
- Questions related to computational thinking (CT):
  - Can learning theories be applicable to the domain of CT (learning and teaching)?
  - Should we have its own CT learning theories?

Paper Summarization

- Literature review of learning theories and education:
  - Implicit learning and the brain
  - Informal learning
  - Formal learning and beyond



- Synergy of these theories to create, for the next ten years, more efficient and better learning and education theories:
  - Share methodologies
  - Share tools
  - Actively identify “conceptual collisions”



Implicit Learning

- Definition: “information that is acquired effortlessly and sometimes unconsciously…”
- Examples: visual pattern learning, early speech learning, syntactic language learning, young children’s imitative learning of tools/artifact behaviors, customs, etc.
- Occurs in many domains: skill learning, language learning, learning about people (social cognition)
- Plays an important role, starts early in life, and continues across the life span
- Studies of the brain (neuroscience) can reveal more about implicit learning

Discussion

- Can people learn CT implicitly? If yes, how do we engage in implicit learning of CT? Examples?

Brain Science: Misconceptions and Findings

- The brain at birth: "*is entirely formed at birth*"
  - But it is incorrect, because of … the processes of "overproducing" and "pruning" synapses
    - Explain for changes in brain during its development
  - Brain development is product of complex interaction of both nature and the rest

- Critical periods for learning: *"the ability to learn certain kinds of information shuts down if the critical period is missed"*
  - However, … "brain is more plastic"; and the critical period varies significantly among domains, e.g., visual, auditory, language
  - So, "critical or sensitive periods" only hold to some extend
  - Findings: "neural commitment", and "mental filter"
  - Filters in: attention, structure perception, thought, emotion
  - "Expertise" in many areas reflects this "metal filter"
    - Enable us to think efficiently, fast; but, might limit our ability to think in novel ways

Discussion

- Does “neural commitment” or “critical periods” apply to learning CT?
  - Is that harder for those outside computer science or computing areas to learn CT?
  - At which ages (e.g., elementary, middle, high school, university) are best to learning CT?

Neuroplasticity

- Babies learn new languages better than adults
  - Infants' system is not thoroughly committed
  - Be able to develop more than one "mental filter"
  - Through social interaction
- "Complexities" of live/social interaction enhances infants' learning
- It might be good that initial learning should take into account the full complexity, in terms of transfer, and generalization

Discussion

- How does social interaction help, if any, learning CT?
- Does the “complexities” strategy work in the domain of learning CT? i.e., initially teach something complex first?

Informal Learning

- Definition: “learning that happens in designed, non-school public settings such as museums, zoos, and after-school clubs, homes, playgrounds, among peers… where designed and planed agenda is not authoritatively sustained over time.”
- Most of people’s activities and time involve in informal learning: during school age years, 79% of a child’s waking activities are spent in non-school settings; of the human life span is more than 90%
- While it is a good alternative to schools, concerns include:
  - Lead people to naïve and misconceived ideas
  - Quality of thinking and practices
  - Lack of thinking and the consumption of a degraded popular culture

Discussion

- Can we informally learn CT? and How to avoid misleading, lack of thinking quality when we do informal learning in CT?

Informal Learning: Principles and Contributions

- The role and meaning of context in learning
  - Context has two related "senses":
    - Setting-based: for example, "work", "play", "school", and "street", forming bases for comparative analysis
    - Comparisons across settings, in terms of activities, forms of participation, types of interaction
    - Example: dinner-table conversations of middle-class families
    - Expectations of learning in different contexts are different
- New ways to understand how people learn
  - How does learning happen in non-school settings?
    - Through "keen observation and listening, intent concentration, collaborative participation"
- What changes when people learn
  - Individual mental concepts, mental processes (e.g., reasoning strategies)
  - Forms of participations
  - Identities
  - Tool-mediated, embodied skills

Discussion

- What are contexts in learning CT? How do we classify or define contexts in such a way that help learning CT best?

Informal Learning: Research Directions

- Within-context studies
  - How to organize/categorize contextual aspects?
    - Hierarchies (e.g., concrete/abstract)
    - Distinctions (e.g., expert/novice)
      - Formal vs. informal classification is limiting because of homogeneity
  - Even what constitutes a “context” is an open question
  - How is learning organized in contexts?
- Across-context studies
  - How people learn and develop as they make transitions across contexts?
    - A long temporal dimensions, for example, synchronic and diachronic

Discussion

- Should we embed teaching CT within-domain (context) or across-domain (context)? what are pros and cons?

Design for Formal Learning

- The use of knowledge about learning to create designs for formal learning and school redesign
- Creating effective learning environments:
  - What do we want students to know and able to do?
  - How will we know if we are successful, i.e., what kind of assessments do we need?
  - How to help students meet learning goals?

Discussion

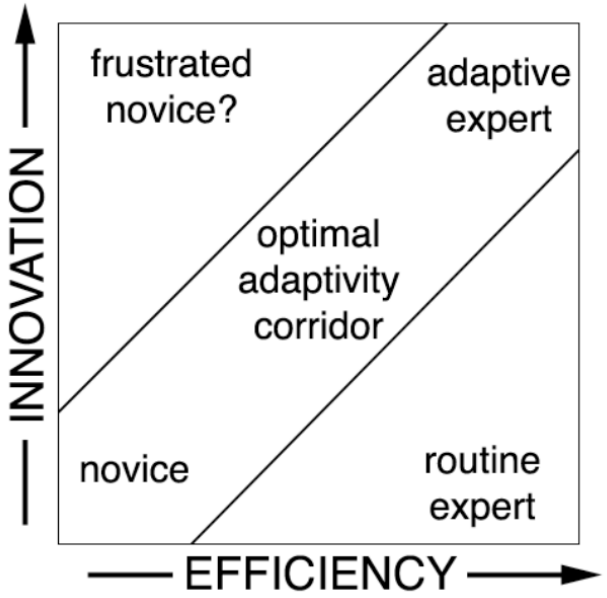
- If experts are not always good teachers, then who best teach CT?

Expertise Lessons

- Noticing and paying attention
- Knowledge organization
  - Support effective reasoning and problem solving
  - Prioritized into:
    - Enduring ideas of the discipline
    - Important things to know
    - Ideas worth mentioning
- Expertise and teaching
  - Relationship between expert knowledge and teaching abilities
  - Expert blind spots

Adaptive Expertise

- Being both innovative and efficient *vs.* being only efficient (routine expert)
- Willingly and able to change core competencies and continually expand knowledge deeply and broadly
- Required to leave "comfort zones" often
- Being "intelligent novices"



Discussion

- Can/how CT help us to become adaptive expertise?
- How to avoid “comfort zones” when learning CT?
- How deep and broad should we learn/teach CT?

Assessments

- Summative assessment
  - How students perform at the end of some course?
- Formative assessment
  - Measures designed to provide feedback to students and teachers
- How to design assessments of being "adaptive expertise"

Efficiency Assessments

- Sensitive to well-established routines and schema-driven processing
- Capture people's abilities to directly apply the procedures and schemas learned in the past to new settings
- Often be summative measures as standardized tests, e.g., sequestered problem solving assessments (SPS)
- Fail to assess adaptive expertise

Beyond Efficiency Measures

- Premise is people learn for their whole life
- Assessments emphasize on “preparation for future learning” (FPL), instead of SPS
- Assessments should be able to measure adaptive expertise

Discussion

- What are assessments in CT?
- How do we know someone is routine expert or adaptive expert in CT?

Toward a decade of synthesis

- Sharing methodologies
  - Combine research in strand 1 of neuroscience, linguistics, and social-cognition with the use of ethnographic analyses
  - Coordination of ethnographic, lab-based, classroom intervention research
- Perspectives on people knowledge and the social brain
  - Cooperative and collaborative learning
    - Groups outperform individuals
    - Friends have better conversations during problem-solving than acquaintances
    - Students learn better about contents if they know who develop the contents
- Sharing research tools
- Searching for “conceptual collisions”
  - Multiple or different perspectives on similar phenomena
  - Resolve conceptual collisions can effectively contribute to communications among the strands, and ultimately help learning
  - Uncover conceptual collisions with learning principles: preconceptions, learning with understanding, and metacognition

Preconceptions

- All learners begin with preconceptions, or existing efficiencies—habitual ways of thinking about or doing things
- Equivalent with “neural commitment” or “mental filter” in the strand 1 research
- Disadvantages, e.g., learning a second language
- Therefore, new learning requires exposure to patterns of covariance or new instances frequently

Discussion

- How do we teach CT to those who do not have any preconceptions about CT?

Learning with Understanding

- Involve developing a recognition of the deep structure of an idea or situation, or understand “why”
- This can be achieved by social interaction and practices: learning through observing the behaviors and customs of others
- Learning with understanding transfer better than “brute learning”

Discussion

- How do we know if students understand concepts in CT, given the fact that some concepts are abstract?

Metacognition

- Mindset or habits of self-generated inquiry, self-assessment, self-explanation, self-reflection
- Metacognition helps learners have a deeper conceptual understanding in, for example, math, science learning
- Strand 1 emphasizes on the “social brain” metacognition, i.e., natural adjustment to other people… to bootstrap more conscious and metacognitive ways of self-thoughts or others’
- Strand 2 focuses on the social and cultural contexts of metacognition
- Strand 3’s emphasis on metacognition that supports adaptation and innovation, i.e., adaptive expertise

Discussion

- How does metacognition work in learning CT?

Thank You!

- Any questions or comments?