



Center for  
**LifeLong  
Learning  
& Design**

University of Colorado at Boulder

Wisdom is not the product of schooling  
but the lifelong attempt to acquire it.  
- Albert Einstein

## Overview of Learning

Gerhard Fischer and Hal Eden  
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# A Chinese Saying

I hear and I forget,

I see and I remember,

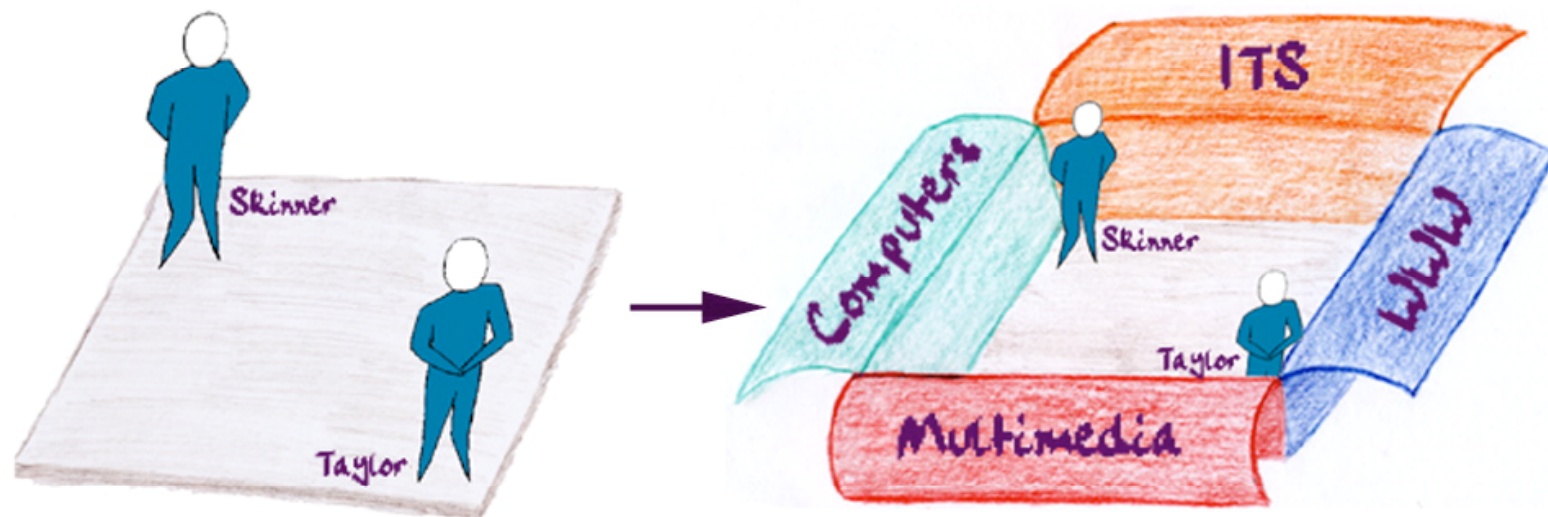
I do and I understand.

## Some Claims about Learning

- people learn best when engrossed in the topic, motivated to seek out new knowledge and skills because they need them in order to solve the problem at hand
- real learning — the way we learn is trying something, doing it and getting stuck. In order to learn, we really have to be stuck, and when we're stuck we are ready for the critical piece of information. The same piece of information that made no impact at a lecture makes a dramatic impact when we're ready for it.
- *"A major illusion on which the school system rests is that most learning is the result of teaching"* — Ivan Illich (in "Deschooling Society")
- learning and teaching are not inherently linked:
  - much learning takes place without teaching
  - much teaching takes place without learning

# Learning and Media

## Adding Technology to Existing Educational Practice

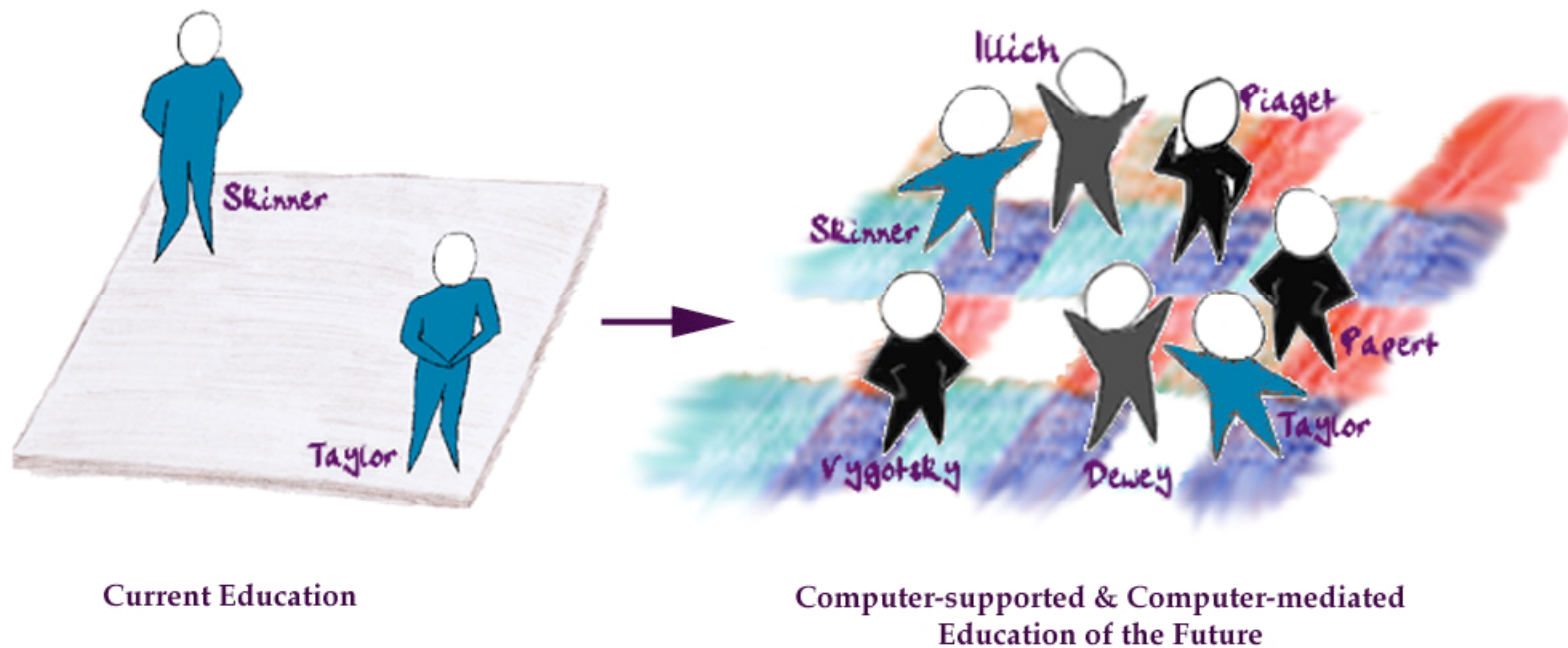


Current Education

Current Education  
wrapped in Technology

# Learning and Media

## Rethinking, Reinventing and Reengineering Educational Theory and Educational Practice



# How the World Has Changed

<b>dimension</b>	<b>old paradigm</b>	<b>new paradigm</b>
<b>information</b>	scarce	plentiful
<b>reproduction of documents</b>	expensive and restricted	cheap
<b>specialization</b>	low	high
<b>change within a human life time</b>	slow	fast
<b>interaction / collaboration</b>	physical proximity	shared professional interests
<b>economy</b>	rigid, hierarchical organizations, long-term personal identity	dynamic economy, flexibility, networking, no long-term

# Learning in Humans and Machines

- **machine learning** = subfield of AI concerned with programs that learn from experience
  - **applied learning systems — a practical necessity?**
    - \* to overcome the tedious work of programming
    - \* the ultimate form of knowledge acquisition in knowledge-based systems
  - **machine learning as a science**
    - \* understand human learning well enough to reproduce aspects of that learning behavior in computer systems
    - \* computer enforces a commitment to fine-structure process-level detail
    - \* exploration of alternative learning mechanism complementing human learning methods
- **in this course:** we are interested in computational media and environments in support of **human learning** (specifically in the context of design and collaboration)

# Global Theories about Learning

- **B. F. Skinner (1904 – 1990)**— behavior is affected by its consequences. We reward and punish people, for example, so that they will behave in different ways. → [programmed instruction, multiple choice questions](#)
- **Jean Piaget (1896-1980)** — developmental psychology and genetic epistemology: how does knowledge grow? → [children's logic and modes of thinking are initially entirely different from those of adults](#)
- **Lev Vygotsky (1896-1934)** — social interaction plays a fundamental role in the development of cognition → [computer-supported collaborative learning \(CSCL\)](#)
- **John Dewey (1859-1952)** — application of his theory of knowledge to education: informal education, passion for democracy (public versus private schools) → exploration of thinking and reflection, environments for learning



## **Jerome Bruner (1915 - ): Education and Learning**

- It is surely the case that schooling is only one small part of how a culture inducts the young into its canonical ways. Indeed, schooling may even be at odds with a culture's other ways of inducting the young into the requirements of communal living.
- What has become increasingly clear is that education is not just about conventional school matters like curriculum or standards or testing. What we resolve to do in school only makes sense when considered in the broader context of what the society intends to accomplish through its educational investment in the young.
- How one conceives of education, we have finally come to recognize, is a function of how one conceives of culture and its aims, professed and otherwise.

# Global Theories about Learning

- **Ivan Illich** — convivial tools, deschooling society → learning webs
- **Seymour Papert** — constructionism → LOGO, Turtle Geometry
- **Frederick W. Taylor (1856-1915)** — scientific management: the study of relationships between people and tasks for the purpose of redesigning the work process to increase efficiency

# Transcending Skinner and Taylor

Skinner/Taylor		Beyond Skinner and Taylor	
there is a “scientific,” best way to learn and to work (programmed instruction, computer-assisted instruction, production lines, waterfall models)	→	real problems are ill-defined and wicked; design is argumentative, characterized by a symmetry of ignorance among stakeholders	
separation of thinking, doing, and learning	→	integration of thinking, doing, and learning	
task domains can be completely understood	→	understanding is partial; coverage is impossible	
objective ways to decompose problems into standardizable actions	→	subjective, situated personal interests; need for iterative explorations	
all relevant knowledge can be explicitly articulated	→	much knowledge is tacit and relies on tacit skills	
teacher / manager as oracle	→	teacher / manager as facilitator or coach	
operational environment: mass markets, simple products and processes, slow change, certainty	→	customer orientation, complex products and processes, rapid and substantial change, uncertainty and conflicts	

# Learning: Current Theories

- learning is a process of **knowledge construction**, not of knowledge recording or absorption
- learning is **knowledge-dependent**; people use their existing knowledge to construct new knowledge
- learning is highly **tuned to the situation** in which it takes place
- learning needs to account for **distributed cognition** requiring to combine knowledge in the head with knowledge in the world
- learning is affected as much by **motivational issues** as by cognitive issues
- **learning and teaching are not inherently linked** (“much learning takes place without teaching” — but: “much teaching takes place without learning”)

## Learning: Current Theories → Specific System Developments

- learning is a process of **knowledge construction**, not of knowledge recording or absorption → *reflection-in-action, argumentation*
- learning is **knowledge-dependent**; people use their existing knowledge to construct new knowledge → *differential descriptions, user models, personalization*
- learning is highly **tuned to the situation** in which it takes place → *human problem-domain communication, domain-oriented design environments*
- learning needs to account for **distributed cognition** requiring to combine knowledge in the head with knowledge in the world → *learning on demand, using on demand, Envisionment and Discovery Collaboratory*
- learning is affected as much by **motivational issues** as by cognitive issues → *gift cultures, an interest is a terrible thing to waste*
- **learning and teaching are not inherently linked** → *learning when the answer is not known, informed participation*

## **An Example: Learning about Gravity**

- teach about gravity  $\leftrightarrow$  letting people experience it
- use contradictions as a source for curiosity and insight
- ask interesting questions and let the students come up with answers
- use of new media (specifically Squeak = open source version of Smalltalk; used for Swikis and the Envisionment and Discovery Collaboratory)
- reinvent the classroom culture with new media

# **“Basic” Skills in the Age of Computational Media**

## ▪ **“basic” skills**

- question: if most job-relevant knowledge must be learned on demand what is the role of “basic” education?
- what is the critical background knowledge which makes learning on demand feasible?
- question: do “basic skills” change their meaning under the influence of technology?

## ▪ **example: influences / changes by hand-held calculators**

**step 1:** ignore the existence of the gadget

**step 2:** make people learn arithmetic, multiplication tables, long division, drawing square root by hands → and after they have it all mastered, they can use hand-held calculators

**step 3:** create / invent new calculators, which makes learning these skills more fun and creates a deeper understanding

**step 4:** find new ways to distribute responsibilities between humans and machines

- humans do the qualitative reasoning, use estimation skills
- machines do the detailed quantitative computations

**ask the same questions:** spelling checkers, grammar programs, assembly language, mathematica, training of pilots for today’s aircrafts, .....

# Motivation

- **claims:**

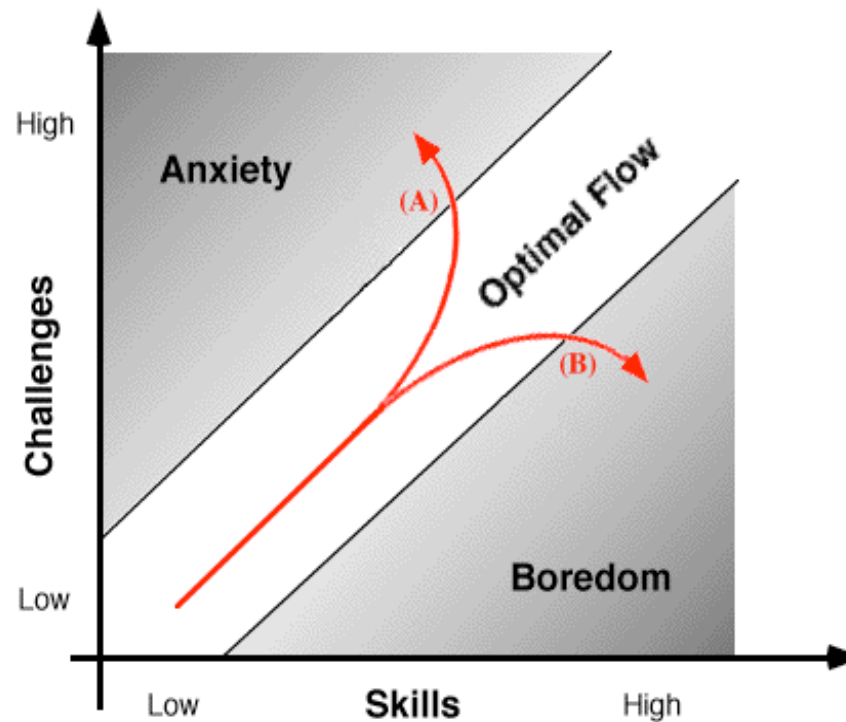
- the chief impediments to learning are not cognitive but motivational
- people can learn many things if they want to
- motivation is a tricky problem in learning because while it plays a major role, it is not well understood

- **impact of our approach on motivation:**

- make information relevant to the task at hand
- create interesting products
- provide multiple learning opportunities
- provide challenges matched to skill levels
- create communities (among peers, over the net)
- provide access to real practitioners and experts



# Optimal Flow as a Motivating and Driving Force in Learning



- **architectures and concepts for optimal flow:**
  - low threshold and high ceiling
  - increasingly complex micro-world
  - co-adaptive systems

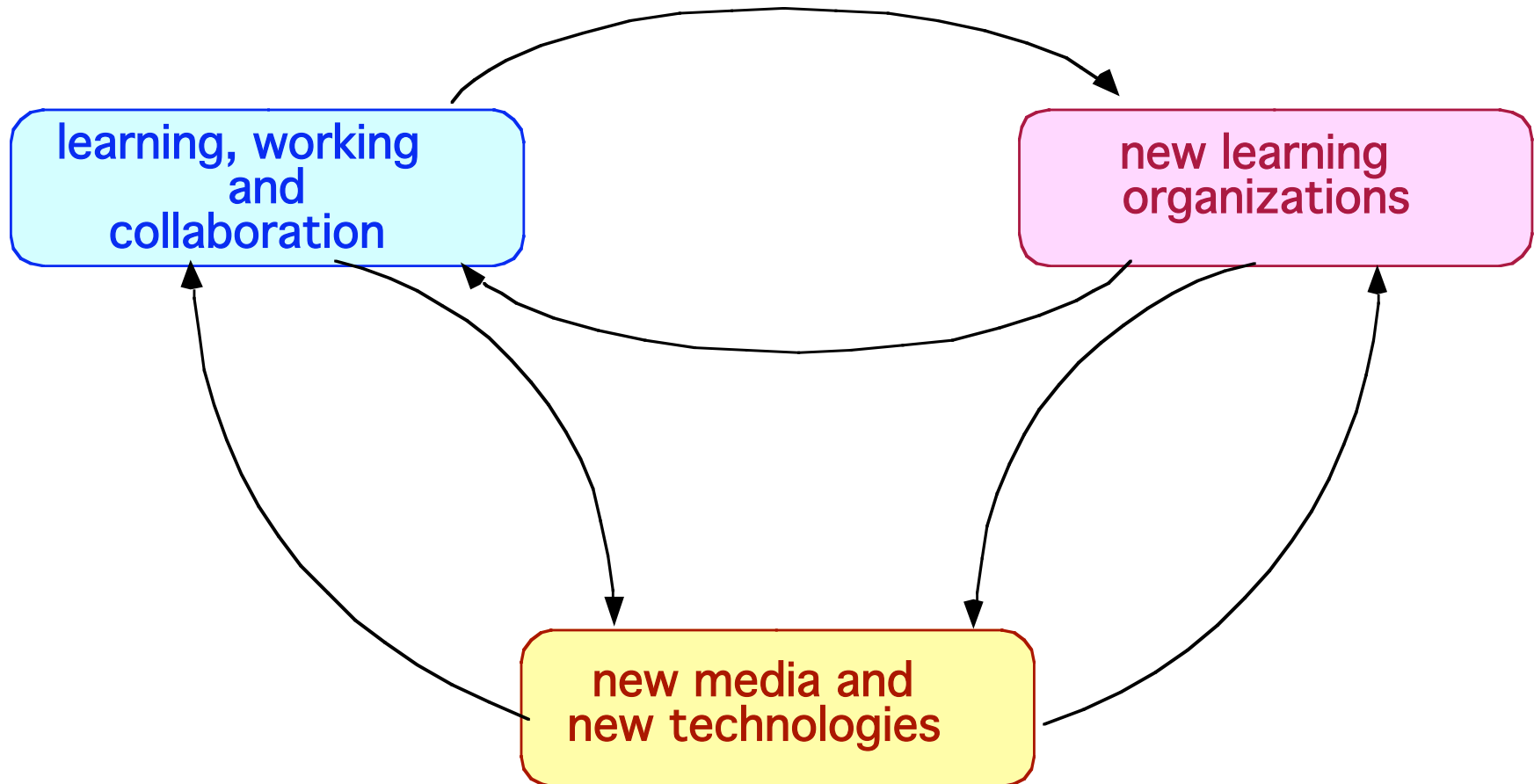
# Different Approaches to Learning

concept	definition	strengths	weaknesses	media support
learning by being told				
just-in-time learning				
learning on demand				
integration of working and learning				
self-directed learning				
discovery learning				
problem-based learning				
collaborative learning				
organizational learning				
lifelong learning				

# Myths and Misconceptions

- Computers by themselves will change education
- Information is a scarce resource
- “Ease of use” is the greatest challenge or the most desirable goal for new technologies
- The content, value, and quality of information and knowledge is improved just because it is offered in multi-media or over the WWW
- The “Nobel Prize winner” myth: Every school child will have access to a Nobel Prize winner
- The single or most important objective of computational media is reducing the cost of education

## ***Co-Evolution: Beyond “Technology-Driven Developments” and “Gift-Wrapping”***



## Some References about Learning

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