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

Lifelong Learning and its Impact on Human-Centered Computing

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LifeLong Learning

- more than “adult education” → tries to cover and unify all phases: intuitive learner (home), scholastic learner (school and university), skilled domain worker (workplace)

- integration of working and learning → learning is a new form of labor

- engagement in self-directed, authentic learning activities → see lecture about “Long Tail”

- learning on demand → coverage is impossible and obsolescence cannot be avoided → see lecture on domain-oriented design environments (reflection-in-action, critiquing)

- organizational and collaborative learning: the individual human mind is limited → see lecture on Envisionment and Discovery Collaboratory
# School Learning and Lifelong Learning

<table>
<thead>
<tr>
<th>School Learning</th>
<th>Lifelong Learning</th>
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<tbody>
<tr>
<td><strong>emphasis</strong></td>
<td>“basic” skills</td>
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<tr>
<td><strong>potential drawbacks</strong></td>
<td>decontextualized, not situated</td>
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<tr>
<td><strong>problems</strong></td>
<td>given</td>
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<td><strong>new topics</strong></td>
<td>defined by curricula</td>
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<td><strong>structure</strong></td>
<td>pedagogic or “logical” structure</td>
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<tr>
<td><strong>roles</strong></td>
<td>expert-novice model</td>
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<tr>
<td><strong>teachers</strong></td>
<td>expound subject matter</td>
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<tr>
<td><strong>mode</strong></td>
<td>instructionism (knowledge absorption)</td>
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</table>
Designing Technological Support for Lifelong Learning

- who is the teacher or the learner — computer or student?

- **the computer as teacher**
  - Programmed instruction
  - Computer-assisted instruction
  - Intelligent Tutoring Systems
  - Intelligent Agents

- **the students as teacher** → Interactive **programming** environments
  - LOGO, Smalltalk, Squeak, Scratch, Agentsheets, Hypergami
  - domain-oriented design environments

- **media and tools transcending the unaided, individual human mind**
  - interactive learning environments → simulation, visualization, critiquing, intelligent summarizing (*Movie: Learning about Gravity*)
  - computer-mediated communication and collaboration → Wikis, Warehouse
Create and share your own interactive stories, games, music, and art

Check out the 1,440,756 projects from around the world!

To create your own projects:

Download Scratch

Featured Projects

- Starcatcher
  by Echovoice

- Make a Face
  by bluefox12

- Happy Thanksgiving
  From: Enzo1997

Scratch Tours

New to Scratch? Take a tour to see what Scratchers are creating and sharing.

Take a tour

Video Tutorials

Check out our new collection of intro video tutorials.
Movie: Learning about Gravity

- teach about gravity ↔ 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 (Squeak = open source version of Smalltalk)

- reinvent the classroom culture with new media (beyond clickers)
Duality between Learning and Contributing

(supported by \textit{meta-design})

End-User Modifiability, End-User Programming

Learning on Demand
New Learning Environments for the 21st Century


- **21st century:**
  - the pace of change continues to increase
  - the world is becoming more interconnected and complex,
  - the knowledge economy requires more intellectual competencies

- **challenge:** find ways to tap the naturally occurring curiosities of learners to do more learning on their own
New Learning Environments for the 21st Century

- **most students today will not have a fixed, single career**
  - encompasses multiple careers
  - moving from career to career: much of what people will need to learn won’t be what they learned in school a decade earlier → they will have to be able to pick up new skills outside of today’s traditional educational institution

- **nearly all of the significant problems of tomorrow are likely to be systemic problems**
  - problems that can’t be addressed by any one specialty
  - learners need to feel comfortable working in cross disciplinary teams that encompass multiple ways of knowing
Our Credo of Lifelong Learning

- **assumption**: If the world of working and living relies on *collaboration, creativity, definition and framing of problems* and if it requires dealing with *uncertainty, change, and intelligence that is distributed* across minds, cultures, disciplines, and tools

- **consequence**: education should foster on competencies that prepare students for having meaningful and productive lives in such a world
Beyond a Divided Lifetime: the Fallacy of the “Big Switch” Approach

- **the problem:** the gap between school-based learning and learning in practical settings

- **misleading assumption:** humans at a certain age will be able to throw the “big switch” and become self-directed learners, engage in problem framing, communication, and collaboration..... — after they have not experienced and practiced this during their the first 30 or 40 years of their lives

- **goal:** close the gap between school and workplace learning
  - allow learners to engage in activities requiring collaboration, creativity, problem framing, and use of powerful tools
  - integrate learning into working and playing instead of conceptualizing it as a separate activity
Mindsets — The Fallacy of the “Big Switch” Model

The “Big Switch” Model
An alternative model

- instruction
- access
- individual performance
- solve given problems
- tool-free environment
- self-directed learning
- informed participation
- collaboration
- problem framing
- learning on demand
- communication

school university work
Science of Learning

- “A decade of interdisciplinary research on everyday cognition demonstrates that school-based learning, and learning in practical settings, have significant discontinuities. We can no longer assume that what we discover about learning in schools is sufficient for a theory of human learning.” — Scribner and Sachs

- “In important transformations of our personal lives and organizational practices, we must learn new forms of activity which are not there yet. They are literally learned as they are being created. There is no competent teacher. Standard learning theories have little to offer if one wants to understand these processes.” — Yrjö Engeström
Formal and Informal Learning?

<source: LIFE Center, University of Wash + Stanford>
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, long tail learning

- Learning and teaching are not inherently linked → learning when the answer is not known, informed participation
Hand-Held Calculators — What Do Learning Scientists Have to Say?

- **position 1**: ignore the existence of the gadget; we are not interested in technology, but in important mathematical skills — do *not use* hand-held calculators in schools.

- **position 2**: keep the curriculum the same, make children learn arithmetic, multiplication tables, long division, drawing square root by hands — *after* they have it all mastered, allow the use of hand-held calculators.

- **position 3**: create new calculators, new curricula, new scaffolding mechanisms that make learning these skills more fun and create a deeper understanding of underlying concepts — using these hand-held calculators, the learners would acquire the skills and the knowledge and eventually become *independent* of the gadget ("scaffolding with fading", "tools for learning").

- **position 4**: find new ways to *distribute responsibilities between humans and machines* such that humans do the qualitative reasoning, use estimation skills, relate the mathematical result to the real world and machines do the detailed quantitative computations ("distributed intelligence", "tools for living").
Basic Skills in the 21st Century?

<source: John Anderson in Cognitive Science Panel 1993 about “learning on demand”>

- If most job-relevant knowledge must be learned on demand what is the role for basic education?

- consider the role of a traditional high school mathematics education
  - there is a general perception that American children are poorly prepared in mathematics and that this is part of the reason for our lack of international competitiveness
  - the kind of mathematics that American schools fail at teaching (and which other countries excel at) has increasingly little relationship to work performance
  - almost all of the mathematics that students learn in traditional high school mathematics is job-irrelevant (e.g., doing proofs in geometry) or now automated (e.g., algebraic symbol manipulation).
  - most people’s on-the-job contact with mathematics (if they have any) will be in using tables and software packages based on mathematics

- perhaps
  - the function of a high-school mathematics education is to train students to intelligently use these mathematical artifacts
  - perhaps we need only teach traditional mathematics to a small minority of the population who will maintain these systems
Old Model: Learn in School what is Needed in Life
Problem with the Old Model in Today’s World

Coverage and Obsolescence
Distributed Cognition

- **claim:** distributed intelligence provides an effective theoretical framework for understanding what humans can achieve and how artifacts, tools, and socio-technical environments can be designed and evaluated to empower humans beings and changing tasks.

- **forms of distribution:**
  - between internal and external structures
    - internal structures: memory, attention, executive function (internal scripts)
    - external resources: artifacts, oeuvres, tools (external scripts)
  - across the members of a social group → leading to social creativity, facilitated by systems such as the EDC
  - throughout time (design time / use time, meta-design, long-term, indirect collaboration)

- **claim:** working with people with **cognitive disabilities**
  - creates new unique challenges for theories about distributed intelligence
  - provides a deeper understanding of distributed intelligence
Distributed Cognition

- **traditional view:**
  - human cognition has been seen as existing solely ‘inside’ a person’s head
  - studies on cognition have disregarded the social, physical, and artifactual surroundings in which cognition takes place

- **claim:** in real life (in contrast to the classroom and the psychological laboratory) mental work is rarely done without the assistance of tools

- **differentiate between:** Tools for Living ↔ Tools for Learning
# Tools for Living ↔ Tools for Learning

<table>
<thead>
<tr>
<th>Definition</th>
<th>Tools for Living</th>
<th>Tools for Learning</th>
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<tbody>
<tr>
<td>do task with tools</td>
<td>do tasks without tools</td>
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<tr>
<th>Examples</th>
<th>Tools for Living</th>
<th>Tools for Learning</th>
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<tr>
<td>eye glasses, phone, radar, cockpits, scuba diving gear</td>
<td>spelling correctors, hand-held calculators, tricycles, wizards,</td>
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<th>Tools for Living</th>
<th>Tools for Learning</th>
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<td>spelling correctors, hand-held calculators, tricycles, wizards</td>
<td>learning Braille, learning how to use prompts, learning a bus route</td>
<td></td>
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<th>prompting systems (MAPS)</th>
<th>Tools for Living</th>
<th>Tools for Learning</th>
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<tbody>
<tr>
<td>for people with memory problems (disabilities, elderly)</td>
<td>for people without memory problems (but: people use calendars on paper, reminding systems)</td>
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<th>distributed cognition perspective</th>
<th>Tools for Living</th>
<th>Tools for Learning</th>
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<td>resource rich (professional life)</td>
<td>become independent of external resources (school)</td>
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Over-Reliance on Tools for Living

"Nurse, get on the internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon."
Assessment Dimensions

- **over-reliance on tools for living** → does it lead to *learned helplessness* and *deskilling*, ruining the users native abilities by making them dependent on the tool?

- **beyond human capabilities** → under which conditions are tools for learning (and the associated “scaffolding with fading”) simply out of the question (e.g. advanced visualization tools, simulation tools, critiquing tools, .... that *complement* human cognitive abilities and thereby preclude internalization of the functions they provide)?

- **values in our culture** → how do new cultural values change our thinking about tools for living versus tools for learning in a world that is characterized by pervasive computing, always-on Internet access, reliable service networks, and sufficient level of technological fluency?
New Possibility for 21st Century Learningscapes

- a hybrid model of learning \(\rightarrow\) combine
  - the power of passion-based participation in niche communities of practice \(\rightarrow\) the tail of the long tail
  - core curriculum for teaching the rigorous thinking and argumentation specific to that field \(\rightarrow\) the head of the long tail

- assumption: given the nearly infinite number of niche communities that exist on the net \(\rightarrow\) nearly every student of any age will find something that he or she is passionate about
Learners and Teachers
School and Cultural Literacy
Teacher, Learner = f{person} → f {context}

- today’s students are “digital natives”— they engage in Facebook, Second Life, Flickr, YouTube, World of Warcraft, Wikipedia, Open Source

- exploit the “symmetry of ignorance” as a source of power
Areas of Tension in Technology Enhanced Learning

- data tracking for personalized learning $\leftrightarrow$ data privacy
- digital divide despite technology spread
- ubiquitous learning opportunities $\leftrightarrow$ focused and critical processing of information
- approved practices $\leftrightarrow$ continuous innovation in the classroom
- individual learning paths $\leftrightarrow$ standardized learning paths
Outsourcing — Will CS Students find a Job in the USA?

- **an emerging question** for prospective computer science students: “if the heart and soul of computing (programming) is being auctioned off to the lowest offshore bidder, what is the future for me?”

- **question**: what will be the computing jobs, skills, and knowledge that are less likely to migrate offshore

- **my claim**: activities related to upstream activities: communication, collaboration, design, context, integration of problem framing and problem solving, deal with fuzzy and shifting requirements, satisfy customers → these are the difficult and important problems