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

The Social and Technological Dimensions of Scaffolding and Related Theoretical Concepts for Learning, Education, and Human Activity

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Pea, R. D. (2004) "The Social and Technological Dimensions of Scaffolding and Related Theoretical Concepts for Learning, Education, and Human Activity,"
The Journal of the Learning Sciences, 13(3), pp. 423-451.
http://l3d.cs.colorado.edu/~gerhard/courses/dlc06/Pea-Roy-2004-JLS.pdf

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")

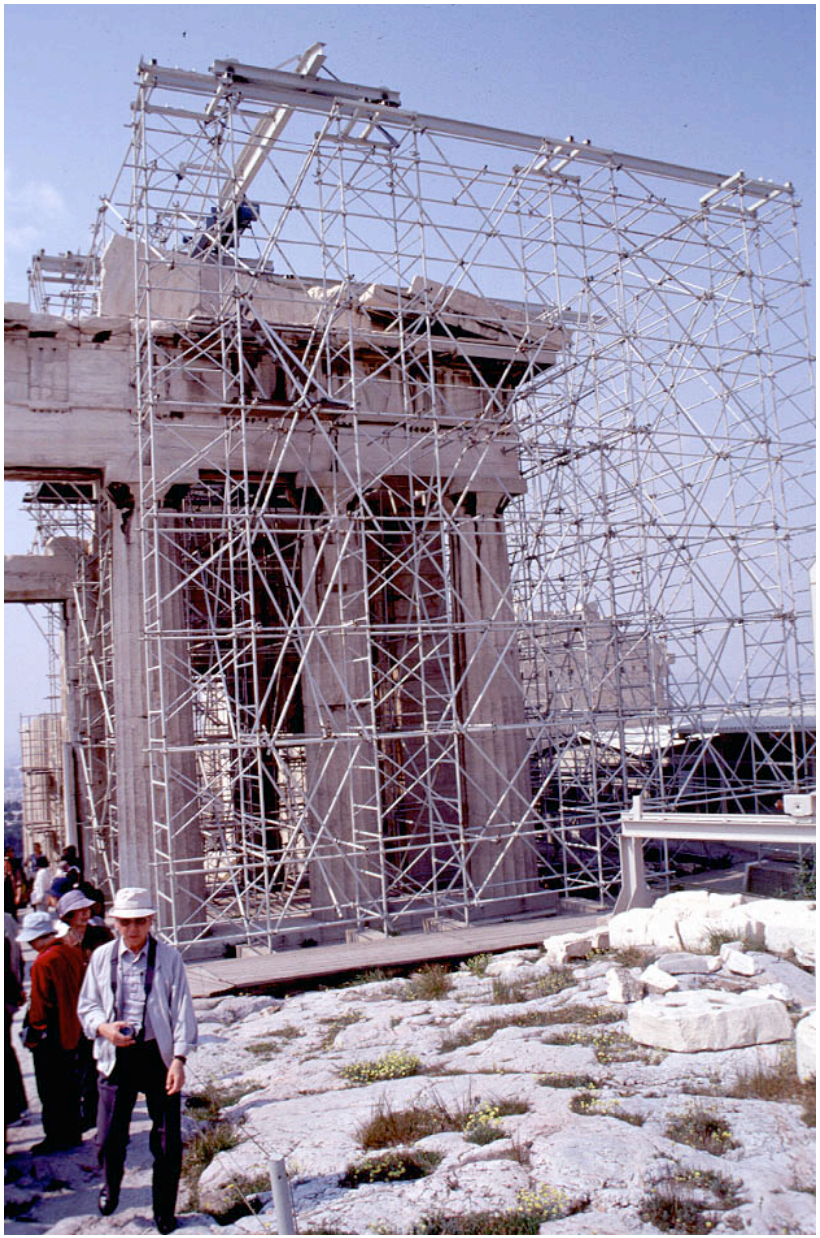
- **position 4:** find new ways to ***distribute responsibilities between humans and machines*** such that humans do the qualitative reasoning, use estimation skills, relate the mathematical result to the real world and machines do the detailed quantitative computations ("distributed intelligence", "tools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

Scaffolding

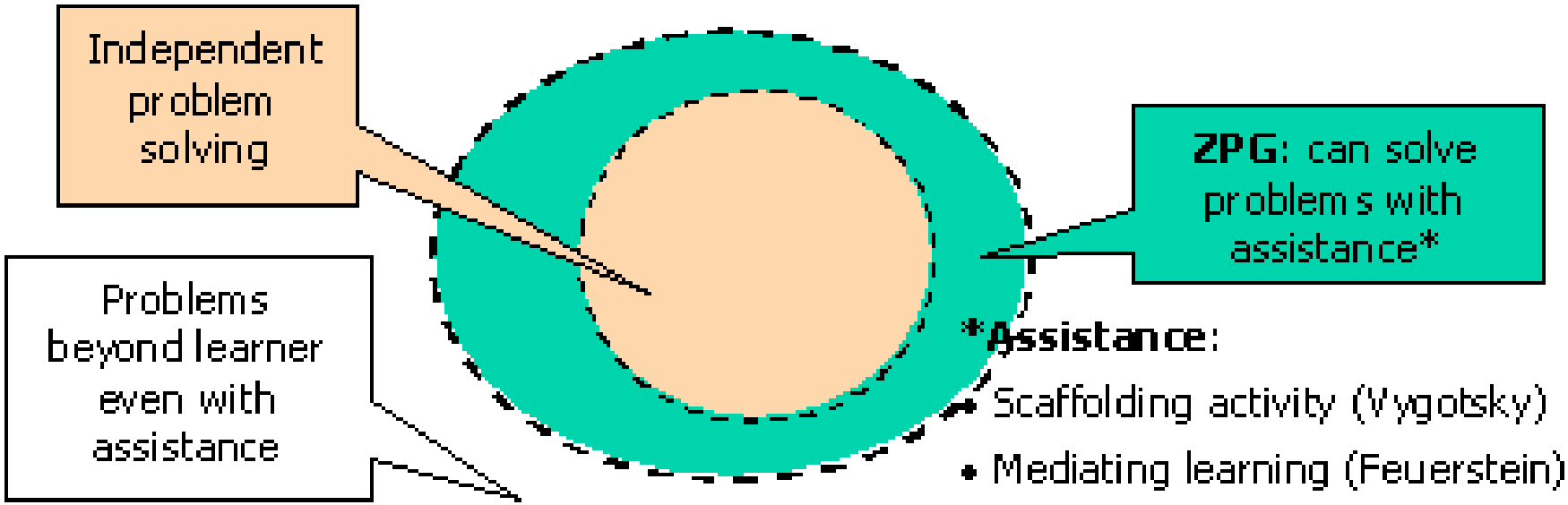
- **scaffolding**
  - the provision for assisted performance
  - “a ‘scaffolding’ process that enables children or novices to solve a problem, carry out a task or achieve a goal which would be beyond their unassisted efforts”

- **dimensions**
  - extending reach
  - simplifying a task
  - **temporary → “fading”**

- **theoretical origins**
  - Vygotsky is the notion of a learner's zone proximal development (ZPD)
  - ZPD = the distance between the actual development of a child as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers
  - learners ultimately internalize (appropriate) the knowledge transacted through assisted performance so that it becomes their own
  - a teacher's task is to place learning in the ZPD



Scaffolding



Common Elements of Scaffolding

- task definition
- direct or indirect instruction
- specification and sequencing of activities
- provision of materials, equipment and facilities
- scaffolding may include assistance with planning, organizing, doing and/or reflecting on the specific task → Such assistance is best made available in a timely manner matched to the learning needs and interests of the learner

The Value of Scaffolding

- makes it easier for the learner to undertake a task successfully
- expands the possible learning activities and experiences
- increases the rate at which learning may be achieved
- extends what is possible for a learner to perform and thus expands the ZPD since the provision of powerful tools and well formed instructions enable higher order problems to be solved more rapidly
- assistance of scaffolding was provided
  - traditionally by a teacher directly to a learner in real time
  - scaffolding can also be provided indirectly with media
  - **claim:** technology has the potential to contribute to the provision of scaffolding

Distributed Intelligence (or Distributed Cognition)

- ***claim:*** many scientific approaches have seen *human cognition* as existing solely "inside" a person's head, and studies on cognition have often disregarded the physical and social surroundings in which cognition takes place

- **distribution:**
  - distributed among **people** → collaborative learning and working (social dimension)
  - distributed between **humans minds and artifacts** → intelligence augmentation (technological dimension)
  - these two dimensions can and should be **integrated** (technological support for collaboration)

- **working hypothesis:** 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 to change tasks

Distributed Intelligence

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

- **challenge: develop, apply, and evolve a distributed cognition framework**
  - learning, education, and instruction
  - social creativity
  - collaborative human-computer systems

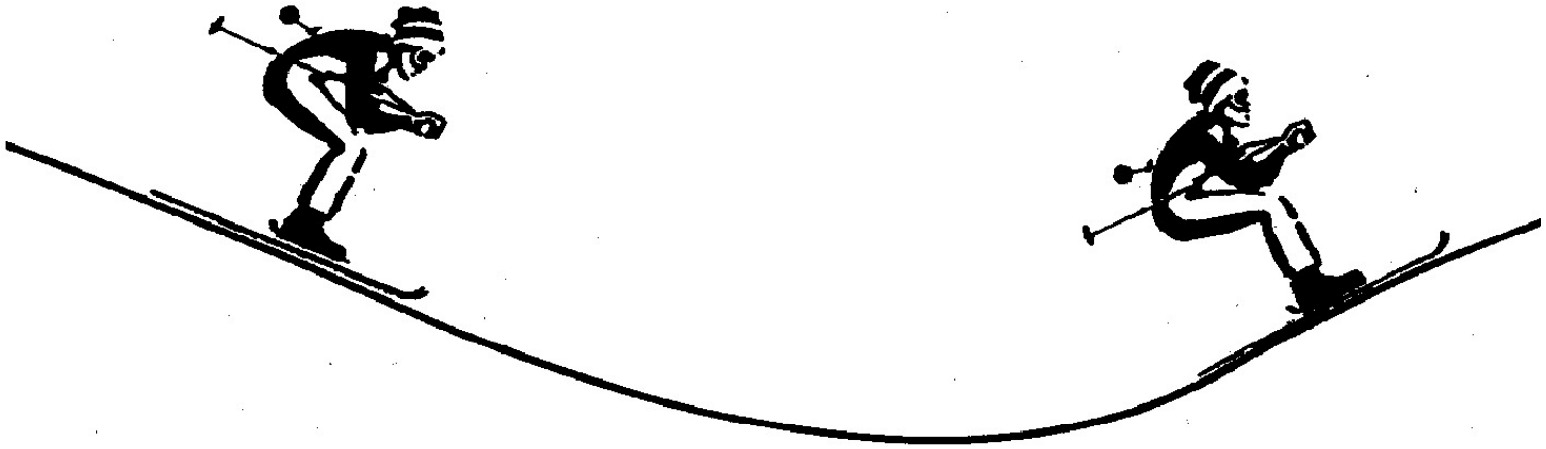
- **claim:** working with people with **cognitive disabilities**
  - creates new unique challenges for theories about distributed intelligence
  - provides a deeper understanding of distributed intelligence

Scaffolding (Temporary) and Technology Support (Permanent) in Skiing

source: Burton, R. R., Brown, J. S., & Fischer, G. (1984) "Analysis of Skiing as a Success Model of Instruction: Manipulating the Learning Environment to Enhance Skill Acquisition." In B. Rogoff, & J. Lave (Eds.), *Everyday Cognition: Its Development in Social Context,* Harvard University Press, Cambridge, MA - London, pp. 139-150.

- decoupling gliding and stopping
- graduated length method
- ski lifts → allow people to spend “time on the essential task”
- safety binding

How physical environments can simplify the skill of skiing



GLIDING
(INCREASING SPEED)

GLIDING
(DECREASING SPEED)

No subskill for stopping
is required.

Increasingly Complex Microworlds Paradigm

- **microworlds can provide:**
  - the right entry points into an environment, making it easier to get started on a subskill
  - an environment in which the student feels safe, allowing him to focus his attention on learning skills
  - intermediate goals or challenges that are, and seem to be, attainable
  - practice of the important subskills in isolation, allowing the common "bugs" to occur one at a time instead of in bunches

- **danger of oversimplification**
  - packed slopes → perfecting performance in one environment, such as packed slopes, may reduce the willingness of a skier to practice in another environment, such as powder, because the difference between his performance in the two environments may be too great
  - knowledge about avalanches → one of a coach's jobs is gradually to reduce the level of protectiveness, leading people to the right new challenges

Basic Skills in the 21st Century?

<source: John Anderson in Cog Sc 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

Overview of Distribution (Distances and Diversity)

Dimension	Rationale	Addressed by	Media / Technologies	Challenges
spatial	participants are unable to meet face-to-face; low local density of people sharing interests	computer-mediated communication	e-mail, chat rooms, video conferences, local knowledge in global societies	achieve common ground; involve large communities *("the talent pool of the whole world")*;
temporal	design and use time: who is the beneficiary and who has to do the work?	long-term, indirect communication; meta-design	group memories, organizational memories	build on the work of the giants before us; design rationale, reflexive CSCW

Overview of Distribution — Continued

Dimension	Rationale	Addressed by	Media / Technologies	Challenges
conceptual within domains	shared understanding	communities of practice (CoPs), legitimate peripheral participation (LPP)	domain-oriented design environments (DODEs)	innovation; avoid group-think
conceptual between domains	make all voices heard	communities of interest (CoIs); boundary objects	Envisionment and Discovery Collaboratory	common ground; different ontologies; integration of diversity
technological	things are available; complement human abilities	distributed cognition, socio-technical environments; meta-design	agents, critics, simulations	formalization; human-problem-domain interaction; digital fluency

Education in a World of Omnipotent and Omniscient Technology

- **question:** in terms of efficiency, economics, reliability, and human gratification and enjoyment → what tasks (or part of tasks) are really better reserved for an educated human mind, and which should be taken over by or aided by what kind of cognitive artifacts?

- **tools for living** versus **tools for learning** (lecture on Wed, 3/22/2006) — specifically in the context of people with cognitive disabilities, aging populations

Claims / Assertions by Roy Pea

- *"delineating the boundaries between*
  - *scaffolding with fading ("tools for learning")*
  - *distributed intelligence without fading ("tools for living")*

  is a central problem for the learning sciences and for education and the arguments structures and warrants used in marking these boundaries will be informative" p 431

- many new forms of human activity that involve computing would be simply unachievable without the computing supports enabling the acts of distributed intelligence
  - fading is simply out of the question. People cannot do the activities without the technologies, or it becomes meaningless to ask whether they can do so
  - If the support does not fade, then one should consider the activity to be distributed intelligence, not scaffolded achievement

Claims / Assertions by Roy Pea — Continued

- considered scaffolding activity to be assisting performance generally (p 439):
  - walking up stairs, sitting in chairs, flying in planes, scuba-diving, skiing with lifts,
  - each of which is assisted performance that would not be possible if unaided

- the computer- supported activities of adult scientists using advanced scientific visualizations for reasoning about qualitative and quantitative relations about physical variables as in global warming, or making inferences about statistical relations in census data, or longitudinal data modeling → activities to be done without these tools?

- question: Sum Random Random
  - Random returns a random number between 1 and 10
  - we need: to select randomly an object of a list of length 20

Claims / Assertions by Roy Pea — Continued

- With distributed intelligence, the point is often **not about fading at all**, but being able to act in a context of assumptions of availability of tools—representational, material, and other people—for achieving ends.

- Educators, policymakers, and learners need to weigh the perceived risks affiliated with the loss of such support with the value of the incremental effort of learning how to do the task or activity unaided should such tools and supports ever become inaccessible, and the answer has to do with the **social and technological assumptions** humans make.

- As we approach a world in the coming years with pervasive computing with always-on Internet access, reliable quality of service networks, and sufficient levels of technological fluency, the context assumptions that help shape **cultural values for distributed intelligence versus scaffolding with fading are changing.**