Scaffolding principles and early applications

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Outline

• Scaffolding
• Two articles
  – Idea and key principles
  – Potentials for computer support
• Exercise
Scaffold, dictionary def

**Scaffold**

- **noun**
  1. a temporary structure for holding workers and materials during the erection, repair, or decoration of a building.
  2. an elevated platform on which a criminal is executed, usually by hanging.
  3. a raised platform or stage for exhibiting spectacles, seating spectators, etc.
  4. any raised framework.
  5. a suspended platform that is used by painters, window washers, and others for working on a tall structure, as a skyscraper.
  6. Metallurgy. any piling or fusion of materials in a blast furnace, obstructing the flow of gases and preventing the uniform descent of the charge.
  7. a system of raised frameworks; scaffolding.

- **verb (used with object)**
  8. to furnish with a scaffold or scaffolding.
  9. to support by or place on a scaffold.

**Origin:**
1300–50; ME scaffot, skaffaut, scaffalde < OF escadafaut; akin to CATAFALQUE

**Example usage:** The scaffolding must be removed once the house is built.
Two articles


What they have in common

• The first article is about human tutoring, which can be seen as application of Vygotsky’s ZPD concept

• The second article addresses possibilities for computer-based scaffolding, in particular AI-based intelligent tutoring systems, two types
What range of tasks do they talk about in terms of scaffolding?

From problem solving ..

.. to design and construction
Relevance to IS students (OOA/D)
Scaffolding for complex tasks

Building block kit for 3-5 yr olds

Reproduction of Mies van der Rohe’s Farnsworth House in Second Life
Zone of proximal development

- This is one of the inspirations for the scaffolding idea, namely Vygotsky’s notion:
- “The gap between what a given child can achieve alone, their potential development as determined by independent problem solving, and what the child can achieve through problem solving under adult guidance or in collaboration with more capable peers”
- This was discussed in lecture 1 (F1 foils)
Instructional scaffolding

• Wood, Bruner & Ross (1976):
  • “To enable a child or novice to solve a problem, carry out a task or achieve a goal that would be beyond his unaided performance”
  • “Scaffolding is accomplished by an adult or more capable peer controlling those elements of the task that are initially beyond the learner’s capacity”
• It acts like individualized feedback from the environment, supporting the learner to progress
Task in article 1

- Discovery learning with a collection of wooden building blocks
- Need to take into account both “blind” (serendipitous) action and the more rigid instruction rules followed by the tutor
- The tutor provides scaffolding during the building and learning processes, sometimes being there and sometimes fading away to support the learner’s gradual development
Types of feedback by tutor

• Showing
  – Direct intervention (giving example)

• Telling
  – Verbal correction (telling)
  – General verbal directions (reminder, checking)
Experiment with children

• The paper describes an experiment with children aged 3, 4, and 5 years
• They interact with a human tutor (adult) who helps them to build a pyramid out of the basic building blocks (shown in foil 11)
• Data is categorized according to the three types of scaffolds and compared across age groups (direct intervention, verbal corrections, general verbal directions)
Results

• 3 year olds learn less from telling (ignore them) than from showing (demonstration),
• 4 years are more explorative and verbal and learns also from telling (verbal correction and direction), whereas
• 5 year olds are more independent and need less feedback, they learn from telling, especially confirmation or checking of constructions
Proposal: scaffolding process

- Recruitment (engagement, motivation)
- Reduction in degrees of freedom
- Direction maintenance
- Marking critical features salient (identify ZPD)
- Frustration control
- Demonstration (showing)
- Two intersecting dynamic planes: 1) gradual structuring/regulating, and 2) role changing
Implications for computer support

• According to Wood et al., a good tutor makes hypotheses about the learner’s hypothesis
• This is a dynamic process among tutor and tutee, which is important for successful tutoring
• They suggest a “task model” and a “learner model” to be part of a “computer tutor” to perform at the level of a human tutor
• This has stimulated research on intelligent tutoring systems (ITS), critiquing systems (F4), and collaborative learning environments
The early computer applications

- Wood & Wood (1996) revisit the older paper
- Since then educational technology has matured, but they tend to look at older tools
- Intelligent tutoring systems
  - Controlled environments
    - To find the right answer, problem solving
    - E.g. Lisp tutor, Geometry tutor, Algebra tutor
  - Explorative environments
    - To see that there are multiple answers, inquiry
    - E.g. Smithtown, Daytona
How is scaffolding operationalized in the first type of ITS

• They are based on a theory of human cognition, advanced computer tutoring (ACT), which models human mind by production (if-then) rules

• The system maintains a model of the learner and can adapt its feedback as the learner develops, and correct error immediately

• Goal driven, helping students to solve mathematical problems in optimal ways
Algebra tutor

Solve $3-3(X-4)=-X$ for $X$.

- **Cleanup:** $3-3(X-4)=-X \rightarrow 15-3X=-X$
- **Distribute:** $-3(X-4)$ in $3-3(X-4)=-X \rightarrow 3-3X+12=-X$
- **Collect constants:** $3-3X+12=-X \rightarrow 15-3X=-X$
- **Move $X$ terms to one side:** 

$15=-4X$ is wrong because you added $3X$ instead of its inverse to $X$.

Try again.

How is scaffolding operationalized in the second type of ITS

- They are based on a different philosophy of learning, guided discovery learning
- Composing hypotheses from word choices
- An automated coach provide feedback by evaluating the constructed sentence in this micro world (Smithtown is about economics)
- Exploring alternative answers before finding the optimal answer (more of an inquiry process than a problem solving process)
From: Shute & Glaser (1990)
Challenges for computer support

• W&W mentions two ingredients of effecting tutoring
  – Giving someone help at the right time
  – Fading: Giving someone less help when they become more independent

• They refer to the pair as “contingent teaching”, which they consider key to successful human tutoring

• Contingent: something not yet certain; conditional (often followed by on or upon): Our plans are contingent on the weather.
Open issues for class discussion

• How would you characterize the intelligent tutoring systems you have seen here (Algebra tutor and Smithtown), according to Sfard’s (1998) two metaphors (acquisition and participations), i.e. to which metaphor, if any, do they subscribe?

• To what extent do the two system support (or fail to support) Wood & Wood’s (1996) two contingency ingredients?
A third type of computer tutor is design critique systems, next time.

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