CS160: Lecture 5

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Human Learning

- Why study human learning for technology design?
Why Study Learning?

Ans: People need to *learn* new applications
Ans: Human knowledge is heavily layered.
Ans: People typically go through stages of understanding of a new concept/system.
Ans: Learning is an important part of knowledge work.
Ans: In the learning sciences, there is a good understanding of how to measure human performance.
Learning and existing knowledge

- Learning is a process of building new knowledge using existing knowledge.

- Knowledge is not acquired but constructed out of existing “materials”.

- The process of applying existing knowledge in new settings is called *Transfer.*
ZPD

- Learning is layered and incremental.
- In real societies, learners are helped by others.
- In fact learners have a “zone” of concepts they can acquire with help.
- This is the Zone of Proximal Development (ZPD).
Back to learning..

- Example: Who knows what this is?

![Circuit Diagram]

- 10k
- 100k
Back to learning..

- Example:
Learning new applications

- Applications are designed to fit in ordinary users’ ZPD.

- In most cases, you can’t assume that there is human available to help a user learn the new system.

- A tutorial help system can provide much of this support.
Learning new applications

- People learn best by doing (constructing new knowledge).

- Using a system exposes a user’s conceptual models of how it works, and allows them to diagnose mistakes.

- A tutorial help system should be able to recognize and respond to common user misunderstandings.
Learning and experience

- Learning is most effective when it connects with the learner’s *real-world* experiences.

- The knowledge that the learner already has form those experiences serves as a foundation for new knowledge.
Learning and transfer

- Transfer is certainly enhanced by similarity between the old and new contexts.

- What other factors should affect transfer?
Transfer and understanding

- Transfer depends on thorough learning in the first situation (learning with understanding*).

- The more thorough the understanding in the first situation, the more easily knowledge will transfer.
Understanding

- By understanding we mean that a person has a mental model of why a thing behaves as it does.

- This model allows the person to predict how the thing behaves in other situations, and to “explain” their reasons for that conclusion.
Transfer and Generality

- Generality of existing knowledge: has the learner already seen it applied in several contexts?
Motivation: is the new knowledge useful or valuable?

Motivation encourages the user to visualize use of the new knowledge, and to try it out in new situations.

Students are usually motivated when the knowledge can be applied to everyday situations.
Transfer and Abstraction

- Is the existing knowledge abstract or specific?

- Abstract knowledge is packaged for portability. Its built with virtual objects and rules that can model many real situations.

- E.g. clipart
Metacognition

- Metacognition is the learner’s conscious awareness of their learning process.

Metacognition helps transfer
Metacognition

- Strong learners carefully manage their learning.
- For instance, strong learners reading a textbook will pause regularly, check understanding, and go back to difficult passages.
- Weak learners tend to plough through the entire text, then realize they don’t understand and start again.
Another very good strategy is to predict the next main point in an argument before you read it:
- “What would a user interview be like?”
- “What techniques will improve learning”?
- Then when you see the real answer, the new knowledge will tie with real experience - the experience you just had.

Let me guess what’s coming next..
Structuring Learning

- A similar strategy is very effective for teaching.
- Ask students to work on a problem first, trying out their own approaches.
- Then provide an explanation (a set of principles to explain the problem’s behavior).

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<th>Activity</th>
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<td>Reading, lecture</td>
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<tr>
<td>Problem, lecture</td>
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<td>Problem work only</td>
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Structuring Learning

- Again this gives students some rich and immediate experience with the problem.
- When the explanation is given, students can relate the new information with the experience they just had.

- Reading, lecture
- Problem, lecture
- Problem work only
Break
Piaget: Stages of learning

- Piaget observed very systematic progression of knowledge in young children through stages:
  - Sensori-motor (acting, observing, remembering)
  - Semiotic or symbolic (naming things)
  - “Concrete” operations (relationships, transformations)
  - Propositional or formal thought
Sensori-motor stage (< 2 years)

- Conditioned behaviors, and first hand-eye coordination.
- Grasping, manipulating things.
- Some indirect manipulation.
- Object persistence.
Semiotic stage (>1.5 years)

- Children continue to play with “missing” objects, and may use gesture to invoke them.
- This soon turns to imaginary play.
- Drawing.
- Speech - naming first the things that are present.
- Then referring to things that are not present, and to the past and future.
Concrete thought (2-7,7-11 years)

- Concrete thought: a system of (real) objects, relationships, and operations on them.
- Children “understand” things by being able to relate them to similar things, and to predict the consequences of their actions.
- They can plan and act to achieve a desired outcome.
Concrete thought

- But early concrete thought is still tied to direct experience - it is not “de-centered.”
- E.g. children in this stage can navigate through their neighborhood, changing their route if needed.
- i.e. they can mentally model and predict the results of their actions.
- But they cannot indicate that route abstractly, say on a map.
Concrete thought

- Concrete thought includes rich spatial and temporal relationships.
- Visual design is a “concrete” process.
Formal thought (11+ years)

- Objects and operations no longer need to relate to the world. Things don’t need to be true or consistent. Thinking is a “game”.
- “Operations” are more abstract, and often complementary e.g. joining-separating.
- Children learn a number of principles, like reversibility, proportion, chance.
Formal thought caveats

- Researchers have found that the transition to formal thought is not as reliable as Piaget had thought.
- Many features of this stage are missing in children who do not attend school.
- This stage corresponds with the transition from learning from experience (pre-school), to learning from texts (school).
Formal thought (7+ years)

- Side-effects of abstract representations:
  - Context disappears - things are just true or false everywhere.
  - Rules are very powerful, and both the rules and the reasoning must be accurate, or false conclusions will be drawn.
  - Detail must be discarded or the rules may conflict.
Thought styles

- Designers and other visually-oriented people usually favor concrete thought - context-dependent, rich representations.

- Technologists and mathematically-oriented people favor formal thought - context independent, sparse representations, rich consequences.
A mismatch

- Many interface researchers (technologists) tried to build UI design tools using abstract interface specs (UIMSe)
  - the designer specifies rules about the interface and the system finds a solution satisfying them.

- Real designers hated this idea. They lost control over spatial relationships and overall layout which was lost in the rules.
Macro and micro-Piaget

- Piagetian stages are often evident in learners' acquisition of particular concepts.
- i.e. the learner’s first experience is “sensori-motor” – if I do X, then Y happens.
- They develop a language for naming the operations, objects, groups of objects etc.
- They acquire concrete understanding of the system’s operation: I can change state X to Y using operation Z.
- Finally, they may develop a formal understanding of how the system works (as explicit rules).
Piaget’s progression

- The Piagetian progression can be a good model for the progression in learning new concepts, like how to use a computer program.

- Look for a Sensori-motor → Symbolic → Concrete → Abstract progression in your own learning, and in your users'.
Learning summary

- Learning is a layering process of new knowledge over old. New knowledge is “constructed” from old.
- New knowledge must fit in a “Zone of Proximal Development” to be learned even with help.
- Transfer is influenced by many factors: understanding, generality, motivation, abstraction.
- Piaget identified systematic stages in development.
- Concrete and Formal thought styles differ among the population.
- A concrete → abstract progression is manifest in learning of particular concepts.