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?

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?

Transfer and Motivation

- 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. It's 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.
Metacognition

- 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.

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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<thead>
<tr>
<th></th>
<th>Reading, lecture</th>
<th>Problem, lecture</th>
<th>Problem work only</th>
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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.

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 (UIMSes)
  - 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.