Chapter 12:

Synthesis & Exam preparation
How do people learn? By conditioning

$p (B \mid S)$

analytics
Burrhus Frederic Skinner (1904-1990), Operant Conditionning

"The Science of Changing Behavior"

SKINNER OPERANT CONDITIONING

DESIRED POSITIVE

GIVE PLEASURE

REMOVE PAIN

MAINTAIN POSITIVE

FADE Reinforcers

21 DAYS

UNDESIRRED NEGATIVE

GIVE PAIN

REMOVE PLEASURE

"The closer you implement a Reinforcer to a Behavior, the greater the chance of changing behavior"

https://sites.google.com/a/adams12.org/harp-mrhs-home-v1/06-powerpoint-section/skinner-s-operant-conditioning
Key ideas in behaviorism

① Psychology is becoming more scientific
② The brain is a black box; the focus is on behaviors
③ Learning is « engineered »
④ Association results from immediate feedback
⑤ The learner is permanently active
⑥ Small steps increase the probability of positive feedback
   ➔ Programmed instruction
⑦ Then it moved to larger step: modular instruction ➔ mastery learning
Modular Instruction

**Pre-requisite test:** Does the learner have the pre-requisite to start the course?

**Pre-test:** Should the learner skip some modules?

**Intermediate-test:** Did the learner reach the objectives of this module?

**Post-test:** Did the learner reach the objectives of this course?
Knowledge space

Instructional Design

Digital courses
Example of exam question

Which learning mechanism(s) benefit from immediate feedback? Why?

① Elicitation
② Proceduralisation
③ Association
④ Metacognition
Example of exam question

For which learning objectives would you use a behaviorist approach? How could it work?

① Identifying categories of clouds (cumulus, stratus,..)
② Identifying the bug in a piece of code
③ Identifying the best business plan among 3 proposals
④ Identifying a fossil on a stone
Constructivism

How do people learn? By constructing cognitive structures from experience (trial & error)
Assimilation and Accommodation

How can this girl use her “dog” schema when encountering a cat?

- She can assimilate the experience into her schema by referring to the cat as a “dog”
  - or
- she can accommodate her animal schema by separating the cat, and even different types of dogs, into separate schemas.
Cognitive Conflict as key learning mechanism

1. I wanted to get this

2. I got that

3. The problem is here

define "house1 [[
forward 100
right 45
forward 60
right 120
forward 60
right 45
forward 100
right 90
forward 60
]]
Cognitive Conflict
as key learning mechanism

- Learning from experience
- Learning by doing
- Learning from failure
- Discovery learning

Conditions:
1. The conflict is detected
2. The learner finds how to solve it

Role of the environment (sequence of projects / teacher / peer)
Constructivism

Microworl ds

Radical

Constructionism

Guided Discovery

- microworl ds
- Simulations
- Modelling

Quest for effectiveness
Learning for simulations is difficult

Hypothetico Deductive Reasoning

1. (Raise a question)
2. Generate an hypothesis
3. Design an experiment
4. Run/simulate the experiment
5. Interpret results
Manipulating real or virtual objects?
Summary: From Constructivism to Augmented Reality

1. People learn by adapting their knowledge structures through interaction with artefacts. Educational philosophy: from telling students what to do to letting them invent things.

2. In practice, this approach does not work very well without external support and requires talented teachers. Learning from simulation requires inquiry skills. Training these transversal skills are key goals of any education.

3. Evolution of pedagogical methods from building mental schemes to building concrete objects. Digital artefacts offer rich interactions but digital education is not limited to virtual object. Tangible interfaces and augmented reality open it to physical manipulation.
Example of exam question

How does assimilation and accommodation occur when learning from a simulation?
Example of exam question

For which learning objectives would you use a microworld?

What would learners do in this microworld?

① Learning to express clearly one’s idea
② Learning to decompose a problem
③ Learning to learn from one’s own mistakes
④ Learning to take the viewpoint of someone
Social Cognition

The hardware is individual
But the software is social
We internalise social interaction because thinking is a dialogue with oneself.
Collaborative learning

1. Collaborative learning is often effective, but not systematically.

2. It is effective when rich interactions occur such as explanation, argumentation, mutual regulation.

3. To make it more effective, the technology or the script increases the necessity for students to produce these interactions.

4. The theory behind emphasizes that cognition is inherently social because thinking mostly relies on language.
Example of exam question

There are 400 architectures students in an online course on urbanism. You would like to apply the JIGSAW script to design their team project. The project concerns the positioning of car parks in the city. What would the script do?
Example of exam question

For which learning objectives would you collaborative learning methods?

① Solving problems when there is a single clear solution

② Solving problems when there are several solutions, but some are better than others.

③ Solving problems where the goal is to find many solutions.
Learning Theory

- Behaviorism
- Constructivism
- Socio-cultural theory

Learning Technology

- Lesson (eLearning)
- Exploratory environment
- Collaboration Tools
The Gartner Cycle of Technology Adoption

MOOCs

- Technology Trigger
- Trough of Disillusionment
- Slope of Enlightenment
- Plateau of Productivity
- Peak of Inflated Expectations

VISIBILITY

TIME
A good MOOC includes rich activities
Fluid Dynamics (Gallaire & Ancey)

http://128.178.27.98:8082/LHE1.html

Statics (Muttoni & Burdet)
Computer-based learning is effective

Hypertexts are effective for learning

Multi-media courseware increases learning

Virtual reality is good for education

Augmented reality is good for education

MOOCs radically enhance teaching

Mobile learning changes education

Tabletops are effective for team learning

Robots enhance learning
How to prove the effectiveness of X?

Independent Variable: Solo / Team

Dependent Variable: Test Score
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Question</td>
<td>To be answered by the experiment</td>
</tr>
<tr>
<td>Hypothesis</td>
<td>Expected results ( A &gt; B ); an affirmation</td>
</tr>
<tr>
<td>Independent variables</td>
<td>What one varies between the conditions (or Factor)</td>
</tr>
<tr>
<td>Modality</td>
<td>Value of a factor</td>
</tr>
<tr>
<td>Condition</td>
<td>Set of ((\text{factor, modality})) per group of subjects</td>
</tr>
<tr>
<td>Control group</td>
<td>The reference against which one will compare</td>
</tr>
<tr>
<td>Dimension</td>
<td>Number of factors</td>
</tr>
<tr>
<td>Dependent variables</td>
<td>How does one measure the effects?</td>
</tr>
<tr>
<td>Controlled variables</td>
<td>Things you try to keep constant or to randomize</td>
</tr>
<tr>
<td>Intermediate variables</td>
<td>Explain the link from Independent to Dependent Variables</td>
</tr>
<tr>
<td>“Significant” difference</td>
<td>Probably (&lt;5%) not due to sampling error</td>
</tr>
<tr>
<td>Interaction effect</td>
<td>The effect of one IV on the DV depends upon another IV</td>
</tr>
<tr>
<td>Between/Within subject</td>
<td>Do subjects pass in one or several conditions?</td>
</tr>
<tr>
<td>Counterbalancing</td>
<td>Inverting the order of conditions for within-subject plans</td>
</tr>
</tbody>
</table>
Example of exam question

Design an experiment that compares the effectiveness of constructionism versus constructivism. Verify if the effect depends upon the age of students. What would be the independent, controlled, intermediate and dependent variables? Describe a potential interaction effect.

Design an experiment that measures the effectiveness of immediate feedback from learning vocabulary. Verify if the effect varies with the level of prior knowledge of the participants. What would be the independent, controlled, intermediate and dependent variables? Describe a potential interaction effect.
**Learning Theory** *(behaviorism, constructivism, socio-cultural)*

Pairs of students with conflicting viewpoints, probably get higher learning gains (than ...), because conflict increases argumentation intensity and opportunities for decentration.

**Orchestration Graphs**

How to form conflicting pairs among 20, 200 and 2’000 students?
A pedagogical scenario starts with a test on english vocabulary. Then, the high score students have a lecture on the construction of negative sentences, while the low score do individual exercises to acquire more vocabulary. Then, students work in pair, one low score and one high score on negative sentence construction exercises.

Describe the graphs and specify the label and operators on edges.
Projects in CHILI

- Analytics
- FROG
- Cellulo
The Pacman game is iteratively co-designed with neurologists, therapists and patients through pilots done in 4 therapy centers