

# Example-Based Learning

May 16th, 2014

Prof. Dr. Nikol Rummel  
Institute of Educational Research  
Ruhr-Universität Bochum, Germany

# Instances of Learning by Example?

# Instances of Learning by Example

Watching mother make pancakes

Reading manual to figure out how the new camera works

Math course book: example of how to solve equation for  $y'$

Learning how to Cha-Cha in dancing lesson

Observing host using cutlery in fancy restaurant

Watching YouTube tutorial on how to play a song on guitar

# Lines of Research

## - Two Paradigms

Learning from **observing a model's** problem-solving behavior

*Social-Cognitive Theory  
(Bandura)*

Learning from **studying worked examples**

*Cognitive Load Theory  
(Sweller)*

**Both perspectives share:**

constructing appropriate cognitive representations in order to show the behavior later

**Difference:**

nature of attention processes

# Observational Learning (OL)

## - Introduction

- Learner observes model performing task
- Model shows how problem is solved
- Model can behave naturally or didactically
  
- Presentation: FtF, video, screen recording, animation
  
- Danger: Transient information in modeling examples!

# Observational Learning

## - Research Example: Rocky Experiment (Bandura 1965)

Exp.  
Phase

- Children (age: 3-6) watched video of an adult male (Rocky) and his behavior towards a Bobo-Doll
- the model showed
  - novel aggressive behavior
  - novel verbal aggression

# Observational Learning

## - Research Example: Rocky Experiment (Bandura 1965)

Exp.  
Phase

- Children (age: 3-6) watched video of an adult male (Rocky) and his behavior towards a Bobo-Doll
- the model showed
  - novel aggressive behavior
  - novel verbal aggression
- Model experiences consequences
  - Cond. 1: reward (drinks, sweets, praise)
  - Cond. 2: punishment (scolding, threat)
  - Cond. 3: no consequences

Test  
Phase I

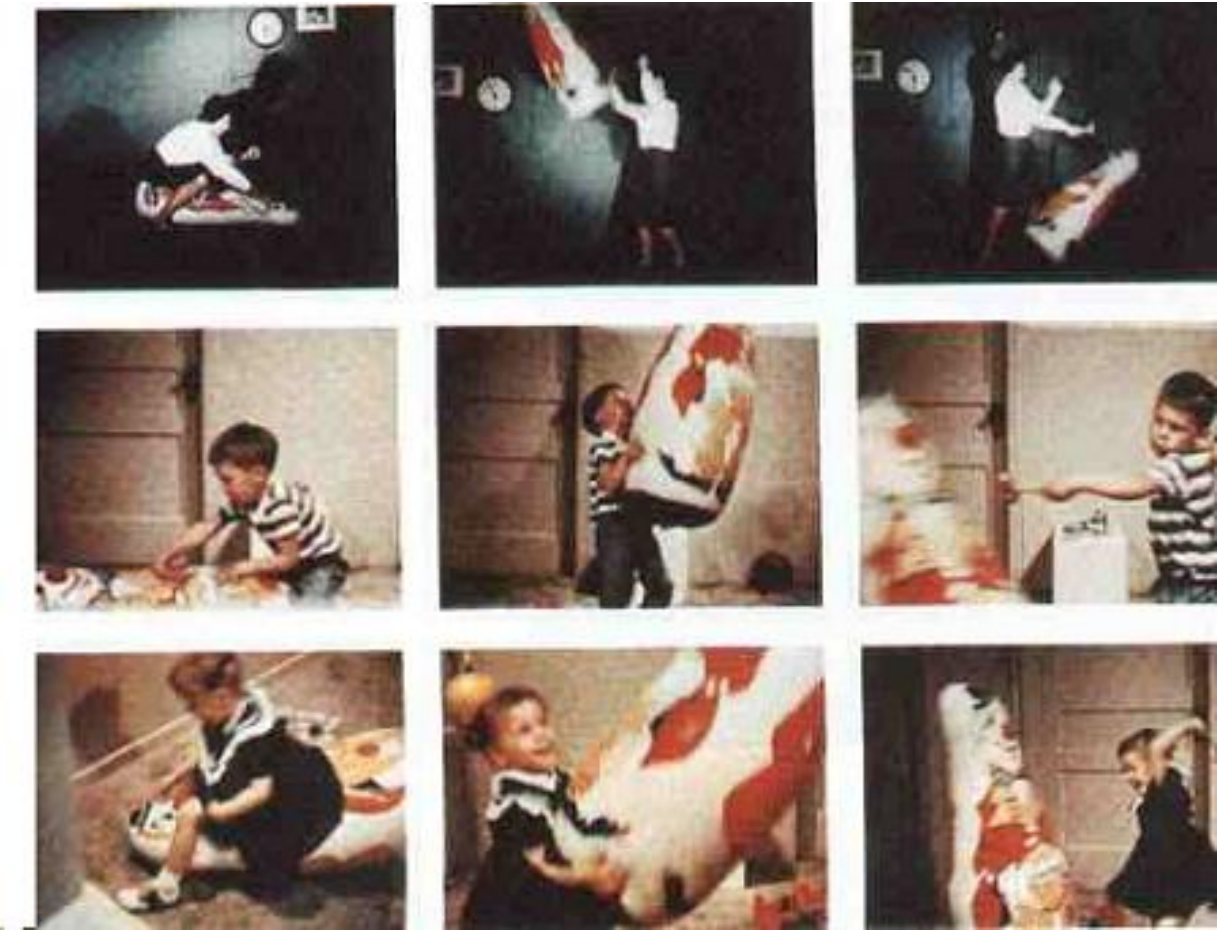
- Children play in the same room  
→ spontaneous imitation

Test  
Phase II

- Children are asked to reproduce observed behavior; receive reward  
→ reinforced imitation of behavior

# Observational Learning

- Research Example: Rocky Experiment (Bandura 1965)





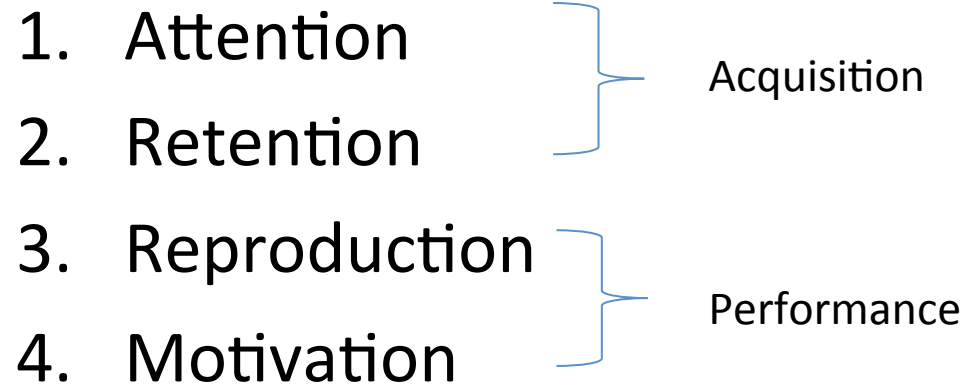
# Observational Learning

## - Research Example: Rocky Experiment (Bandura 1965)

- Test Phase 1: spontaneous imitation of observed behavior;
  - model punished: less imitation
  - model rewarded: more imitation
  - observing consequences for others has effect
  
- Test phase 2: reinforced imitation
  - imitation same in all conditions
  - observing a model leads to learning

# Observational Learning

## - Learning Process (Bandura)

- 1. Attention
  - 2. Retention
  - 3. Reproduction
  - 4. Motivation
- Acquisition
- Performance
- 
- A diagram illustrating the four stages of Bandura's observational learning process. The stages are listed vertically: 1. Attention, 2. Retention, 3. Reproduction, and 4. Motivation. A blue bracket on the right side groups the first two stages (Attention and Retention) under the label "Acquisition". Another blue bracket on the right side groups the last two stages (Reproduction and Motivation) under the label "Performance".

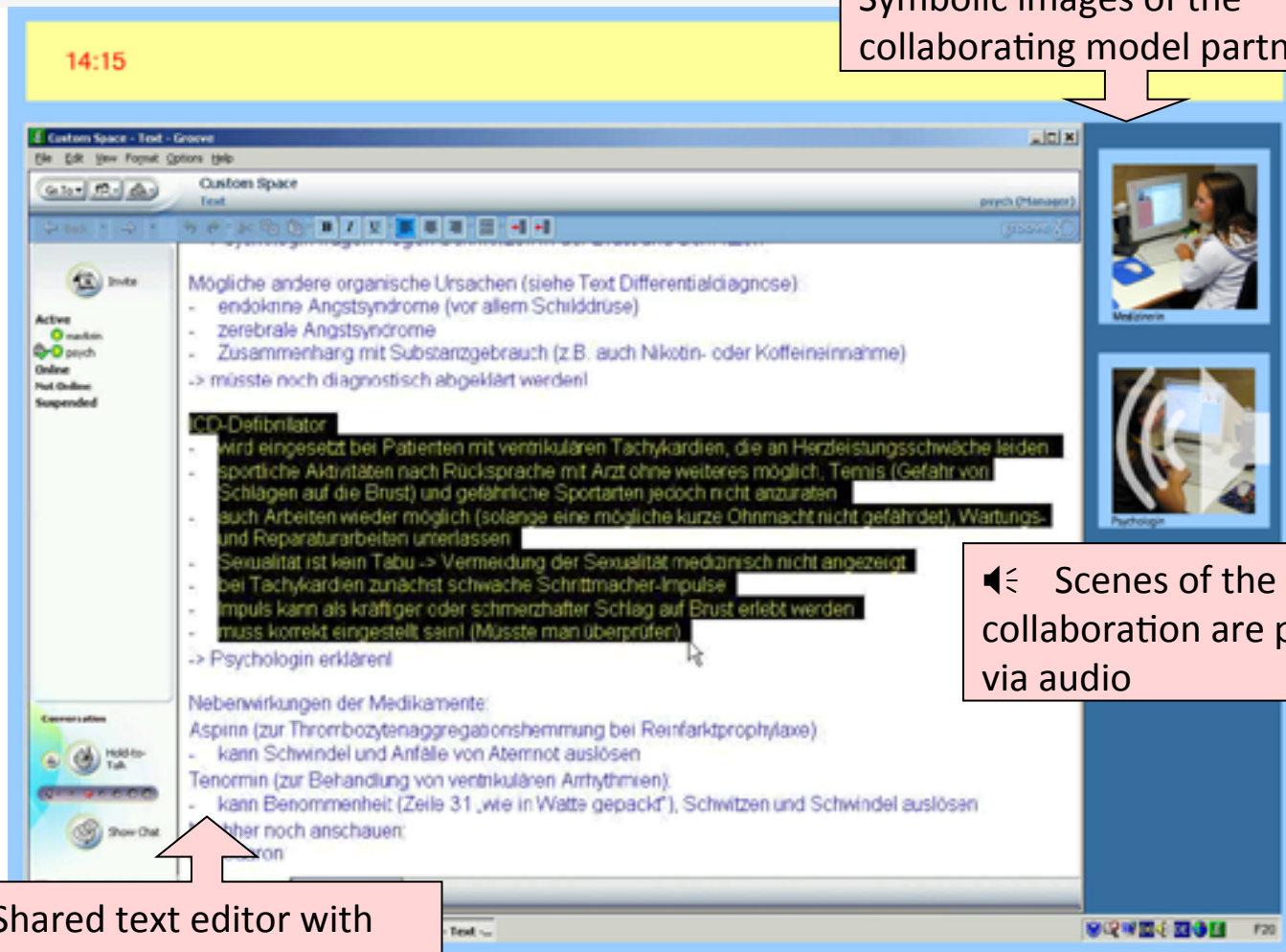
Bandura ,1986

# Observational Learning

- Research Example: (Rummel, Spada & Hauser, 2009)

- Students observe scenes of a well-structured, successful collaboration
- model setting resembles the collaboration setting
- delivered as multimedia presentation on the computer screen
- audio recordings of dialog supplemented by animated slide-clips

- Research Example: (Rummel, Spada & Hauser, 2009)



Symbolic images of the collaborating model partners

Scenes of the model collaboration are presented via audio

Shared text editor with joint model solution.

# Observational Learning

- Research Example: (Rummel, Spada & Hauser, 2009)

- Observing model leads to better collaboration and better joint solution in subsequent own problem-solving as compared to
  - Scripting first collaboration
  - Unsupported first collaboration
- prompting of self-explanation activities further enhanced effect of model

# Observational Learning

## - Design Principles

- Model-observer similarity
- Mastery modeling vs. coping model
- Personalization and voice principle
- Image principle
- Attention guidance

Van Gog &  
Rummel, 2010

Renkl, 2014

# Observational Learning

- Effectiveness: advantages & boundaries

- No trial learning **vs.** complexity of behaviour

# Observational Learning

## - Categorizing Influences of Model (Bandura)

<b>Response Facilitation</b>	<ul style="list-style-type: none"><li>• Behavior already acquired</li><li>• Shown unconsciously</li></ul>
<b>Inhibition</b>	<ul style="list-style-type: none"><li>• Behavior has already been acquired</li><li>→ observing consequences: effect on frequency</li></ul>
<b>Acquisition of new behaviour by observation</b>	<ul style="list-style-type: none"><li>• New behavior, parts are already available (configuration)</li></ul>
<b>Social Prompting</b>	<ul style="list-style-type: none"><li>• Observing (socially accepted) alternative behavior being rewarded leads to alternation of own behavior</li></ul>
<b>Changing Emotional State</b>	<ul style="list-style-type: none"><li>• Emotional state is transferred from model to observer (acquisition by repetition)</li></ul>



# Worked Examples (WE)

## - Introduction

- Contain problem and worked-out solution steps leading to final solution
- Demonstrate didactically how to solve a problem
- Focus learner's attention on problem states, operators, and application of operators
- Presentation: written account (usually)

# Worked Examples

## - Example: Problem

You are planning to invest part of the money you inherited from your aunt in a savings-certificate. The remaining amount, however, should be invested at the highest interest-rates possible, bearing therefore a higher risk, too. Motivated by the movie "Wall Street" which you have seen only recently on TV where stock-brokers are making huge profits, you decide to invest your money in so-called Junk-Bonds. Your uncle is shocked because this form of investment is indeed very speculative and risky but this time you want to decide on your own. After you have read over various literature on this subject you decide to buy Russian Junk-Bonds with a life-span of 5 years ( $n = 5$  years) and an interest rate of 30 % ( $p = 30\%$ ). The interest is booked as compound interest.

Which amount do you have to invest in the Russian Junk-Bonds as start-capital, if you want to receive \$ 8,000 ( $K_5 = \$ 8,000$ ) at the end of 5 years? That would be the exact amount of money you will need for your planned trip to Australia!

Renkl et al. 1998: 100

## Solution

### Step one: selection of the givens

$$K_5 = \$ 8,000$$

$$p = 30 \%$$

$$n = 5 \text{ years}$$

to be searched:  $K_0$

$K_5$ : end capital after 5 years

$p$ : interest rate

$n$ : life-span in years

$K_0$ : start capital

### Step two: selection of the correct formula

$$K_0 = K_n : q^n$$

$$K_0 = K_5 : q^5$$

$q^n$ : discount factor

### Step three: calculation of the compound interest factor

$$q = 1 + p/100$$

$$= 1 + 30/100$$

$$= 1.3$$

$$q^5 = 1.3^5$$

$$= 3.71$$

### Step four: set in the values in the formula

$$K_0 = \$ 8,000 : 3.71$$

$$= \underline{\underline{\$ 2,156.33}}$$

The interest rate being this high, you "only" need a start capital of \$ 2,156.33 in order to get \$ 8,000 in 5 years. Your desired journey is saved!

# Worked Examples

## - Worked-Example Effect

- Positive effects of studying worked examples compared to problem-solving
- Self-explanation activities are paramount to success
- Robust effect: learning from WE compared to learning with ITS

Atkinson,  
Derry, Renkl  
& Wortham,  
2000

Van Gog &  
Rummel,  
2010

Sweller, Van  
Merriënboer  
& Paas, 1998

McLaren, Lim  
& Koedinger,  
2008

# Worked Examples

## - Worked-Example Effect

- WE more effective particularly for novices
- Problem solving of novices:  
weak strategies → high cognitive load  
→ less learning
- With worked-out steps: student can spend  
cognitive capacity on understanding solution

Sweller et al.  
1998

# Worked Examples

## - Research Example (Sweller & Cooper 1985)

### Experiment 3: Algebra

- Students (year 9 High School) learning 4 categories of Algebra problems: solving for  $a$

Acquis.  
Phase

- WE condition: example – problem pairs
- PS condition: problems to solve

Test  
Phase

- 4 Problems to solve

- WE spent less time in acquisition phase
- WE required less time to solve test problems + made less math. errors

# Worked Examples

## - Design Principles

- Avoid split attention
- Avoid redundancy
- Segmenting/ explicit subgoals
- Prompt self-explanations
- Example-problem pairs
- Completion Problems
- Multiple examples
- Erroneous examples

For Overview  
see:  
van Gog &  
Rummel 2010

# Worked Examples

## - Effectiveness: advantages & boundaries

- Little cognitive load **vs.** need for self-explanation
- Effective **vs.** not at any stage of the learning process
- Efficient **vs.** little transfer of schemas



# Integration of Perspectives

## - Commonalities and differences of WE and OL

- Discuss in your groups and try to sort the examples in the google file:
  - Which examples are instances of OL, which are instances of WE?
  - Why? What are commonalities and differences of OL and WE?

# Instances of example-based learning

	Worked Example or Observational Learning?
Math course book: how to solve equation for ,y'	<b>Worked Example</b>
Observing host using cutlery in fancy restaurant	<b>Observational Learning</b>
Learning how to Cha-Cha in dancing lesson	<b>Observational Learning</b>
Watching YouTube tutorial on how to play a song on guitar	<b>Observational Learning/ Worked Example</b>
Reading manual to figure out how the new camera works	<b>Worked Example</b>
Watching mother make pancakes	<b>Observational Learning</b>

# Integration of Perspectives

## - Commonalities of WE and OL

- Providing example cases for learning is effective and efficient
- Particularly in initial stages of learning
- Goal: Schema-Acquisition
- Important:
  - Connecting examples to underlying principles
  - Facilitating example comparison
  - Facilitating learner activities to connect example(s) and principles

# Integration of Perspectives

## - Phases of Skill Acquisition

1. Principle encoding:
  - acquiring declarative knowledge about domain
2. Relying on analogs
  - to solve problem via analog (AR)
3. Forming declarative rules:
  - learners form “if-then”: how to act to solve the problem
4. fine tuning: automation and flexibilization.
  - chunking and automating solution steps
  - adapting skill to new problems

Renkl 2014



- Anderson, J. R. (1993). *Rules of the mind*. Hillsdale, NJ [u.a.]: Erlbaum.
- Bandura, A. (1965). Influence of models reinforcement contingencies on the acquisition of imitative response. *Journal of Personality and Social Psychology*, 1, 589-595.
- Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.
- Renkl, A. (2014), Toward an Instructionally Oriented Theory of Example-Based Learning. *Cognitive Science*, 38: 1–37. doi: 10.1111/cogs.12086
- Renkl, A., Stark, R., Gruber, H. & Mandl, H. (1998): Learning from Worked-Out Examples: The Effects of Examples Variability and Elicited Self-Explanations. *Contemporary Educational Psychology* 23, 90-108.
- Sweller, J., Cooper, G. (1985). The Use of Worked Examples as a Substitute for Problem Solving in Learning Algebra. *Cognition and Instruction*, 1985, 2 (1) 59-89.
- Sweller, J., van Merriënboer, Jeroen J.G. & Paas, Fred G.W. C. (1998). Cognitive Architecture and Instructional Design. *Educational Psychology Review*, 10 (3), 251–296.
- van Gog, T. & Rummel, N. (2010). Example-Based Learning: Integrating Cognitive and Social-Cognitive Research Perspectives. *Educational Psychology Review*, 22 (2), 155–174.

# Other Sources

- Slide 07:
  - <http://www.moguul.de/papil/wp-content/uploads/2008/02/bobo-doll-experiment.jpg> [05/03/2014]
- Slide 14,25, 32:
  - <http://3.bp.blogspot.com/-aWbxYuniqH0/UM3B3CitwXI/AAAAAAAAAqI/iiwZ82CtjDM/s1600/question2.jpg> [05/04/2014]