Chapter 6: Constructivism:

From Piaget to Augmented Reality

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Reminder of Chapter 3: **Behaviorism**

How do people learn? *By conditionning*

$p (B \mid S)$

*analytics*
Reminder of Chapter 2: **Behaviorism**

How do people learn? **By reinforcement**
How do people learn? ➔ Which technology for learning?
Reminder of Chapter 2: **Behaviorism**

How do people learn? ➔ Which technology for learning?

Drill & Practice, Courseware, e-Learning

**Mastery Learning:** Controlling the acquisition of correct responses through a sequence increasingly complex situations, regulated by immediate feedback.
Knowledge space

Instructional Design

Digital courses
Learning Fractions: Comparing 3 methods

- [www.khanacademy.org](http://www.khanacademy.org)
- [nrich.maths.org/4332](http://nrich.maths.org/4332)
- [streaming.discoveryeducation.com/braingames/iknowthat/Fractions/FractionGame.cfm?Topic=namematch](http://streaming.discoveryeducation.com/braingames/iknowthat/Fractions/FractionGame.cfm?Topic=namematch)
Lesson A

A **splountz** is a triangle with 3 smaller shapes placed on different sides, one in the same color as the triangle and the two others in a different color.

Is this a Splountz?  
- Yes
- **No**
Lesson B

WHAT IS A SPUC?

Positive instances

Negative instances

Near-Miss instances
Chapter 6: **Constructivism**

How do people learn? By constructing cognitive structures from experience (trial & error)
Jean Piaget

Stages of development

Sensori-motor (0-2 years)
- Schema created by child reinforcing that objects are permanent
- Understanding of world developed through sensory and physical experimentation

Pre-operational (2-7 years)
- Beginnings of language through understanding of symbols
- Egocentric
- Difficulty understanding conversation or more than one aspect of a situation

Concrete Operational (7-11 years)
- Ordering and classifying based on appearance
- Ability to sequence numbers
- Developing ability to empathise
- Simplistic understanding of maths, geometry and physics

Formal Operations (11+ years)
- Ability to draw conclusions based on hypotheses rather than objects
- Adolescent egocentrism
- Logical

Conservation Task

Permanence of object

Pryramid Task
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.
Piaget (1952) defined a schema as 'a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning'. Basically, a scheme is the building block of intelligent behavior.
Wool is warm but the blanket is too thin.

Wool is insulating.

Mental Model:

1. Wool is warm.
2. Wool.
3. Conflict.
4. Assimilation and accommodation.

Wool is warm but the blanket is too thin.
Cognitive Conflict as key learning mechanism

- Learning from experience
- Learning by doing
- Discovery learning
Constructivism ≠ Teacherless
You experienced the constructivist method « Contrasting Cases »

1

2

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« Contrasting Cases »

Treatment A
Compare cases

Treatment B
Read case summary

Treatment C
Compare cases

Common Learning Experience
Listen to a lecture

Compare cases again

Target Transfer Task
Predictions about a novel memory experiment

« Contrasting Cases »

<table>
<thead>
<tr>
<th></th>
<th>Percent of Possible Predictions about a Novel Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compare cases + Lecture</td>
<td>[Bar Graph]</td>
</tr>
<tr>
<td>Summarize + Lecture</td>
<td>[Bar Graph]</td>
</tr>
<tr>
<td>Compare cases twice</td>
<td>[Bar Graph]</td>
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</tbody>
</table>
Today’s Orchestration Graph

Class
- Listen refresh lecture

Team
- Compare platforms
- Test one platform

Individual
- Collect knowledge

Listen lecture on constructivism

Produce a constructivist OG on standard deviation

A time for Telling

Constrasting cases
“Produtive Failure”

Who’s the most consistent striker?

<table>
<thead>
<tr>
<th>Year</th>
<th>Mike Arwen</th>
<th>Dave Backhand</th>
<th>Ivan Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>14</td>
<td>13</td>
<td>13</td>
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<tr>
<td>1989</td>
<td>9</td>
<td>9</td>
<td>18</td>
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<td>1990</td>
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<td>16</td>
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<td>2001</td>
<td>13</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>2002</td>
<td>17</td>
<td>17</td>
<td>10</td>
</tr>
</tbody>
</table>

Mike Arwen: Mean = \frac{280}{20} = 14 \text{ goals/year}  
Mode = 14

Dave Backhand: Mean = \frac{280}{30} = 14 \text{ goals/year}  
Mode = 14

Ivan Right: Mean = \frac{280}{30} = 14 \text{ goals/year}  
Mode = 18 \text{ and } 10
From Question paper: Average = \( \frac{280}{20} \)

- Mike has 8 years < average
- 4 years = average
- 8 years > average

- Dave has 7 years < average
- 6 years = average
- 7 years > average

- Ivan has 9 years < average
- 2 years = average
- 9 years > average

Frequency of years above, below, and at average

Consistency = years at the mean / years away from the mean

Sum of year-on-year deviation

Mike: 9-14 = -5
   14-9 = 5
   10-14 = -4
   15-10 = 5

Dave: -4
   7
   -2
   -4
   1
   2
   4
   5
   -2
   3
   -1
   4
   -2
   1
   -1
   8
   5
   -9
   2

Ivan: 5
   -3
   1
   1
   5
   2
   3
   4
   1
   4
   1
   -7
   1
   -1
   8
   9
   2

Sum = 0

Average of year-on-year absolute deviation

Mike = \frac{5+5+4+5+4+4+5+4+4+5+4+5+4+4+5+4+4}{20 - 1} = \frac{84}{19} = 4.42

Dave = \frac{4+3+2+4+1+2+1+4+3+2+3+1+3+4+1+4+4+1}{19} = \frac{54}{19} = 2.89

Ivan = \frac{5+3+5+1+6+7+7+2+2+5+5+4+9+1+8+7+1+8+0}{19} = 4.39

Range: Mike = 9 - 14 = 10
      Dave = 9 - 19 = 10
      Ivan = 9 - 19 = 10

Sum of deviations about the mean
Goals Scored

1986 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07

- Nike Ahren
- Dave Backlund
- Ivan Right

Idea 3) Measure Graph Length

MA \( \frac{1}{2}a + \frac{1}{3}b + \frac{1}{2}c + \frac{1}{3}d + \frac{1}{2}e + \frac{1}{3}f + \frac{1}{2}g + \frac{1}{3}h + \frac{1}{2}i + \frac{1}{3}j + \frac{1}{2}k + \frac{1}{3}l + \frac{1}{2}m + \frac{1}{3}n + \frac{1}{2}o + \frac{1}{3}p = 83.26 \)

DB \( \frac{1}{2}a + \frac{1}{3}b + \frac{1}{2}c + \frac{1}{3}d + \frac{1}{2}e + \frac{1}{3}f + \frac{1}{2}g + \frac{1}{3}h + \frac{1}{2}i + \frac{1}{3}j + \frac{1}{2}k + \frac{1}{3}l + \frac{1}{2}m + \frac{1}{3}n + \frac{1}{2}o + \frac{1}{3}p = 56.44 \)

IR \( \frac{1}{2}a + \frac{1}{3}b + \frac{1}{2}c + \frac{1}{3}d + \frac{1}{2}e + \frac{1}{3}f + \frac{1}{2}g + \frac{1}{3}h + \frac{1}{2}i + \frac{1}{3}j + \frac{1}{2}k + \frac{1}{3}l + \frac{1}{2}m + \frac{1}{3}n + \frac{1}{2}o + \frac{1}{3}p + \frac{1}{2}q + \frac{1}{3}r = 94.54 \)

Dave Backlund is the most consistent player as he has the shortest 'stretched-out' graph, showing consistency over time.

Azaac Arkeen
How do people learn? ➔ Which technology for learning?
Jean Piaget

If I cannot reach object A, I can take object B that connects my hand to A

Scheme

To implement a complex program, I can decompose it into sub-problems

Object to think with

Seymour Papert

Function/method in programming language
define "carre [size]
[repeat 4 [forward :size wait 0.1 right 90]]

define "fleur [size]
[clean repeat 60 [carre :size left 6]]

fleur 100

http://www.alancsmith.co.uk/logo/

Papert, S. & Solomon, C. (1971, Twenty things to do with a computer, AI Memo 248, MIT
define "Zum [[length divider]
  [if :length < 1
    [stop]
    [left 45
      forward :length
      zum :length/:divider :divider
      back :length
      right 90
      forward :length
      zum :length/:divider :divider
      back :length
      left 45
    ]
  ]
]}

zum 100 2

zum 100 1.5
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
 ]]

METACOGNITION
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 ➔ constructionnism
https://aseba.wikidot.com/fr:thymiovpl

https://www.youtube.com/watch?v=8RiEDT8bsOs
http://guerrillamakerspace.squarespace.com/space-4/
From constructivism to constructionnism

- FabLab+
- Components Toolkit
- Modular ToolKit
- Tool (Thymio, EPFL)
Constructivism

Microworlds

Constructionism

Guided Discovery

- Content-rich microworlds
- Simulations
- Modelling

Radical

Quest for effectiveness
The scandal of education is that every time you teach something, you deprive a [student] of the pleasure and benefit of discovery.

I think schools generally do an effective and terribly damaging job of teaching children to be infantile, dependent, intellectually dishonest, passive and disrespectful to their own developmental capacities.

Every maker of video games knows something that the makers of curriculum don't seem to understand. You'll never see a video game being advertised as being easy. Kids who do not like school will tell you it's not because it's too hard.
Quest for effectiveness: Adding Contents

https://www.geogebra.org/

Cabri Géomètre
Learning from Simulations

Acquire Skills

Discover underlying model
NET LOGO

setup

basic sliders:
- initial-cows: 20
- stride-length: 0.08
- cooperative-probability: 0.50
- metabolism: 6
- reproduction-cost: 54
- reproduction-threshold: 102

Cows over time
- greedy cows: 353
- cooperative cows: 508

advanced sliders:
- grass-energy: 51
- high-growth-chance: 77
- max-grass-height: 10
- low-growth-chance: 30
- low-high-threshold: 5

ticks: 115
Learning from Simulations

More examples

An Overview paper
Inquiry learning

“Inquiry-based learning involves learners
- asking **questions** about the natural or material world,
- collecting **data** to answer those questions,
- making **discoveries** and
- testing those discoveries rigorously”

*de Jong, 2006*
Hypothetico-deductive reasoning

1. (Raise a question)
2. Generate an hypothesis
3. Design an experiment
4. Run/simulate the experiment
5. Interpret results
1. Question
   • No clear hypothesis is formulated or badly formulated (42%), i.e. no relationship between variables

2. Hypothesis
   • Design unconclusive experiments, students vary several parameters at a time

3. Design
   • Confirmation bias: to design experience that confirm the hypothesis

4. Run

5. Interpret
   • 35% to 63% errors in data interpretation and graphics readings
1. Question
2. Hypothesis
3. Design
   - Change several parameters
   - Keep hypothesis despite negative evidence
   - Reject hypothesis despite positive evidence
4. Run
5. Interpret
Example of tools to overcome these pitfalls

Tool to express hypotheses
Example of scenario to overcome these pitfalls

① Ask students to write their hypothesis
② Find student with conflicting hypothesis
③ Ask them to find out with the simulation which hypothesis is right

The effects of any learning technology depends upon the quality of classroom orchestration.
Cycle of engagement and reflection
by Mike Sharples, Open University

- Find my topic
- Decide my inquiry question or hypothesis
- Plan my methods, equipment, actions
- Collect my evidence
- Analyse and represent my evidence
- Respond to my question or hypothesis
- Share and discuss my inquiry
- Reflect on my progress
- Reflect on my progress
- Cycle of engagement and reflection by Mike Sharples, Open University
Inquiry is a more open process than simulations

A lesson is not inquiry based if:

• Students know what results they are supposed to get

• The questions and steps are pre-determined for them

• The teacher is working harder than the students

http://www.stemmom.org/2012/03/what-inquiry-is-not.html

http://www.sciencescope.co.uk/Pages/SensorCategories.aspx
Learning from simulations

- **Scientific Model**
- **Computation Model**
- **Mental Model**

**Didactic Transformation:** simplify it for didactic reasons

**Computation transformation:** approximate it for computational reasons

**Hypothetic-deductive reasoning**
Learning from modelling

Scientific Model

Computational Model

Matlab, Octave,…

Mental Model
Figure 2: A SCY concept map with drawers attached. Available peers are above and a SCY chat is active to the right.
Modelling Space
Manipulating real or virtual objects?

Cuisenaire Rods

iPad Version

Drag, Snap, Rotate

https://itunes.apple.com/gb/app/number-rods/id536204074?mt=8
The real-virtual debate: offer both!
Digital ≠ Virtual
Manipulating real or virtual objects?
Summary:

From Constructivism to Augmented Reality

1. People don’t learn by being taught but 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.