Educational Technologies
WS2006

Media Principles
Approximate Plan of the Course

10.1. Authoring tools, CTAT
17.1. Tutorial dialogues
24.1. Action analysis and Machine Learning techniques
31.1. Cognitive tools
14.2. student projects

14.2. Meta-cognitive support

15.11. Web technologies and security
22.11. Tutorial Planning and instructional design
6.12. Interactive exercises
29.11. Media Principles

13.1. Diagnosis: constraint based
20.12. Diagnosis: model tracing and domain reasoning

13.12. Diagnosis: constraint based
20.12. Diagnosis: model tracing and domain reasoning

13.12. Diagnosis: constraint based
20.12. Diagnosis: model tracing and domain reasoning

25.10. XML - Knowledge Representation
18.10. Introduction
Media comparison

- Same instructional methods – same learning
- Better not mirror instruction from other medium

eLearning specials for effective human learning

- Practice with automated tailored feedback
- Automated diagnosis
- Interactivity
- Integration of collaboration with self-study
- Use of simulation to accelerate expertise
- Diverse range of media elements
How do People Learn?

Mental processes transform information into knowledge and skills in memory

- Information processing through channels:
  - visual, auditory, haptic
- Human memory has limited capacity
- Learning occurs by active processing in memory system
- Knowledge and skills retrieved from long-term memory for transfer
Processes involved in Learning

- **Selection** of important information
- **Management of limited capacity** in WM
- **Integration of auditory and visual sensory information** in WM with existing knowledge in long-term memory
- **Retrieval** from long-term memory
- **Management** of all these processes via meta-cognition

- **How can systems support these processes??**
MultiMedia Learning Principles (Richard E. Mayer)

- Multimedia Principle
- Contiguity principle
- Modality principle
- Redundancy principle
- Coherence principle
- Personalization principle
- Worked-examples principle
Multimedia Principle

Use words and graphics rather than words alone

- Graphics: decorative vs instructional role
- Graphics to capture location and focus
- Graphics to illustrate organisation (relations between ideas, lessons..)
- Graphics to show relationships among variables or make invisible phenomena visible
- Animation to illustrate process, procedure

Information delivery theory: words efficient – format does not matter

Cognitive theory of learning: process of active sense making
mentally construct representations
mentally connect representations
Example: How a bicycle pump works

- As the rod is pulled out, air passes through the piston and fills the area between the piston and the outlet valve. As the rod is pushed in, the inlet valve closes and the piston forces air through the outlet valve.
Hallo Anton.


### Vorgefertigte Bücher

Bücher auf deutsch:
- Auf und nieder: Die Ableitung
  Seitenanzahl: 15
- Grundkurs-Inhalte von LeAM_calculus
  Seitenanzahl: 160
- Leistungskurs-Inhalte von LeAM_calculus
  Seitenanzahl: 166

### Eigene Bücher

- Mein Buch
  Seitenanzahl: 10

**Buch zusammenstellen**

Um LeActiveMath nutzen zu können, brauchen Sie:
- Firefox ab Version 1.5 oder Internet Explorer Version 6 (andere Browser können funktionieren, sind aber nicht voll unterstützt). Cookies und Javascript müssen aktiviert sein.
- Java Plugin für den Browser.
- Bildschirmgröße mind. 1024x768.
- eine schnelle Internetverbindung (DSL).
Example: presentation of complex system
Contiguity principle

- Place corresponding words and graphics close
  - Place feedback close to question and solution
  - Place explanatory text adjacent to graphic
  - Guarantee parallel access to exercise and directions
  - Use pop-ups etc to support integration

Psychology:
Sense-making includes integrating information from words and pictures (cognitive resources, cognitive load)
FERTIGKEITEN - BRÜCHE - MULTIPLIZIEREN UND DIVIDIEREN VON BRÜCHEN

Bruch als Rechnung

Welche Rechnung wird durch den Bruch \( \frac{2}{3} \) dargestellt?

- Erst "mal 2", dann "geteilt durch 6".
- Erst "geteilt durch 5", dann "mal 2".
- Erst "geteilt durch 2", dann "mal 5".
- "Geteilt durch 2", dann "geteilt durch 5".

Die richtige Antwort wäre:

Welche Rechnung wird durch den Bruch \( \frac{3}{4} \) dargestellt?

- Erst "mal 2", dann "geteilt durch 6".
- Erst "geteilt durch 5", dann "mal 2".
- Erst "geteilt durch 2", dann "mal 5".
- "Geteilt durch 2", dann "geteilt durch 5".

Hilfe
Fehler melden

Bibliothekseinträge Brüche 1 2 3
Example: hints in exercise

**Hint!**

Try to transform the statement into an equivalent, but simpler statement. Then it should be easier to decide whether for the smallest $n$, it is true or false, resp., whether you can deduce $A(n+1)$ from $A(n)$.

A proof by induction for the statement $\forall n \in \mathbb{N} : n + 4 \leq 4 \cdot n - 3$ fails...

- at the anchor of induction.
- at the induction hypothesis.
- at the induction step from $n$ to $n+1$.

Source: Erica Melis | Educational Technologies WS 2006/07
Modality principle

Present words as audio rather than on-screen text
- Use audio to explain graphics or animations
- For some learners use audio feedback
- For some learners use audio for attention

Does this apply to mathematical formulas as well??
Make students speak about goals and solutions??

Psychology:
- Information delivery: printed text easier to produce than spoken text, does same job
- Cognitive theory of learning: visual/pictorial –auditory/verbal channels
Overloading visual channels

**Multimedia**
- Printed words
- Pictures

**Sensory Memory**
- Ears
- Eyes

**Phonetic processing**

**Multimedia**
- Printed words
- Pictures

**Sensory Memory**
- Ears
- Eyes

**Visual processing**
Redundancy principle

- Presenting words in text *and* audio can hurt learning
  - Avoid spoken words and identical text in the presence of *graphics* (redundant information)
  - Consider narration of on-screen text in special situations - when language is challenging

- Information delivery theory (learning style view): add info

- Cognitive theory:
  - *all people have separate channels for audio, pictorial*
  - *Channels are limited; learners actively integrate*
Audio Presentations

(Interactive) generated audio presentation
Text-to-speech Mary server

(Interactive) audio presentation
human voice
Audio Output

Of exercise feedback
Coherence principle

Adding (interesting) material can hurt learning

- Avoid eLessons with extraneous sound
- Avoid eLessons with inessential graphics, videos
- Avoid eLessons with extraneous words

Source: Erica Melis  Educational Technologies WS 2006/07
Personalization principle

- Use conversational rather than formal style (I, we, you)
- Use on-screen coaches to promote learning

- Agents serve a valid instructional purpose
- Agent dialogue presented as audio
- Provide tailored and (job-)relevant material
- Adapt to motivational state of learner
  - Autonomy
  - Approval

- People work harder when in conversation rather than receiving information
On-screen coaches
Provide material relevant to learner
Provide material relevant to learner
Adapt to motivational state
Worked-Example Principle

- Mix exercises with worked-examples
  - Less cognitive load
- Worked-examples support transfer
- Apply media principles to worked examples
- Use examples close to learner’s experience or goal
- Prompt students to self-explain
EXAMPLE 1: Boy rescued by a helicopter

Jake, an 80Kg undergrad, is rescued from a burning building by a helicopter. He hangs at the end of a rope dangling beneath the helicopter. If the helicopter accelerates, straight downward with respect to the ground, with an acceleration \( a = 2\text{m/s}^2 \),

**FIND:**
The tension \( T \) exerted by the rope.

\[ m = 80\text{Kg} \]

\[ a = 2\text{m/s}^2 \]

**FREE BODY DIAGRAM:**

**SOLUTION**

Because we want to find a force, we apply Newton's 2nd law to solve this problem.

We choose Jake as the body to which to apply Newton's 2nd law.

The helicopter's rope exerts a tension force \( T \) on Jake.

The tension force \( T \) is directed upwards.

The other force acting on Jake is his weight \( W \).

The weight \( W \) is directed downwards.

To apply Newton's 2nd law to Jake, we choose a coordinate system with the Y axis directed downward.

The Y component of Jake's weight \( W \) is \( W_y = W \).

The Y component of the tension \( T \) on Jake is \( T_y = -T \).

The net force acting on Jake along the Y axis is

\[ \text{Net-force}_y = W_y + T_y. \]

Therefore, substituting \( W_y = W \) and \( T_y = -T \) into the net force equation, we obtain

\[ \text{Net-force}_y = W - T. \]

If we apply Newton's 2nd Law to Jake, along the Y axis, we obtain:

\[ \text{Net-force}_y = m\cdot\text{a}_y \]

The Y component of Jake's acceleration \( a \) is \( a_y = a \).

Therefore, if we substitute \( a_y \) and

\[ \text{Net-force}_y = W - T \]

into

\[ W - T = m\cdot\text{a}_y \]

we obtain:

\[ W - T = m\cdot(80\times2) \text{ Newtons}. \]

Solving the preceding equation for \( T \) gives:
Andes: Prompts to Self-Explain

- Stimulate self-questioning on relevant explanations

Source: Erica Melis  Educational Technologies WS 2006/07
Andes: SE-Coach Hints

We choose Jake as the body to which to apply Newton's 2nd law.

The helicopter's rope exerts a tension force T on Jake.

Self-Explain with the Plan Window

Self-Explain with the Rule Browser
We choose Jake as the body to which to apply Newton's 2nd law.

The Y component of the tension T on Jake is $T_y = -T$. 

Click on the [+] to expand a Rule Category
Double Click on a Rule to submit it
Does practice make perfect?

- Use of practice improves learning
- Type, number and placement of practice questions
- Distribute questions throughout lessons
- Critical tasks require more practice
- Train self-questioning when lessons lack practice

- Practice to support selection and integration
- Practice to support retrieval, more frequent encoding improves retention, connection and retrieval
- Asking ‘why?’ Improves learning
Benefits of collaborative learning

- **Teaching back improves learning** (find gaps, errors, motivation)
- **Collaboration can deal with (more complex) problems**
  (plan, monitor, avoid unproductive ways)
- **Collaboration offers alternative solutions**

- Structuring groups and process appropriately
- **Online collaboration possible**
Wizard of Oz experiments

- Gather in group of min 3 students
- Select one principle and test with 2 variants
- Explain why which variant worked better
- Devise report

- Multimedia principle
- Modality principle
- Redundancy principle
- Coherence principle
- Personalization principle
- Worked-example principle

Source: Erica Melis  Educational Technologies WS 2006/07