


## Essential Skills in Computer-Enhanced Learning


### Principles of online instructional design

#### Part 1. Planning your course to promote learning

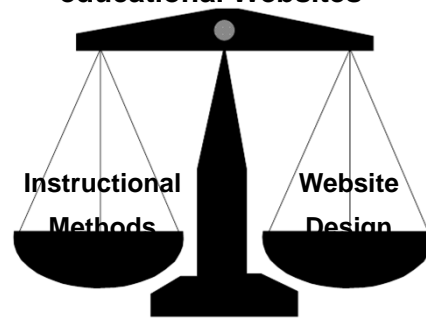



### What is an educational website?

- Educational vs informational
- Alur et al, 2002
  - 17% of websites had all components of a "learning paradigm"
    - critical thinking, independent learning, evidence-based learning, feedback
  - <50% met any criteria
  - Conclusion: Most "educational" websites just provide information


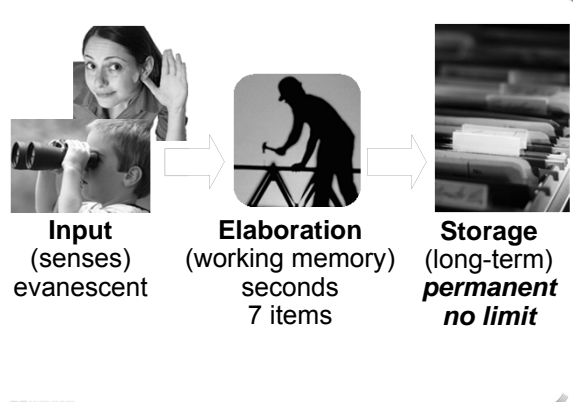


### Key issues in designing educational Websites

### Core principles of learning Kaufman (BMJ 2003)


1. Learner an **active contributor**
2. Context of real-life problem ("situated")
3. Activate prior knowledge
4. Self-direction (metacognition)
5. Practice and feedback
6. Reflection

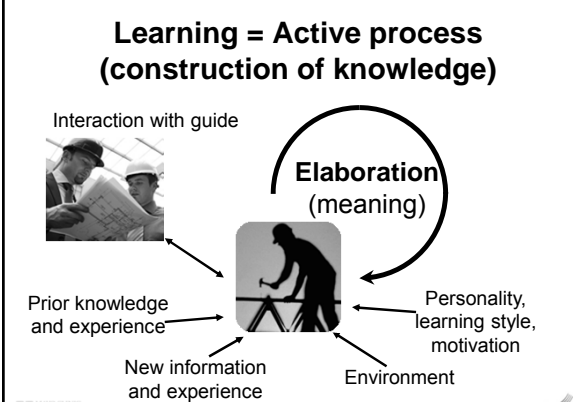
**Input**  
(senses)  
evanescent

**Elaboration**  
(working memory)  
seconds  
7 items

**Storage**  
(long-term)  
**permanent**  
**no limit**



### Learning = Active process (construction of knowledge)



**Elaboration**  
(meaning)


Interaction with guide

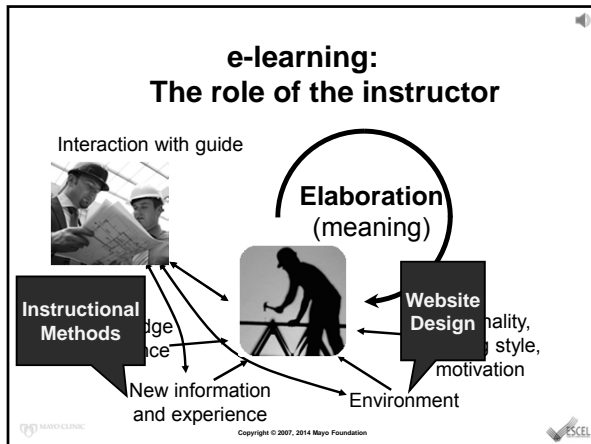
Prior knowledge and experience


New information and experience

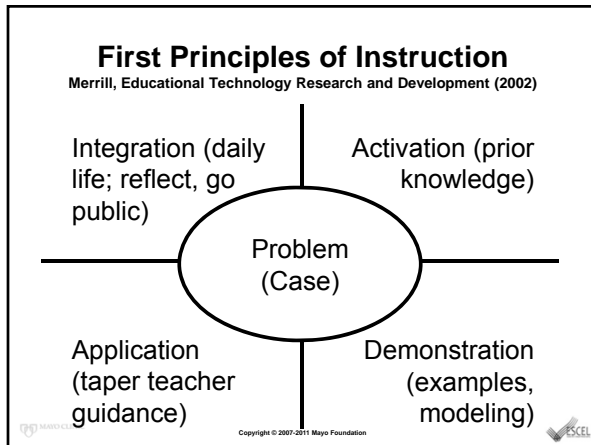
Personality, learning style, motivation

Environment





- ### Active learning on the Web: How to facilitate?
- 
- *Activity vs active learning*
    - Clicking and typing ≠ active learning
    - “Butterfly defect” – hover/flit
    - *Cognitive* activity, not physical activity
  - Online lectures?
  - Online small groups?
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- ### Activation (of prior knowledge)
- Analyze problem (group > alone)
  - Respond to thoughtful questions
  - Generate questions on topic
  - Study advance organizer
  - Engage in experience (case, interactive model, experimental data ...)
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- ### Demonstration
- Don't just "talk" – *demonstrate*
    - Example and non-example of *concept*
    - Picture or video of *procedure*
    - Diagram or animation of *process*
  - More than one example
    - Multiple representations, points of view
  - Multimedia may be helpful
    - Images, video, text emphasis
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- ### Demonstration (cont'd)
- Build mental models
    - Use analogies
    - Teach process knowledge (how, why)
    - Promote elaborative rehearsal
      - Ask questions
      - Facilitate concept maps
      - Encourage learners to self-question
      - Provide for online collaboration
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## Application

- Learners should **solve problems**
  - More than one – multiple perspectives
  - Represent real life
  - Complexity consistent with objectives
  - Group or individual
- Simulation (low/high fidelity), written case
- Coaching should fade over time
- Feedback (automated or from instructor)
- Reflection (questions, portfolio)

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## Integration

- **Do** something with knowledge
  - Demonstrate ("go public")
  - Reflect upon
  - Defend
  - Share (e.g. teach)

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## Problem-centered

- Context of *representative* problem
  - Activation
  - Demonstration
  - Application
  - Integration
- Whole task (not just components)
- Progression of complexity & guidance
  - Compare problems

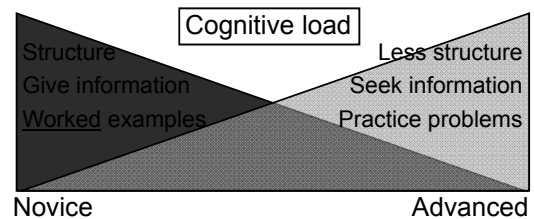
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## Expertise Reversal Effect

- **What works for beginners doesn't work for intermediate/advanced**

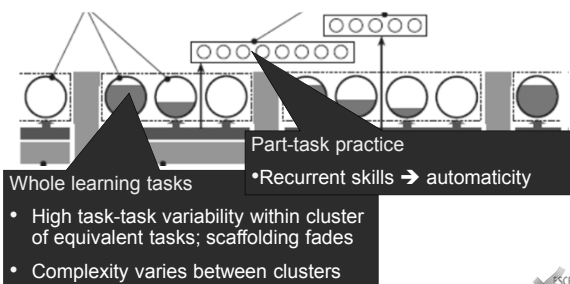


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## 4-component instructional design (4C/ID) – van Merriënboer



Whole learning tasks

Part-task practice

Recurrent skills → automaticity

- High task-task variability within cluster of equivalent tasks; scaffolding fades
- Complexity varies between clusters



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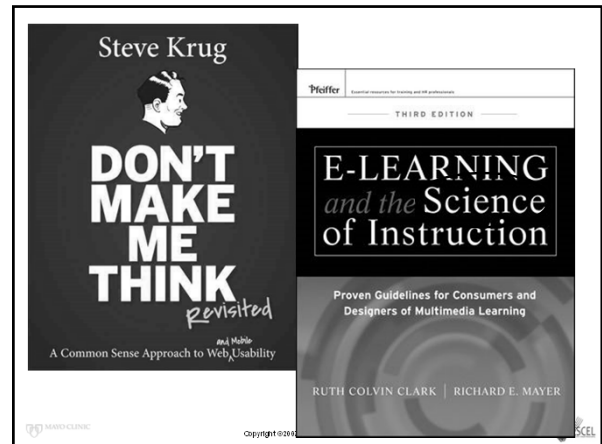
#### Part 2. Effective multimedia design

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## Cognitive Load

- $7 \pm 2$ 
  - Letters ... words ... sentences ... paragraphs ... concepts ...
- Limiting factor in learning
- How to manage cognitive load
  - Minimize “extraneous” → effective instructional design



## 1. Multimedia Principle

**People learn more from graphics + words than words alone**

Types of graphics and appropriate applications	
Decorative	Aesthetic value
Representative	What it looks like
Relational	Quantitative relationships
Organization	Qualitative relationships
Transformational	Show change over time/space
Interpretive	Make conceptual relationships explicit

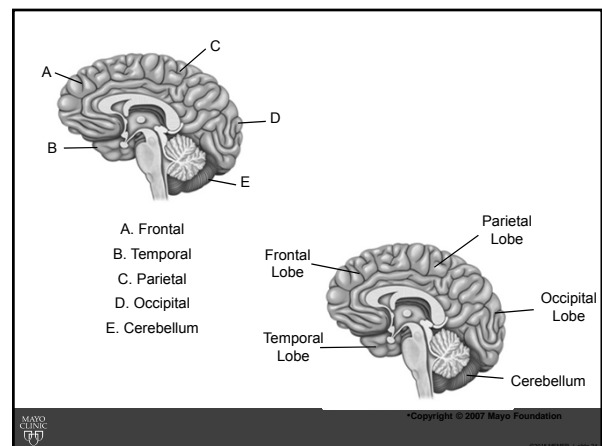
## 1. Multimedia Principle

- With multimedia, keep in mind
  - Graphics “can add value, but *won't improve a bad learning program*”
- Graphics appropriate to content
- Less is often more
- Copyright

## 2. Contiguity Principle

**Place words near (or within) corresponding graphics**

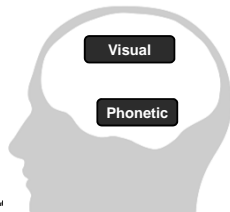
- Helps learners to see the relationships
- Limits the amount of cognitive effort
- **Synchronize spoken words with graphics**



### 3. Modality Principle


***When there are graphics, present words as speech rather than on screen text***

- "Dual channel" input
  - Phonetic processing
  - Visual processing



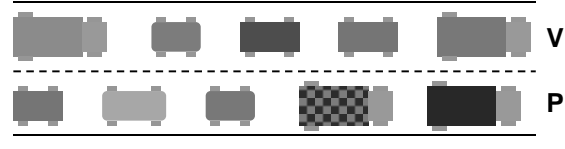
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### 3. Modality Principle



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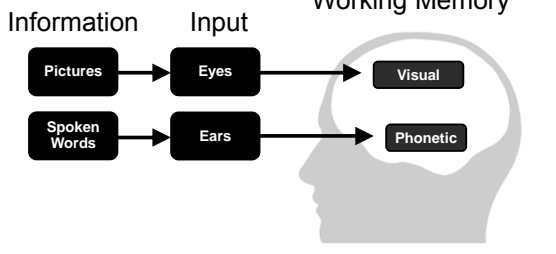
### 3. Modality Principle



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### 3. Modality Principle Maximizing Input Capacity

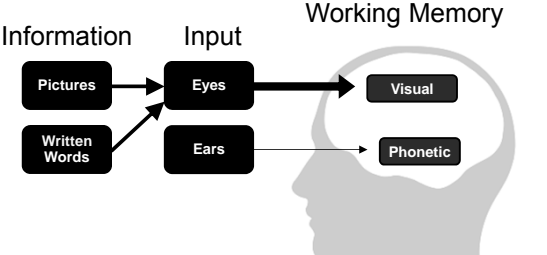
Information    Input    Working Memory



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### 3. Modality Principle Cognitive Overload!

Information    Input    Working Memory



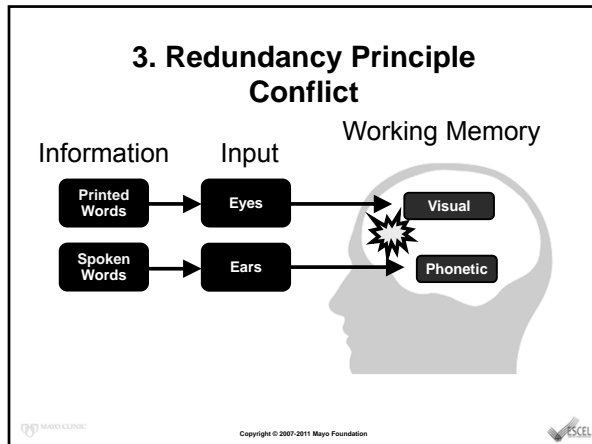
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### 4. Redundancy Principle

***Explain graphics with words in audio or text – NOT BOTH***

- Learners read the words rather than focus on graphics
- ("Don't read your slides")

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### 4. Redundancy Principle

**Explain graphics with words in audio or text – NOT BOTH**

- Learners read the words rather than focus on graphics
- Exceptions
  - No graphics
  - Unfamiliar or complex material
  - Learner disability

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### 5. Coherence Principle

**Less is More – Avoid the extraneous**

- Interesting but *irrelevant* details **detract**
  - Sounds
  - Graphics
  - Words
- Why? Inhibits effective elaboration:
  - Distraction (irrelevant)
  - Disruption (interfere)
  - Seduction (incorrect)

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### 6. Personalization Principle

**Use a conversational style**

- Activates social response
- Increases active cognitive processing
- Human voice
- Important not to be too informal
- On screen coaches (pedagogical agents)
  - May help maintain interest

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### 7. Segmenting and Pretraining Principles

**Manage intrinsic cognitive load by chunking information**

- Segmenting – breaking the lesson into smaller parts
- Pre-training – teach names and key concepts up front

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### Does it Matter?

Multimedia Principle	Effect Size
Multimedia	1.5
Contiguity	1.11
Coherence	1.32
Modality	.97
Redundancy	.69
Personalization	1.30
Segmenting	.98
Pretraining	1.3

From Clark & Mayer 2007

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