The Influence of Text Modality on Learning with Static and Dynamic Visualizations

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Learning with Dynamic and Static Visualizations

Research on learning with dynamic vs. static visualizations: unclear

- Meta-analysis by Höffler & Leutner (2007): moderate overall advantage of dynamic over static visualizations

⇒ Benefits and drawbacks of dynamic and static visualizations
### Dynamic vs. Static Visualizations

**Dynamic Visualizations**

**Possible benefits**
- Changes are presented continuously
- Trajectory has not to be inferred/mentally animated
- Properties like velocity or acceleration are presented in a direct way

**Possible drawbacks**
- Transient information
- Perceptual/cognitive overload ("overwhelming")

**Static Visualizations**

**Possible benefits**
- Important discrete states can be accentuated
- External representation can easily and accurately be perceived and understood

**Possible drawbacks**
- Cognitive overload due to mental animation
- Trajectory may be reconstructed incorrect
- Velocity and acceleration are not represented in a direct way
Visualizations used in this Study
**Modality and Split-attention**

**Modality effect** (Mayer, 2005; Sweller, van Merriënboer & Paas, 1998):
students learn better when visualizations are presented with spoken instead of written text

**Split-attention** (Ayres & Sweller, 2005; Sweller et al, 1998):
picture accompanied by written text and text is not integrated in the picture

**Written text**

**Spoken text**
Hypotheses

- Potential of dynamic visualizations may especially unfold for spoken text

1. Type of visualization: Main effect
2. Modality: Main effect
3. Interaction
### Procedure

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Learning Outcome Measures - Examples

Factual knowledge

Which of the following statement(s) is / are true?

- The propelling forces of each individual propelling element add up to an overall propulsion.
- The lateral forces of each individual propelling element add up to an overall propulsion.
- The all of the propelling forces in more or less cancel one another out.
- The all of the lateral forces in more or less cancel one another out.

Pictorial Recall

Transfer tasks
Learning Outcome Measures - Examples

Factual knowledge

Pictorial Recall

Transfer tasks

„Bring these states in the correct order of a fish movement!“
Learning Outcome Measures - Examples

Factual knowledge

Pictorial Recall

Transfer tasks

Written transfer task
"Some fish species have to make some oscillating movements with their head. Why do they do so?"

Static pictures

Animations
Cognitive load

- **Perceived difficulty**: “How difficult was it for you to understand the contents?”

- **Invested mental effort**: “How much effort did you invest to understand the contents?”
Results – Learning Outcomes: Pictorial Recall

1. Type of visualization: n.s.

2. Modality: marginal main effect:
   spoken > written
   \(F(1, 76) = 3.59; \ p = .06\)

3. Interaction: n.s.
Results – Learning Outcomes: Transfer Tasks

1. Type of visualization: main effect: dynamic > static ($F(1, 76) = 4.30; p < .05$)

2. Modality: main effect: spoken > written ($F(1, 76) = 9.86; p < .01$)

3. Interaction: n.s.
Results – Cognitive Load: Perceived Difficulty

1. Type of visualization: marginal main effect: static > dynamic ($F(1, 76) = 3.84; p = .07$)

2. Modality: no main effect

3. Interaction: n.s.
Summary & Discussion

Transfer task:
• Advantage for dynamic visualizations
• Advantage for spoken text
• No interaction

⇒ Initial expectation: dynamic visualizations have high potentials, but also high visual demands ⇒ spoken text particularly helpful to counteract the demands of dynamic visualizations

One possible explanation:
• Extracting information from dynamic visualizations also with spoken text still difficult ⇒ potentials did still not unfold completely

⇒ helping learner extracting information from dynamic visualizations by reducing overwhelming character through attentional guidance
Thank You for Your Attention!

This research was funded by...