More than a Pretty Picture: Evidence-based Guidelines for Effective Instructional Visuals

Ruth Clark
President, Clark Training & Consulting
Session 1 - More than a Pretty Picture: Evidence-based Guidelines for Effective Instructional Visuals

Ruth Clark, President, Clark Training & Consulting
The Power of Graphics

Attention

Emotion

Distract

Disrupt

Evidence-Based Practice

Scientifically-Based Research

“The application of rigorous, systematic, and objective procedures to obtain reliable and valid knowledge relevant to education activities and programs”.

No Child Left Behind Act Section 9101

Which Is Better...

This? Or This??
Which Is Better...

This? Or This??

1. To remove heart, start by holding heart by pointed end, horizontally and parallel to twisted bar. Draw indented part of heart, from inside to outside, through eye of curved bar.

2. Position eye of twisted bar so that it can be dropped downward through the indented part of the heart.

3. With twisted bar now below the heart, draw indented part back through the eye of the curved bar. The heart is now free.

Heart Breaker Demonstration
Performance Vs. Learning

Performance: Doing the job better as a result of help available while doing the work. Will not necessarily reside in memory.

Learning: Doing the job better as a result of acquiring new knowledge and skills in memory.

Performance Vs. Learning

Performance: Doing the job better as a result of help available while doing the work. Will not necessarily reside in memory.

Learning: Doing the job better as a result of acquiring new knowledge and skills in memory.

Do Graphics Improve Performance?
Do Graphics Improve Performance? Research

Text Format:
Using the resistors supplied, make the following connections:
- Connect one end of an 8 ohm resistor to one end of a 3 ohm resistor, and connect the other end of the 8 ohm resistor to the other end of the 3 ohm resistor.
- Connect one end of the 3 ohm resistor to one end of a 5 ohm resistor, and connect the other end of the 3 ohm resistor to the other end of the 5 ohm resistor.

Diagram Format:

Marcus et al, 1996

Do Graphics Improve Performance? Research

Data = Seconds to solution

<table>
<thead>
<tr>
<th>Mode</th>
<th>Single Series (Easy)</th>
<th>Multiple Series (Moderate)</th>
<th>Parallel (Difficult)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagram</td>
<td>59.93</td>
<td>63.13</td>
<td>65.60</td>
</tr>
<tr>
<td>Text</td>
<td>85.73</td>
<td>91.00</td>
<td>176.73</td>
</tr>
</tbody>
</table>

Marcus et al, 1996

Do Graphics Improve Learning? Research

Words Only:
How the 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."

Clark & Mayer, 2002
Do Graphics Improve Learning?

Research

Words + Graphic:
How the bicycle pump works:

HANDLE

As the rod is pulled out,

PISTON

INLET VALVE

Air passes through the piston

And fills the area between the piston and the outlet valve.

Clark & Mayer 2002

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Do Graphics Improve Learning?

Research

<table>
<thead>
<tr>
<th>Narrated Animation Text + Graphic</th>
<th>Words only</th>
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</thead>
<tbody>
<tr>
<td>Percent correct on transfer test</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td></td>
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<td>40</td>
<td></td>
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<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Clark & Mayer 2002

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9 Experiments comparing words only to words and graphics found an average gain of 89% on transfer tests for combination of words + graphics

Clark & Mayer 2002
Are All Graphics Equal?

Base Text and Graphic

Lightning results from the difference in electrical charges between cloud and ground.

Are All Graphics Equal?

Seductive Text and Graphics Added to Base

Metal airplanes conduct lightning very well, but they sustain little damage because the bolt passes right through.

Harp & Mayer, 1998

Are All Graphics Equal?

Mean number of solutions

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>Base + Seductive text &amp; graphics</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
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<td>6</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

Harp & Mayer, 1998
Three Views of Instructional Graphics

- Surface Features
- Communication Function
- Psychological Functions

See Appendix

View 1: Surface Features Static

- Illustration
- Photograph
- Modeled

View 1: Surface Features Dynamic

- Animation
- Video
- Virtual Reality
View 2: Communication Functions

- Decorative
- Representational
- Mnemonic
- Organizational
- Relational
- Transformational
- Interpretive

Carney and Levin, 1981, 2002

Decorative
Aesthetic purposes

Representational
Represents object

Unit 2: Task Analysis
Unit Objectives: At the end of this unit, you will be able to:
- Identify functions of a job
- Determine the tasks within the functions
- Identify whether a task is procedural or principle-based
Mnemonic

Memory support

Tenador
Spanish for fork

Business Server:
The small business environment is supported by small businesses. It is designed to be used by small group of users and managed by people who are not technical experts.
The following are characteristics:
- Can support up to 25 users who can be concurrently connected to the server.
- The server can support 5 concurrent connections — and each of the five can accommodate up to 5 users.

Organizational
Qualitative relationships among content

The Collaboration Pyramid

Relational
Quantitative relationships

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Transformational
Change over time or space

Interpretive
Models theory or principles; Makes concrete the abstract

Activity
Consider a sample instructional graphic and determine its:

- Surface features
- Communication function(s)

Tip: Use job aid tables in your handout
Surface Features vs Communication Functions

A. Text by itself
B. Line drawing by itself
C. Line drawing with text
D. Line drawing with arrows
E. Video

Step 1: The hand is in a fist with the palm facing downward. The centre of the bandage is under the wrist.
Step 2: One end of the bandage lies diagonally over the back of the hand.

A. Text alone
B. Line drawings
C. Line drawings with text
D. Line drawings with arrows
E. Video
How well did they promote learning?

Bandaging Performance Scores

<table>
<thead>
<tr>
<th></th>
<th>Text</th>
<th>Line Drawing</th>
<th>Text + Line Drawing</th>
<th>Line Drawing + Arrows</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score</td>
<td>7</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>8</td>
</tr>
</tbody>
</table>

Text + line drawings, line drawing with arrows, and video better than text alone and line drawing alone.

Michas and Berry, 1999

View 3: Psychological Functions

- Support Attention
- Activate Prior Knowledge
- Manage Load
- Build Mental Models
- Support Transfer
- Motivate Learning

Focus Attention
Avoid Divided Attention

Activate Prior Knowledge

Manage Load
Build Mental Models

Support Transfer

Motivate Learning: Interest

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### Motivate Learning

<table>
<thead>
<tr>
<th>Personal Interest</th>
<th>Materials Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIGH</strong></td>
<td><strong>LOW</strong></td>
</tr>
<tr>
<td>Stories, Visuals</td>
<td>Text Facts</td>
</tr>
<tr>
<td>HIGH Physiology</td>
<td>43.6</td>
</tr>
<tr>
<td>LOW Statistics</td>
<td>40.2</td>
</tr>
<tr>
<td></td>
<td>48.0</td>
</tr>
<tr>
<td></td>
<td>25.7</td>
</tr>
</tbody>
</table>

### Motivate Learning: Interest

- Emotional
- Cognitive

### Activity

Evaluate a sample instructional graphic based on its psychological function.

**Hint:** Use job aid table in your handout
Section 4: A Visual Design Model

Define Goals
Define Content
Design Visual Approach

ID Communication Function matched to Content
Apply Psychological Principles

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Summary

- Relevant graphics improve performance & learning
- Effective graphics must be designed based on their functionality – not just surface features
- Communication functions: Decorative, Representational, Mnemonic, Organizational, Relational, Transformational, Interpretive
- Psychological Functions (Cognitive Events of Instruction): Focus Attention, Activate Prior Knowledge, Manage Load, Build Mental Models, Support Transfer, Motivate Learning

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