Use of Multimedia to Increase Comprehension in an Introductory STEM Course
Lack of STEM Majors & Graduates

Figure 2: A Smaller Percentage of Degrees Are STEM Degrees

Source: Chairman’s staff of the Joint Economic Committee based on data from the Department of Education’s National Center for Education Statistics: Integrated Postsecondary Education Data. STEM Degrees include degrees in: Engineering, Physical Sciences, Geosciences, Math & Computer Sciences, and Life Sciences.
To Aid Underrepresented Students Emphasize:

- Organization
- Visualization & Images
- Less Competitive Atmosphere
- Concrete Conceptualization

Traditional Approach Emphasizes:

- Inductive Reasoning
- Hierarchical & Linear Relationships
- Empirical Research
- Abstract Conceptualization

Multimedia represents a useful tool for accomplishing this
Multimedia Excels in Certain Learning Environments

<table>
<thead>
<tr>
<th>When intrinsic load is high</th>
<th>the use of well-designed multimedia decreases extrinsic load</th>
<th>while managing germane load.</th>
</tr>
</thead>
<tbody>
<tr>
<td>processes cannot be experienced in every day life,</td>
<td>by using dual coding,</td>
<td>to direct schema construction</td>
</tr>
<tr>
<td>vocabulary is complex,</td>
<td>to support working memory,</td>
<td>by connecting vocabulary with structures,</td>
</tr>
<tr>
<td>and spatial relationships are important</td>
<td>while reducing cognitive load</td>
<td>and showing processes in motion</td>
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</tbody>
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Multimedia and Schema Construction

Schemas represent small chunks of information constructed while learning.

Effective instructional techniques create, add to, connect, rearrange schemas to enrich mental model of a concept.

Multimedia helps process:

- Words succinctly connected to structures, structures to concepts.
- Processes seen in motion.
- User defines pace.

Vocabulary  
Structure  
Concept
Experimental Design

Selected four of eight introductory biology course sections

Tested effects of learning photosynthesis with multimedia compared to text document with static pictures

**Quantitative:**

Pretest - Administer Media - Posttest/Quiz/Exam

**Qualitative:**

Focus groups, social validity questions
## Results

Use of multimedia increases comprehension

<table>
<thead>
<tr>
<th></th>
<th>Pre-test/Post-test Results</th>
<th>Daily Quiz Results</th>
<th>Unit Exam Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spring 2012</strong></td>
<td>p&lt; 0.016</td>
<td>p&lt; 0.004</td>
<td>p&lt; 0.024</td>
</tr>
<tr>
<td><strong>Fall 2012</strong></td>
<td>p&lt; 0.045</td>
<td>p&lt; 0.048</td>
<td>no data</td>
</tr>
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Students with lower-prior knowledge benefited more

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</table>
Results

Student Feedback

Compared to Other Methods

Suggested Additions
- Need More Review
- Add Links to Jump to Sections
- Just Right Amount of Information Presented

Suggested Improvements
- Narration too Fast
- Make it Downloadable
- Chunk information into Smaller Sections
- Reviews at End of Sections Most Helpful

I am a Visual Learner
- Seeing Processes in Motion Helpful
- Seeing and Hearing at Same Time Most Helpful
- More Efficient Way to Learn Compared to Textbook
- Less Extra Information Compared to Textbook

Multimedia Holds my Attention
- Multimedia Got Right to the Point
- Didn't Have to Teach Myself
- I Could Explain Carbon Cycle to my Lab Mates
Conclusions

Multimedia can be an effective tool for increasing comprehension within introductory STEM courses.

Multimedia decreases extrinsic load while focusing germane load; this enhances schema construction.

Benefit greater for those with a lower-prior knowledge level.
Diffusion and Concentration Gradients

Simple Diffusion

1. Concentration Gradient

2. Ability to cross the membrane
Examples of In-Class Applications

 Doesn't have to be fancy or professionally done; in fact, it's not recommended

 Students prefer familiar voices using familiar terminology

 Overlap between multimedia and in-class activities, lecture helpful