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Visual Analogies in a Graduate Course: Student-Perceived Learning Outcomes

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Visual Analogies in a Graduate Course: Student-Perceived Learning Outcomes

Susan Spezzini, Ph.D.
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3rd SoTL Commons: March 11, 2010
Today’s Presentation

Describe an SoTL study on visual analogies.

Explain the outcomes of this study.

Guide participants in creating visual analogies.
Typically, students come to the first [linguistics] class session feeling both apprehensive and resentful. They are nervous about having to take the class, and, at the same time, they suspect it will be of no use. No other class, with the possible exception of statistics, triggers these emotions so strongly.

(Freeman & Freeman, 2004, p. ix)
Challenging Learning Objectives

Describe sound production in the vocal tract: larynx, vocal cords, cavities (pharyngeal, nasal, oral), tongue, lips, teeth, alveolar ridge, palate, velum, uvula;

Draw vocal tract structures for producing each sound;

Recognize sounds (phonemes) and their variations;

Match sounds with International Phonetic Alphabet;

Identify pronunciation difficulties of English language learners (ELLs); and

Help ELLs improve their pronunciation.
New master’s program: ESL Teacher Education
New course: *Phonology for ESL Teachers*
New instructor: Had taught related course 15 times (but in a different country)

**January 2004**
First of five Saturday classes (8:00-4:45)
Large class: 45 students (from up to 5 hours away)
Students: Anxious, overwhelmed, despondent

“If you continue like this, you’ll get bad evaluations.”
Instructor (4:45): Requested email feedback
Huh? Is this course going to be hair raising or what? EEEEEEEEK! I have never had a class like this before.

My brain strained to the point that it couldn’t take in any more information.

As I look at my notes, I wonder if I will survive this.

I hope I am not in over my head. It scared me half to death. My first reaction was that I had died and been sent to torment.

I was so lost. I felt like a foreigner in a world where I didn’t belong.

My initial reaction to your course—I had an adrenalin rush. It reminds me of a chemistry class with all those formulas. I consumed most of a bottle of wine before retiring for the evening.
I had to change what I was doing

Initial changes

Immediate (Sp’04):
  Adjusted my assumptions
  Developed handouts, charts, lists
Subsequent semesters (Sp’05, Fa’05, Sp’06)
  Alternated with a Tuesday night format
  Introduced techniques: We’ve been workin’ on phonology

Breakthrough: December 2006

  University’s faculty development program
  Master Teacher Seminar

Biggest Change

  Visual Analogies
Visual Analogies
Harvey Brightman (2006)

Concrete symbols
Help both instructors and students
Bridge gap between the known and unknown
Connect parts: Big Picture Diagram

Instructors are able to ...
Communicate in everyday language
Explain complexity simply
Improve teaching (especially from student perspective)

Students are able to ...
Use familiar image to better understand new idea.
Make effective connections to critical thinking, meaningful-integrated learning, increased retention, and long-term learning
The chambered nautilus shell is the logo for the SoTL Commons. The self-propelling nautilus grows chamber by chamber, each one larger than the previous one, in an unfolding spiral as it develops steadily over time. The shell's elegant trajectory opens outward and its dynamic design is like the persevering, quiet movement of SoTL through the currents of teaching and learning. The SoTL Commons Conference aspires to be a growing, spiraling, lively catalyst for the international momentum of SoTL, encouraging the opening up and opening out of teaching and how students best learn into public conversations and collaborations. The spiraling pattern of the nautilus is found throughout nature. The conference is simply, but importantly, one swirl in the overall SoTL spiraling transformation of the nature of teaching and academic culture.
Studies about Visual Analogies

College students were helped in overcoming writing blocks (Feild & Graves, 1981).

Learning improved significantly --- when designed properly, used with text, and matched with high structural similarity between base domain/familiar (analog) and target domain (Issing, 1990).

Students were aided in understanding math & science – through new representations on computers (Perkins & Unger, 1994).

Greatest gains were experienced by low achievers (Lin, Shiau, & Lawrenz, 1996).
Visual Analogies were most useful in lieu of non-existent visual aids (Siqueira, Remiao & Azevedo, 1988).

A beginning chemistry teacher’s instructional practices changed before and after web treatment with visual analogies (Lin & Chiu, 2000).

Science knowledge and attitudes of pre-service teachers improved, especially with elaborate analogies -- text for explaining similarities (Paris & Glynn, 2004).

Methodology
Research Questions

(1) As indicated by exams and course evaluations, how did visual analogies affect learning outcomes?

(2) As self-reported by students, how did visual analogies affect their knowledge of phonology, ability to teach pronunciation, motivation to learn, anxiety about course content, and attitude towards the course?

(3) To what extent did visual analogies influence the students’ use of visual analogies in their own teaching?
Research Design

Cross-sectional
Mixed-methods

Context of Study

School of Education
Prominent Research University
Southeastern United States

Graduate Course: *Phonology for ESL Teachers*
14 Tuesdays (5:30 to 8:00 p.m.) OR
5 Saturdays (8:00-4:45): 2 in Jan., 2 in Feb., & 1 in April
Study Participants

184 students in Saturday courses (Spring)

70 without visual analogies
45 in 2004
25 in 2005

114 with visual analogies
41 in 2007
49 in 2008
24 in 2009
Student Demographics (1)

Gender

92% female
8% male

Age

32% 23-29
33% 30-39
22% 40-49
13% 50+

Race/Ethnicity

77% Caucasian
10% Afro-American
7% Hispanic
2% Asian
1% Native American
2% other
Student Demographics (2)

Languages
52% monolingual
39% bilingual
9% multilingual

Native language
89% English
11% other

Educational Goal
64% traditional MA with K-12 licensure in ESL
22% alternative MA with K-12 licensure in ESL
9% licensure-only in ESL (for teaching K-12)
5% non-licensure MA for teaching ESL to adults
Diversity across Courses

**Least Diverse**

2004  Gender: 98% female and 2% male  
Languages: 69% monolingual and 31% bilingual  
Educational goal: 91% traditional MA and 9% alternative MA  
Race/Ethnicity: 89% Caucasian, 9% Latino/Hispanic, 2% Native Am.

2009  Age: 46% 23-29, 25% 30-39, 17% 40-49, and 12% over 50

**Most Diverse**

2007  Gender: 83% female and 17% male  
Languages: 32% monolingual, 44% bilingual, 24% multilingual  
Goal: 46% traditional MA, 42% alternative MA, 2% licensure-only, and 10% non-licensure MA)

2008  Race/Ethnicity: 53% Caucasian, 31% Afro-American, 8% Latino/Hispanic, 2% Native American, 4% Asian, 2% other

2005  Age: 20% 23-29, 40% 30-39, 16% 40-49, and 24% over 50
Instructional Intervention
January 2007

Created hand-drawn visual analogies:

- From simple shapes to more complicated designs, and
- With structural similarity between base and target domain.

Introduced one train analogy at a time.

Posted train cars along the wall (even during tests).
February 2007
Provided written explanations of similarities.
Distributed explanations in class and via email.

Tracks = Context (place, topic, speech partners, etc.)
Conductor = Speaker (personal characteristics: gender, age, SES, etc.)
Smoke = Suprasegmental Features: stress, pitch, length, intonation, juncture, linking, rhythm

Cars = Segmental Features: Vowels & Consonants
Coal Car = VOWELS (energy): Each syllable must have a vowel.
Other Cars = CONSONANTS (Different cars = Manner of Articulation)
  Box Car = STOPS (total obstruction of air flow)
  Cattle Car = FRICATIVES (partial obstruction with noisy air flow)
  Circus Car = AFFRICATES (starts as a stop and ends as a fricative)
  Grain Car = NASALS (funny shape with different place for releasing)
  Tanker = LIQUIDS (association with a liquid product)
  Flatbed = SEMI-CONSONANTS (just partial structure of the others)
April 2007: Student Feedback

29 helpful, useful, great, awesome, excellent (“loved it”)
3 fun, interesting, cute
2 seemed somewhat indifferent
2 it didn’t really help

This was great! I referred to it often!
Cute analogy—helped with initially grasping big picture when so much was new and overwhelming.
It really helps to understand the overall picture and how each “car” depends on the other.
It really helped my understanding.
The train helped the difficult information to be more understanding.
One of my favorites! It helped to solidify the concepts.
I am a visual learner and the train analogy was very helpful in learning how segmentals and suprasegmentals work together in speech.
The visuals made it easier to commit to memory.
It helped me learn the concepts very quickly!
Helped in recall for the quizzes.
Once explained, it made a lot of sense and was a great resource.
It was a little hard to follow at first, but after the initial discussion, it was helpful.
An appropriate analogy--- and I know how hard they are to come by.
I prefer to come up with my own analogies. It’s much more meaningful to me that way.
Instructional Intervention (continued)

January 2008

49 students in enormous lecture hall – couldn’t see
Converted to Power Point for projecting on screen.
Posted on Blackboard for online access.

February 2008

Introduced new concepts related to train analogies.
Created weather analogies for intonation features.
Expanded text for explaining similarities.
A Coal Car is like a Vowel System ::

- **A coal car has coal.** Coal provides energy for mobilizing a train. **Without** coal, a train **cannot** move.
- **A vowel system has vowel sounds.** Vowel sounds provide energy for uttering a syllable. **Without** a vowel sound, a syllable **cannot** exist.
A Boxcar is like a Stop Consonant ::

- In a boxcar, the door creates an obstruction with total closure. The door fully blocks the air from flowing from the inside to the outside (and vice versa). When the door is opened, the air is released and flows freely.

- In a stop consonant, the articulator (lower lip or tongue) creates an obstruction with total closure. The articulator fully blocks the air stream (which originated in the lungs) from flowing from the inside (mouth, i.e., oral cavity) to the outside. When the articulator is lowered, the air stream is released and flows freely.
Summer ➔ Fall 2008

Named “The Fun-Analogy Train: Intro to Phonology”

Created 15 visual analogy slides.

Developed 15 ppt sets with about 20 slides per set.

Threaded train theme throughout the semester.
Conducting a train is like Speaking a language ::

- The tracks and surrounding environment determine the train’s itinerary. The conductor’s personal characteristics determine the way he/she conducts the train.

- The social characteristics of the setting (place, topic, formality, conversation partners, etc.) determine the language variety (dialect and register). The speaker’s personal characteristics (gender, age, origin, education, socio-economic status, etc.) determine the way he/she speaks the language.
Fall 2008

Anecdotal evidence

• Student concerns regarding course content diminished substantially.
• Students experienced less anxiety and greater success.
• Feedback indicated enhanced abilities and attitudes towards phonology.
• Learner factors (different learning styles and background knowledge) were being addressed.
• Students felt more empowered.
• Students reported incorporating visual analogies into their own teaching.
Data Collection
Instrumentation

SurveyMonkey

10 questions: 8 quantitative (Likert scale) and 2 qualitative

Pilot Study (February-March 2009)

Surveyed 31 Students in Tuesday evening courses

without analogies (Fall 2005): 2 responded (10%)

with analogies (Fall 2008): 4 responded (44%)

Described SoTL design at 2nd SoTL Commons

Adjustments

Defined visual analogies.

Shortened the invitational email.

Eliminated attachments to the invitational survey.

Identified current email addressed in advance.
Current Study
September-October 2009

<table>
<thead>
<tr>
<th>Saturday Courses</th>
<th>N = 184</th>
<th>With</th>
<th>out</th>
<th>With</th>
<th>2004</th>
<th>2005</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
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<tr>
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<td>45</td>
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<td>49</td>
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<td>Surveys</td>
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<td>17</td>
<td>13</td>
<td>9</td>
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Results and Findings
# Course Exams: Means

<table>
<thead>
<tr>
<th>Saturday Courses</th>
<th>N</th>
<th>With</th>
<th>out</th>
<th>With</th>
<th>out</th>
<th>With</th>
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<tr>
<td></td>
<td></td>
<td>2004</td>
<td>2005</td>
<td>2007</td>
<td>2008</td>
<td>2009</td>
<td></td>
</tr>
<tr>
<td>Quiz 1</td>
<td>184</td>
<td>78.2</td>
<td>78.0</td>
<td>87.6</td>
<td>89.4</td>
<td>89.7</td>
<td></td>
</tr>
<tr>
<td>Quiz 2</td>
<td>184</td>
<td>84.2</td>
<td>79.3</td>
<td>82.4</td>
<td>84.9</td>
<td>88.9</td>
<td></td>
</tr>
<tr>
<td>Mid Term</td>
<td>184</td>
<td>76.8</td>
<td>81.4</td>
<td>85.0</td>
<td>89.5</td>
<td>90.5</td>
<td></td>
</tr>
</tbody>
</table>

_Note: Quiz 2 scores were different from Quiz 1 and Midterm._
Composite Means

Quiz 1

70 Non-Analogy Students  \( M=78.1, \ SD=10.4 \)
114 Analogy Students  \( M=88.8, \ SD=10.4 \)
Significance  \( t=6.76, \ <.0001 \)

Mid Term

70 Non-Analogy Students  \( M=78.4, \ SD=10.9 \)
114 Analogy Students  \( M=88.1, \ SD=7.4 \)
Significance  \( t=6.54, \ <.0001 \)

Satterthwaite
Anxiety

Non-Analogy Students

Significant negative correlations

\[ r = -0.374 \] at the 0.05 level (2-tailed)
anxiety after first class (self-reported on survey)
score on the first quiz

\[ r = -0.548 \] at the 0.05 level (2-tailed)
anxiety after first class (self-reported on survey)
score on the midterm exam

Higher anxiety after first class was related to lower scores

NOTE: Relationship was not significant for anxiety prior to course.

Analogy Students

No significant correlations
## Course Evaluations:
### Questions Related Directly to the Course

<table>
<thead>
<tr>
<th>Selected Questions and Choices with the Corresponding Response Percentages</th>
<th>No Analogies</th>
<th>With Analogies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2004</td>
<td>2005</td>
</tr>
<tr>
<td>Students (N)</td>
<td>45</td>
<td>25</td>
</tr>
<tr>
<td>Responses* (n)</td>
<td>37</td>
<td>24</td>
</tr>
</tbody>
</table>

### Overall Rating of Course and the Importance of Course

6. What is your **overall rating** of this course?
   - one of the best
   - 46% (2004), 48% (2005), 68% (2007), 72% (2008), 91% (2009)

10. In my own judgment, what I am being asked to learn in this course is **important**.
    - strongly agree
    - 73% (2004), 52% (2005), 83% (2007), 91% (2008), 96% (2009)

### Course Impact on Learning, Knowledge, and Reflection

3. Rate how well the various elements of the course worked together in helping you **learn**.
   - very well
   - 57% (2004), 56% (2005), 60% (2007), 74% (2008), 83% (2009)

15. The course prepared me with **knowledge** and skills that related to standards of my profession.
    - strongly agree
    - 59% (2004), 78% (2005), 85% (2007), 89% (2008), 92% (2009)

16. The course encouraged me to **reflect** on my knowledge and practices in order to improve my understanding and skills as a professional.
    - strongly agree
    - 65% (2004), 67% (2005), 91% (2007), 89% (2008), 83% (2009)
6. What is your **overall rating** of this course?

10. In my own judgment, what I am being asked to learn in this course is **important**.
3. Rate how well the various elements of course worked together in helping you learn.
15. Course prepared me with knowledge and skills related to standards of my profession.
16. The course encouraged me to reflect on my knowledge and practices in order to improve my understanding and skills as a professional.
## Course Evaluations: Questions Related to either Students or Instructor

### Selected Questions and Choices with the Corresponding Response Percentages

<table>
<thead>
<tr>
<th></th>
<th>No Analogies</th>
<th>With Analogies</th>
</tr>
</thead>
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<td>2004</td>
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<td>24</td>
</tr>
</tbody>
</table>

### Student Preparedness: Educational Background vis-à-vis Content Difficulty

8. The **difficulty** level of the course activities and materials is:
   - extremely difficult: 51% 30% 26% 18% 4%

9. My **educational background** prepared me with the skills and information I need to achieve success in this course.
   - strongly agree: 24% 35% 57% 59% 67%

### Instructor Qualities: Effectiveness, Application, & Variety of Teaching Methods

5. What is your overall rating of this instructor’s teaching **effectiveness** compared with other college instructors you have had?
   - one of most effective: 73% 61% 77% 85% 100%

17. The instructor related course content to **applied situations** related to my profession.
   - strongly agree: 73% 74% 91% 85% 88%

18. The instructor used a **variety of teaching methods** to meet the diverse learning needs of students.
   - strongly agree: 51% 56% 79% 83% 83%
8. The **difficulty** level of the course activities and materials is …
9. My **educational background** prepared me with the skills and information I need to achieve success in this course.
5. What is your overall rating of this instructor’s teaching **effectiveness** compared with other college instructors you have had?

17. The instructor related course content to **applied situations** related to my profession.

18. The instructor used a **variety of teaching methods** to meet the diverse learning needs of students.
# Survey: Student Perceptions of How Visual Analogies Affected Learning Outcomes

| How do you think the visual analogies used in the phonology course affected ...? | n  | Results from the Survey |
|---|---|---|---|---|---|---|
|  |  | very negatively | negatively | I'm not sure | positively | very positively |
|  | f | % | f | % | f | % | f | % | f | % |
| Your **knowledge** about phonology | 38 | 0 | 0% | 0 | 0% | 5 | 13% | 22 | 58% | 11 | 29% |
| Your **ability** to teach pronunciation to ELLs | 38 | 0 | 0% | 0 | 0% | 7 | 18% | 15 | 40% | 16 | 42% |
| Your **motivation** to learn about phonology | 38 | 0 | 0% | 0 | 0% | 7 | 18% | 19 | 50% | 12 | 32% |
| Your **motivation** to learn how to teach pronunciation to ELLs | 38 | 0 | 0% | 0 | 0% | 6 | 16% | 15 | 39% | 17 | 45% |
| Your **attitude** towards the phonology course | 38 | 0 | 0% | 1 | 3% | 4 | 10% | 17 | 45% | 16 | 42% |
Open-ended Questions

1. If you wish, please provide comments and/or insights regarding the use of visual analogies for teaching and learning.

2. If you wish, please provide comments and/or insights regarding the use of visual analogies in courses like *Phonology for ESL Teachers*. 
The use of analogies has always been something that helps me learn new material.

Super helpful in learning so much new information!

It was good to have visuals for the new terms. They [visual analogies] still help me when categorizing sounds in my mind for the manner of articulation.

They [visual analogies] are very useful in making abstract concepts more concrete.

This was a helpful visual to remember the progression of the course.
Retention of Information

The visual analogies have also helped the content remain in my head… a very effective technique.

More visuals are better; they helped us remember.

A good visual reminder of what we had been learning.

I appreciated the visual; It made it easier to commit to memory.

I was better able to associate the phonological categories with sounds and phonemes by the mental images created by the analogies.

I think connecting content to visual analogies helps make the content accessible to more learners.

Very useful—nice to view repeatedly.

This was great; I referred to it often.
Visual Learners

I loved the train! I’m a visual learner; so it really helped me remember the suprasegmentals.

I loved this analogy and pictorial representation of phonology. As a visual learner, I was able to visualize and recall facts on the tests and even in conversation.

I tend to be a visual learner so for me the train analogy was very helpful in learning how, although segmentals and suprasegmentals are separate, they work together in speech.

I am a visual learner, so I think that visual analogies are especially beneficial for me, and for students like me.

Visual analogies are an excellent way to reinforce concepts and to reach visual learners.
Helpful for others

For me—a fairly straightforward learner, I preferred the charts and graphs [phonetic symbols and vocal tract drawings]. That’s how I learn best.

I felt very positively about the use of the visual analogies; however, for me the vocal tract diagrams were most helpful. It is my opinion that they [visual analogies] work more effectively for some learning styles than for others.

I find them [visual analogies] interesting but not essential as I am able to understand the concepts without them. I think they may be very helpful to those learners who struggle with concepts.

Though I believe visual analogies are helpful teaching aids, I personally do not use them to learn. I believe it is strictly a personal preference and am aware that they are helpful for many. I remember what the train looked like, but I personally did not use it. It also may have been something as simple as where I was seated in the room [2007].
Explanations (textual analogies)

It was not until later in the course that I understood the train. I found it overwhelming the first day with no background in phonology.

When analogies mean something, they are very helpful. The train analogy had meaning behind every part of it, and it was logical and helpful. The instructor’s excitement about the train analogy was contagious and allowed all of us to connect with it more freely.

Excellent analogy—it worked well with the We’ve been workin’ on phonology song.
Anxiety Reduction

For me, I found them [visual analogies] to be helpful in lowering my affective filter toward the content of the phonology course.

They made the content material less intimidating and easier to understand.

They are great for reducing the anxiety that sometimes goes along with learning new things. Difficult new vocabulary or concepts are far less intimidating when they are part of a familiar/silly/funny analogy.
Today, I can still see the train and how it was used to explain concepts. It was truly a life saver when learning detailed information.

I vaguely remember the train analogy, but I would not be able to tell you much now about it unless you provide some details to refresh my memory. At any rate, I taught a section on phonology to TESOL students, and I was well prepared from having taken the phonology course.
No Knowledge about Trains

I honestly \textit{did not know anything about trains}. I imagine I would have caught on faster if the visual analogy had been an airplane or a truck.

\textbf{Not knowing much about trains} to begin with, I have to admit that all the different types of train cars could sometimes get confusing. I think a \textit{train poster} posted in the classroom might have helped a lot for reference purposes.
# Use of Analogies in own Teaching

## Phonology for ESL Teachers (with analogies)

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>1=never</th>
<th>2=rarely</th>
<th>3=sometimes</th>
<th>4=often</th>
<th>5=always</th>
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</thead>
<tbody>
<tr>
<td>Before taking phonology</td>
<td>38</td>
<td>2.61</td>
<td>1.08</td>
<td>7 18%</td>
<td>9 24%</td>
<td>16 42%</td>
<td>4 11%</td>
<td>2 5%</td>
</tr>
<tr>
<td>After taking phonology</td>
<td>38</td>
<td>3.61</td>
<td>0.86</td>
<td>1 3%</td>
<td>2 5%</td>
<td>12 31%</td>
<td>19 50%</td>
<td>4 11%</td>
</tr>
</tbody>
</table>

Before taking the phonology course:  $M=2.61$, $SD=1.08$
After taking the phonology course:   $M=3.61$, $SD=0.86$

$t$-test on the numeric values associated with these ratings: Difference between means is significant ($t=7.09, <.0001, df=37$)
I believe visual analogies are helpful teaching aids.

They [visual analogies] should definitely be used by all teachers when teaching.

I love using analogies because it helps learners connect new concepts to things they already know.

Generally I find visual analogies useful, especially for visual learners and/or for those with limited English skills.

I find them to be very beneficial for students of all ages.

These are useful with younger as well as with older learners.

Visual analogies are very helpful whether you’re teaching children or adults!

Visual analogies are quite useful tools for adult learners.
I didn’t understand the full impact that visual analogies have on learning until I used them in my phonology course.

It was so valuable to use the techniques [visual analogies] in our own learning and studying in order to see how well those techniques would work in the instruction of our own students. Educators learn the “how” and the “why” of using visual analogies.

The use of visual analogies was not only helpful in regard to learning the material in the phonology course, [but] it was a fantastic way to model for us how visual analogies can be used to teach our students. I really appreciated that we were taught the way we are expected to teach.
Conclusions

Visual Analogies …

Reduced student anxiety

Served as Big Picture Diagram (Brightman, 2006)
Common image representing new idea
Communication using everyday language
Bridge connecting known to unknown

Made complex content accessible
Provided meaningful understanding
Fostered long-term learning and application

Improved teaching (from student perspective)
Tips for Creating Visual Analogies

1. Identifying a common object

2. Providing explanations and Maintaining directionality

3. Naming the visual analogy
1. Identifying a Common Object

Chose a difficult concept that you teach.

Select an object or visual image that is analogous.

Identify similarities between the object and the concept.

Make sure it is a commonly known object in your area.

Check with others to see if this object is recognizable.

Example: I replaced the term “Stock Car” with “Cattle Car.”
2. Providing Explanations and Maintaining Directionality

From Known to Unknown

Describe the common object and then the concept

Example: First describe the train car and then the sound system.

“A coal car is like a vowel system.”

Avoid reversing the direction.

Use simple language in describing the analogy.
3. Naming Your Analogy

The Fun-Analogy Train

The Fun-Analogy Train: An Introduction to Phonology
Thank you!

Questions?
References


