Instructional Design Tips for Computer-Based E-Learning

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"The motion picture is destined to revolutionize our educational system and . . . in a few years, it will supplant largely, if not entirely, the use of textbooks."

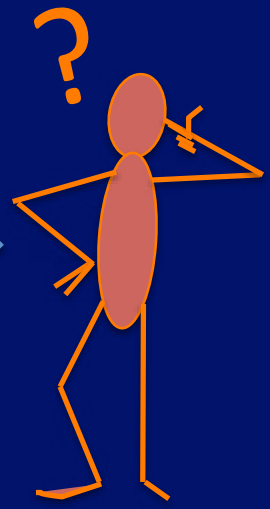
– Thomas Edison, 1922

Similar Prophetic Remarks

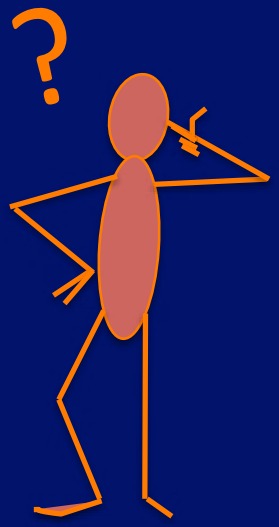
- "Everything that can be invented has already been invented."
  - Director, U.S. Patent Office, 1880
- "The 20th century will see the end of infectious diseases as a significant element in human life."
  - MacFarlane Burnett, Nobel acceptance speech, 1966
- "64K [of computer memory] should be enough for anyone."
  - Bill Gates

Why Was Edison Wrong?

Technology



"How can I use this wonderful technology?"



"How should I structure my content so that students will learn from it?"

Can technology help me?

Ask yourself the following:

- Will students learn better?
  - Content involves demonstrations/processes that students cannot see elsewhere.
  - Acceptable materials for self-learning are not readily available.
  - Students would profit from repetition.
- Will I save time?
  - Teaching content is repeated frequently
  - Content is fixed (will not require frequent revision)

If "yes" to any of these, then proceed with an instructional design

Steps in Creating a Multimedia Learning Programme

- Identify your audience
  - Who is the programme intended for?
- List the learning objective(s)
  - What type of knowledge do you expect the learner to retain?
- Design a multimedia lesson using principles derived from learning research and/or a supported theory of multimedia learning

Who is your intended audience?

- Primary audience
  - State the target audience explicitly
  - Direct the programme to this level
- Who else might benefit?
  - Would a pre-assessment quiz select those who might also benefit from the programme?

Learning Objectives

- State your learning objectives
  - in text, video, or both
  - at least 3; no more than 10
- Optional learning aids
  - Key Points for learning
  - outline of the topic
    - Danger: Don't provide the students with notes; provide a structure in which they may make their own notes

What Kind of Knowledge Do the Students Need to Acquire?

Knowledge Structure	Task	Example
Process	Understand a cause-and-effect sequence	Explain how the heart pumps blood
Comparison	Compare and contrast elements	Compare various forms of transportation in terms of speed, cost, and safety
Generalization	Describe main idea and supporting detail	Explain the causes of World War II
Enumeration	Produce a list	List the 10 largest cities in Ghana
Classification	Place elements in a hierarchy	Identify a soldier's rank by the insignia on his or her uniform

How should the student be able to demonstrate knowledge?

- Retention (repeats elements of a lesson correctly and in order)
  - Lists the anatomical parts of the heart
  - Can cite the steps in the cardiac cycle and normal pressures in each chamber
- Transfer (uses knowledge to solve a problem they have not previously encountered)
  - Can sort out the consequences if a particular heart valve fails to close
  - Can explain the change in blood flow when there is a hole connecting the two atria

Research in Multimedia Learning

(based on R.E. Mayer, Multimedia Learning, Cambridge Univ. Press, 2nd ed. 2009)

- Proposes a Cognitive Theory of Multimedia Learning
- Experiments with various instructional designs
- Uses transfer tests to assess effectiveness of lessons
- Uses different media (computer, printed materials)

A Basic Question for Multimedia Research

Do students learn better with words and pictures, than with just words alone?

"The Multimedia Principle"

Research in Multimedia Learning

(based on R.E. Mayer, Multimedia Learning, Cambridge Univ. Press, 2nd ed. 2009)

- Experimental lesson: How does a bicycle pump work?
  - Narration alone, or
  - Narration with simultaneous animation
- Transfer testing (essay)
  - Suppose to push down on the handle and no air comes out. What could have gone wrong?
  - Why does air enter a pump? Why does it exit the pump?
  - What can be done to make sure that a pump will not fail?

Measuring and Interpreting Effect Size

(Cohen, J. Statistical Power For Behavioral Sciences, Erlbaum press, Mahwah, NJ, 1988)

- Subtract the mean of the experimental and control group (Δ)
- Effect size= Δ ÷ pooled standard deviation (SD)
- Effect size ≈ No. of SDs of improvement
- Interpretation:
  - ~0.8 is considered a large effect
  - ~0.5 is considered medium
  - ~0.2 is consider a small

Results of testing the multimedia principle in several independent studies

Source	Content	Format	Effect size
Mayer, 1989, exp 1	Car Brakes	Paper	1.50
Mayer, 1989, exp 2	Car Brakes	Paper	1.71
Mayer & Gallini, 1990, exp 1	Car Brakes	Paper	1.19
Mayer & Gallini, 1990, exp 2	Pumps	Paper	1.00
Mayer & Gallini, 1990, exp 3	Generators	Paper	1.35
Mayer et al., 1996, exp 2	Lightning	Paper	1.39
Mayer & Anderson, 1991, exp 2a	Pumps	Computer	2.43
Mayer & Anderson, 1992, exp 1	Pumps	Computer	1.90
Mayer & Anderson, 1992, exp 2	Car Brakes	Computer	1.67
Moreno & Mayer, 2002, exp 1	Lightning	Computer	0.45
Moreno & Mayer, 1999, exp 1	Arithmetic	Game	0.47
Median			1.39

Implications of the Theory

- Humans have two separate channels to process auditory and visual information
- At the first transfer to working memory, the learner selects fragments of auditory and visual content to process
- Each channel has a finite capacity and can be overloaded
- The mind creates separate models for each modality and integrates them with past knowledge in the final step of learning

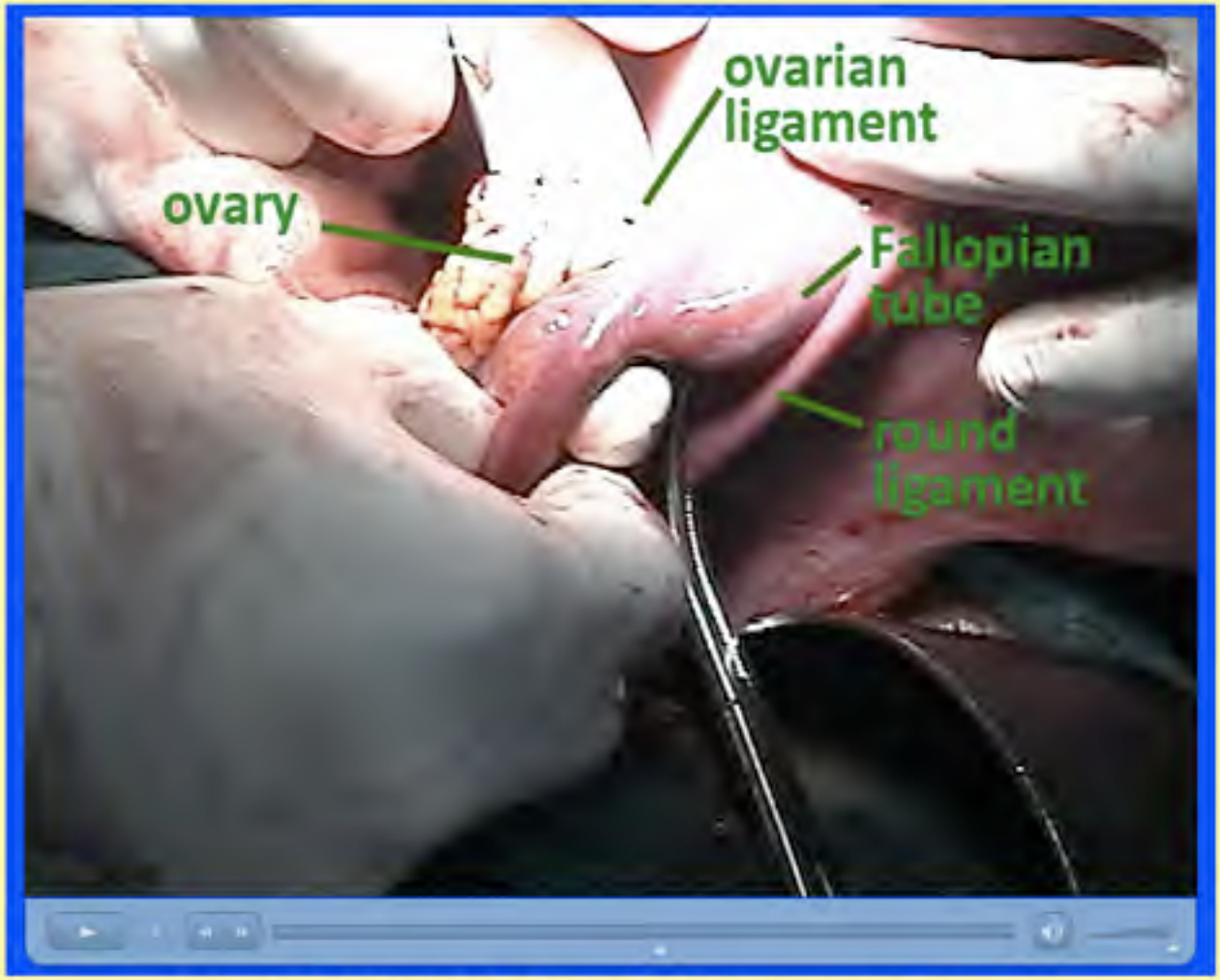
Principles of multimedia instructional design derived from experiments that test the theory

Example video 1:
Consider this lesson on guinea worm

Proven Principles of Multimedia Design

- Coherence:
  - Extraneous material not related to the focus of the lesson overloads the processing channels and impedes learning
    - Visual: unnecessary colors, complicated drawings, irrelevant pictures or on-screen text
    - Auditory: background music or sound effects
  - Median effect sizes
    - 2 studies of irrelevant sounds=1.11
    - 6 studies of irrelevant words or symbols=0.82

Still photo from a surgical video

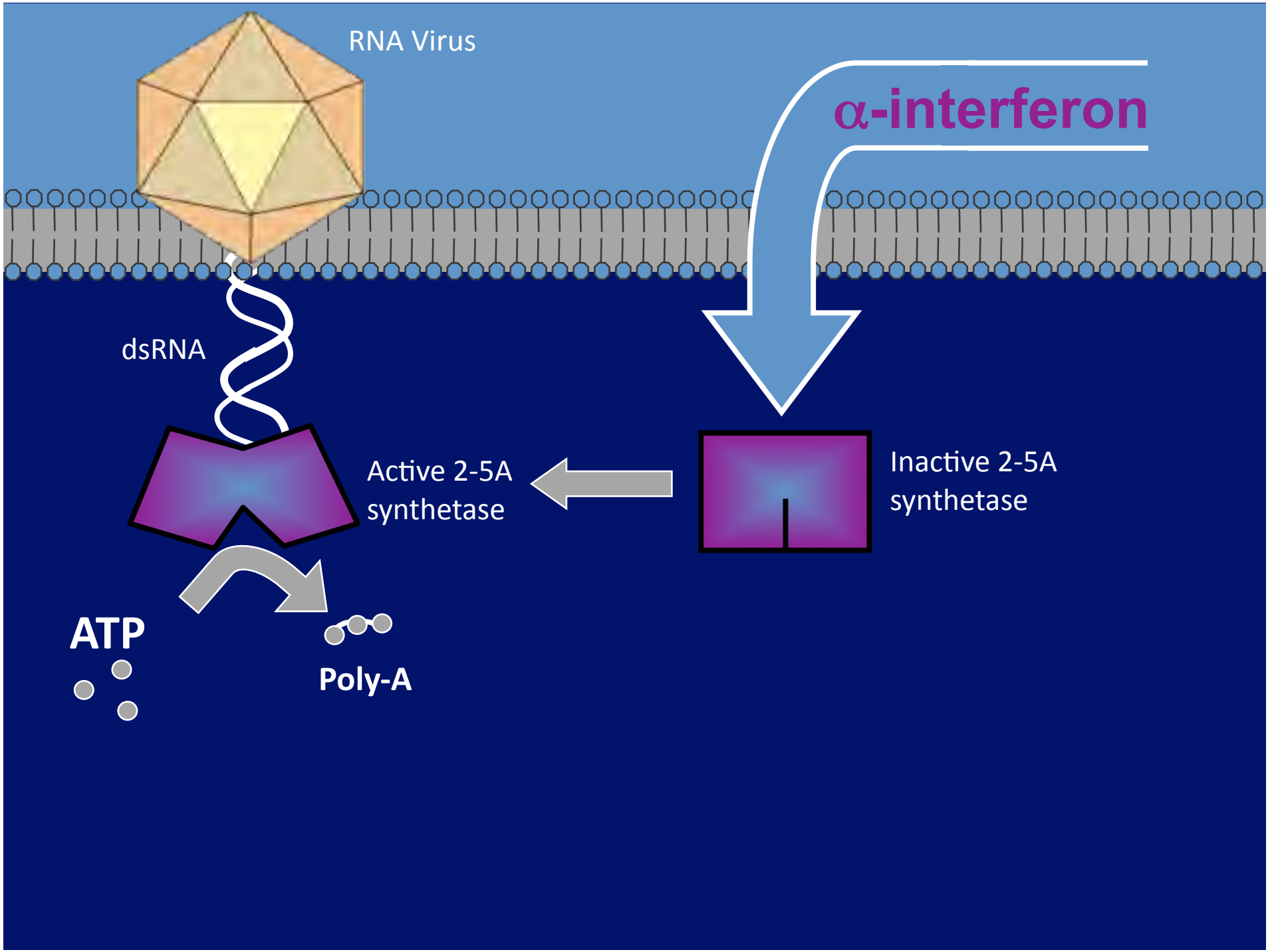


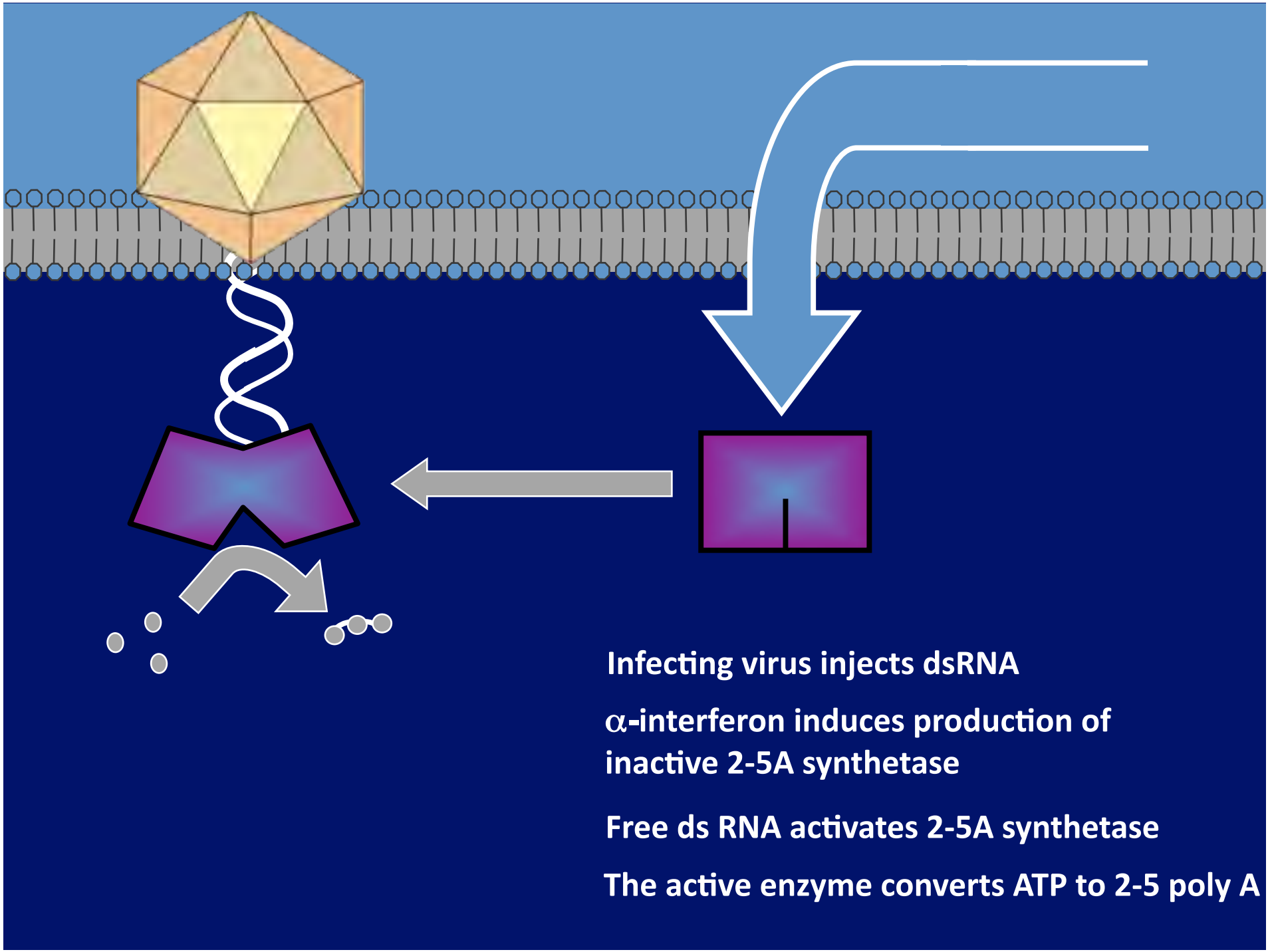
1. Division and Ligation of the Round and Infundibulopelvic Ligaments

 R. Adanu & N.C. Engleberg, University of Ghana

Proven Principles of Multimedia Design

- Signaling
  - Limited text, highlighting, or arrows to focus the learners attention enhances learning
  - Median effect size of 6 studies of signalling=0.52
- Redundancy
  - Elimination of on-screen text of the narration with the video or animation impairs learning
  - Median effect size of 5 studies in which redundant text was eliminated=0.72


RNA Virus
α-interferon
dsRNA
Active 2-5A synthetase
Inactive 2-5A synthetase
ATP
Poly-A


Infecting virus injects dsRNA
α-interferon induces production of inactive 2-5A synthetase
Free ds RNA activates 2-5A synthetase
The active enzyme converts ATP to 2-5 poly A

Proven Principles of Multimedia Design

- Spatial Contiguity
  - Placing text or labels next to the object they label improves learning
  - Median effect size of 5 studies =1.12
- Temporal Contiguity
  - When narration and animation are present simultaneously, learning is improved
  - Median effect size of 8 studies=1.31

Episiotomy and Repair

Index of Videos

Click here for instructions

Introduction to episiotomy

Videos (video size can be adjusted by enlarging the window)

1. Infiltration anaesthesia at the time of crowning (1:10)
2. Episiotomy and delivery of the baby (2:15)
3. Delivery and examination of the placenta (1:26)
4. Placement of a swab and infiltration of local anaesthetic for the repair (1:03)
5. Animation of the closure procedure (1:03)
6. Suturing of the vaginal mucosa (4:03)
7. Suturing of the muscle layer (1:12)
8. Suturing of the skin (2:47)
9. Inpection of the repair (0:17)

Self-assessment quiz (note: the new window may open behind this one in some browsers)

DISCLAIMER: Any medical information in this material is intended to inform and to educate and is not a tool for self-diagnosis or a replacement for medical evaluation, advice, diagnosis or treatment by a healthcare professional. You should speak to your physician or make an appointment to be seen if you have questions or concerns about this information or your medical condition.

Viewer discretion is advised: The educational material contained herein may contain medical images that non-professional viewers may find disturbing.

The patients who appear in this programme freely gave their consent for the authors to use their images for educational purposes. Where real patients were filmed or photographed, we have not shown their faces or other identifiable features.

R. Adanu & N.C. Engleberg, University of Ghana

Proven Principles of Multimedia Design

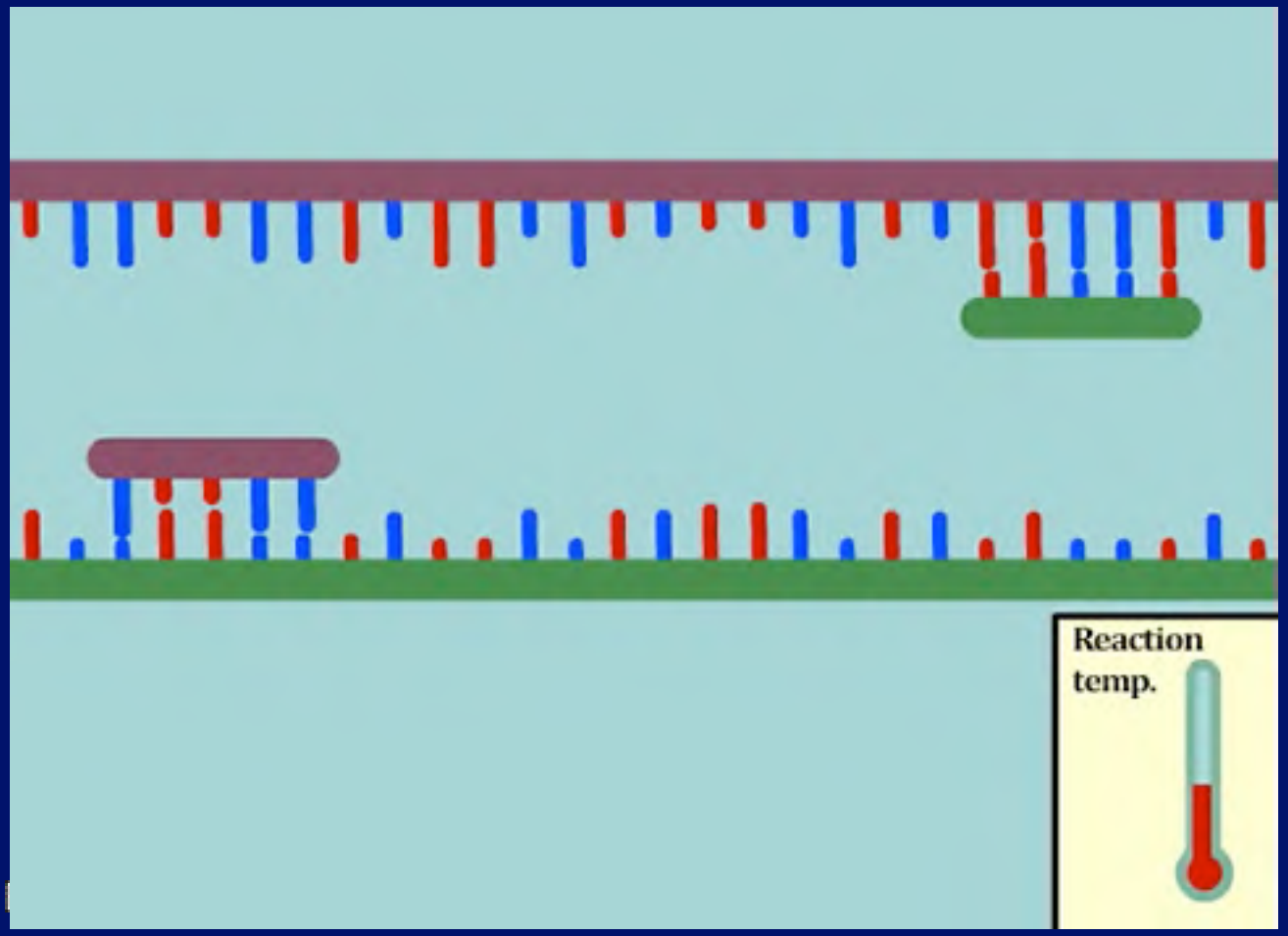
- Segmenting
  - Breaking up complex presentations into learner-controlled segments improves learning
  - Median effect size of 3 studies =0.98
- Pre-training
  - Making learners aware of terms and definitions prior to explaining a process improves learning
  - Median effect size of 5 studies=0.85
- Modality
  - Pictures and voice are better assimilated than pictures and printed words
  - Median effect size of 17 studies=1.02

Improving Generative Learning

Proven Principles of Multimedia Design

- Personalization
  - Narration should be directed personally at the learner, using the pronouns “you” and “I” rather than a passive voice.
  - Median effect size of 11 studies =1.11
- Voice principle
  - A human, familiar voice in narrations enhances learning
  - Median effect size of 3 studies=0.78

Example video 2:
Polymerase chain reaction



Boundary Conditions

- Principles apply most directly to learners with little or no prior knowledge of the subject being taught
- Principles are *more* important in the following situations:
  - Subject-matter is complex
  - Presentation is fast-paced

Elements of Good Programmes

- Pre-programme assessment
  - Helps a learner decide whether they may profit from the programme
  - Helps the learner know where their knowledge deficits are
- Self-assessment
  - Helps the student consolidate and reflect on what they have learned
  - Helps the student recognize points that they missed and should repeat.
- Feedback
  - In the best of circumstances, a student evaluation of the program would be desirable.

unnecessary, gratuitous image