

**Designing learner-centric e-learning in STEM disciplines**  
**Prof. Sahana Murthy**  
**Mr. Soumya Naryananan**  
**Interdisciplinary Programme in Educational Technology**  
**Indian Institute of Technology, Bombay**

**Lecture - 23**  
**Multiple Principle and Contiguity Principle**

With the extensive availability of variety of media available for creation of e learning content, the designers face a variety of questions such as what to use, how much to use and when to use?

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The slide is titled "Pros and Cons of using multimedia in content". It features a presenter, Prof. Sahana Murthy, on the left. The slide is divided into two main sections: "Positives" and "Negatives". The "Positives" section is marked with a green thumbs-up icon and lists four points: Engage learners, Improve attention, Convey information effectively, and Cater to various learner requirements. The "Negatives" section is marked with a red thumbs-down icon and lists two points: Overwhelm learners and Act as distraction. Below these sections, there is a question "What does research say?" and the text "Multimedia Principles". The slide also includes a footer with the NPTEL logo and the text "Learner-centric e-learning in STEM".

- Positives:
  - Engage learners
  - Improve attention
  - Convey information effectively
  - Cater to various learner requirements
- Negatives:
  - Overwhelm learners
  - Act as distraction

What does research say?

Multimedia Principles

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It is taught that multimedia engages learners, captures their attention, conveys information effectively and also caters to different learners needs. At the same time we have to ensure that the students do not get overwhelmed with the excessive use of media. So, how do we decide what is the optimum usage of media? Is there any research based guidelines available for this? There are a set of principles called multimedia principles which provide guidelines on how to effectively integrate media with e-learning content. While literature points to several multimedia principles we will be covering a few of them this week.

(Refer Slide Time: 01:15)

## Multimedia Principle

**Include both words and graphics to convey the information more effectively.**

**✗**

**TEXT ONLY:**  
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.

**✓**

Text and illustrations:

Clark, R. C., & Mayer, R. E. (2016). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. John Wiley & Sons.

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The first principle that we will discuss is the multimedia principle. This principle says that to effectively convey e-learning content, we should use both words as well as graphics.

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## Multimedia Principle

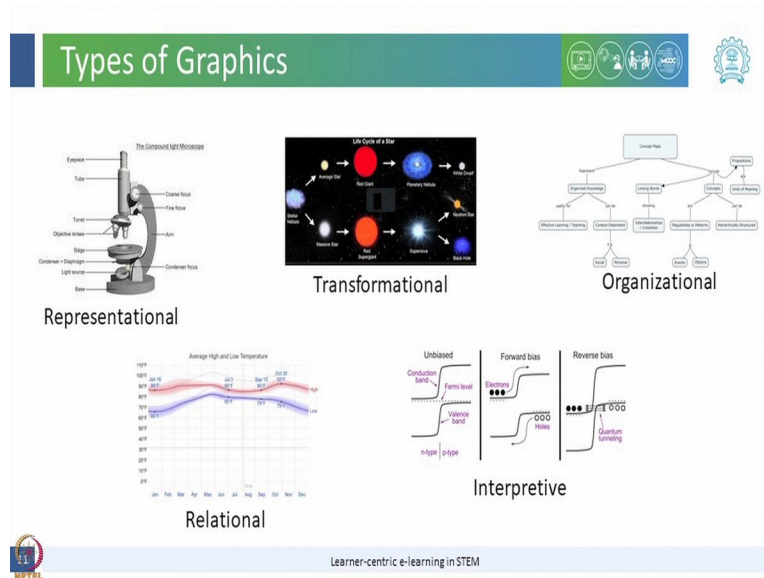
- Including both words and graphics helps learners
  - Engage with the content
  - Make mental connections between the different representations
  - Integrate new content with existing knowledge

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Including both words and graphics helps learners engage with the content make connections with the different representations as well as integrate it with their prior knowledge. This may be

evident, but there are certain recommendations on what kind of graphics to be used to convey what kind of information; let us look at a few of them.

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For example representational graphics may comprise of just an image with a caption such images may be used to convey facts or concepts. Relational graphics on the other hand can be used to convey quantitative relationship among different parameters this can be used to represent processes. Transformational graphics on the other hand convey information about changes during space and time. They can be used to represent again processes and procedure.

Another kind of graphics is the interpretive graphics, these graphics can be used to make the intangible or invisible concepts more tangible and concrete. They can be used to convey concepts, processes or principles. Organizational graphics can make quantitative information between different entities such graphics can be used once again to represent facts and concepts.

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## Reflection Spot

- A teacher is explaining about the lifecycle of a butterfly. She uses the following text and image combination to teach the concept. Is she following multimedia principle?





A. Yes

B. No

**Lifecycle of a Butterfly**

The butterfly goes through four stages in its lifetime. When a butterfly becoming an adult is called metamorphosis.

- First stage - The egg: A female butterfly lays eggs on a leaf
- Second stage - The Larva: Larva is also called a caterpillar. They look like a worm. They eat leaves and flowers and grow quickly.
- Third stage - Pupa: Pupa is also called chrysalis. It is a brown or green colored form that looks like a cocoon. In this the caterpillar begins to change to a butterfly.
- Fourth stage - Butterfly: When the chrysalis opens, the butterfly emerges. It now has wings to fly. It then looks for a mate and then lays eggs.



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Before proceeding further here is a reflection spot. A teacher wants to teach about the life cycle of a butterfly to her students. She prepares an e-learning content with the following combination of words and pictures. Do you think that this content follows the multimedia principle? Think carefully choose your options and then you can proceed.

(Refer Slide Time: 03:15)





## Discussion on Reflection Spot

- Positives
  - Instructor uses both words and pictures while explaining the concept.
  - Instructor uses an actual image while explaining the lifecycle.
- Limitations
  - The use of picture seems to be an afterthought.
  - Picture has not been used effectively to convey the information.

**Lifecycle of a Butterfly**

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Many of you might have appreciated the fact that, the teacher used both words as well as graphics while creating her e-learning content. You might also have observed that she has used actual images of the butterfly in its different forms in her content; however, there is definitely scope for improvement. It seems as if the teacher used the images as an afterthought, the graphics have not been used effectively to convey the information to the students.

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The slide is titled "How to integrate words and visuals?". It features a presenter on the left and a central diagram titled "Lifecycle of a Butterfly". The diagram shows four stages: Egg, Larva, Pupa, and Butterfly, connected by arrows in a clockwise cycle. The text on the slide describes the process of metamorphosis and the characteristics of each stage.

**How to integrate words and visuals?**

**Visuals should not be an afterthought.**

Lifecycle of a Butterfly  
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A more effective usage of graphics would have been to use the graphics to indicate the life cycle progression of the butterfly within the image itself. This brings us to an important point. Visuals must not be an afterthought. The usage of visuals must supplement the e-learning content so, as to maximize learning for the learners. As we can see in the image the visuals emphasize the temporal aspect of the life cycle of butterfly and the text addresses this in greater detail. So, the word text combination is more effective for the learners.



(Refer Slide Time: 04:31)

## How to integrate words and visuals?

Visuals and words should work together to create meaning for learners



**How Solar Cookers Work?**

**Parts of a Solar Cooker**

- Reflective surface
- Black pot
- Glass lid

Solar cookers typically have -

- Glass lid
- Black pots
- Reflective surface

**Basic principle:**  
Sunlight is converted to heat energy, which is used for cooking. Solar cookers need to be placed outdoors to catch maximum sun. Additional reflective surfaces help maximize sun rays focused on food to be cooked.

Incident Sun rays  
Reflected sun rays  
Maximizing heat from Sun

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Here is another example of how visuals and words can work together to create meaning for the learners. We can see that the concept of solar cooker has been effectively captured in this image. The image not only shows a different parts of solar cooker, it also shows how the sunrays are captured the incident and the reflected rise are captured to help in the cooking.

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## Contiguity Principle

Place printed words near corresponding graphics

**Separated Presentation**

Separate text and graphics

As the air in this updraft cools, water vapor condenses into water droplets and forms a cloud.

**Integrated Presentation**

Integrated text and graphics

As the air in this updraft cools, water vapor condenses into water droplets and forms a cloud.

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We now, come to the next multimedia principle which is the contiguity principle. Contiguity principle has two parts to it; one place printed words next to the corresponding graphics and two synchronized spoken words with graphics. By integrating text and graphics, we can ensure that the learner doesn't have to search which part of the graphics correspond to which words in the content. This enables learners to devote their cognitive resources to better understanding of the content.

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Contiguity Principle – Example

- Text and graphics placed adjacent such that learner need not scroll to access text and graphics.

Paramecium

Paramecium is a genus of unicellular ciliates, commonly studied as a representative of the ciliate group. Paramecia are widespread in freshwater, brackish, and marine environments and are often very abundant in stagnant basins and ponds. Because some species are readily cultivated and easily induced to conjugate and divide, it has been widely used in classrooms and laboratories to study biological processes. Its usefulness as a model organism has caused one ciliate researcher to characterize it as the "white rat" of the phylum Ciliophora.

**Description:**

Species of Paramecium range in size from 50 to 330 micrometres in length. Cells are typically ovoid, elongate, foot- or cigar-shaped. The body of the cell is enclosed by a stiff but elastic membrane (pellicle), uniformly covered with simple cilia, hairlike organelles which act like tiny oars to move the organism in one direction. Nearly all species have closely spaced spindle-shaped trichocysts embedded deeply in the cellular envelope (cortex) that surrounds the organism. Typically, an anal pore (cytopyge) is located on the ventral surface, in the posterior half of the cell. In all species, there is a deep oral groove running from the anterior of the cell to its midpoint. This is lined with inconspicuous cilia which beat continuously, drawing food inside the cell. Paramecia feed mainly by heterotrophy, feeding on bacteria and other small organisms. A few species are mixotrophs, deriving some nutrients from endosymbiotic algae (chlorella) carried in the cytoplasm of the cell.

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Here is another example where the text and graphics have been separated in the content, this forces the learner to either scroll across the through the content in order to access different parts of the content or you could also see that the learner has to move their eyes repeatedly to access different parts of the content. Contiguity principle recommends that keeping both graphics and the related words close together and not separating them is one way to mitigate this problem.

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### Contiguity Principle – Example

Labels showing parts of a diagram, shown separately as legend

Labels showing parts of a diagram in the image itself

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Let us look at another example, which we frequently encounter in stem disciplines. We often use images with labels to represent facts and concepts. In such cases contiguity principle recommends that the labels be placed close to the image rather than at the end or the bottom or the side of the image in the form of legend.

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### Reflection Spot

- An instructor asks a series of questions to her students. She provides feedback to all the questions at once in the next page. The feedback comprises of list of choices and explanation as to why they are valid or invalid. Do you think this format is following contiguity principle?

A. Yes

B. No

**Page 1**

**Questions**

MQ1. Constructive alignment involves creation of content involving following three components in their sequential or integral relationship.

A. Learning outcomes, assessment, teaching practices  
B. Learning outcomes, teaching practices, evaluation  
C. Learning outcomes, teaching practices, assessment  
D. None of the above

MQ2. Which is important that we align the assessment questions to learning outcomes? Check all that apply.

A. To ensure that the learners have clarity on the content and the level at which they will be assessed in the exams  
B. To make the exam questions difficult for the learners  
C. To ensure that the instructor gets to know if the learner learning outcomes have been achieved

MQ3. Which of the following are desirable requirements to define an effective learning outcome? (2017)

A. (U) should be measurable and specify the knowledge/skill that you would expect the learner to be able to demonstrate  
B. (U) should be expressed from the learner's perspective  
C. (U) should be formulated in action verbs

**Page 2**

**Feedback**

Feedback 1:  
Constructive alignment is a pedagogical approach to teaching in which the learning outcomes and the learning activities are aligned to achieve defined outcomes by the end of the learning process. Teaching learning activities and assessments are then designed to best achieve those outcomes and to ensure they have been achieved.

Feedback 2:  
A. Correct. When the assessment questions are aligned to learning outcomes, there is a match between the expectations of both the instructor and the learner on what should be the focus of assessment. Learners get a clear idea of the content and the level at which they will be assessed in the exams.  
B. Incorrect. Alignment does not imply that assessment has to be made unnecessarily difficult for the learners.  
C. Correct. The instructor gets an accurate measure of the performance of the learner to ensure progress towards goals and improve on teaching learning activities, if required.

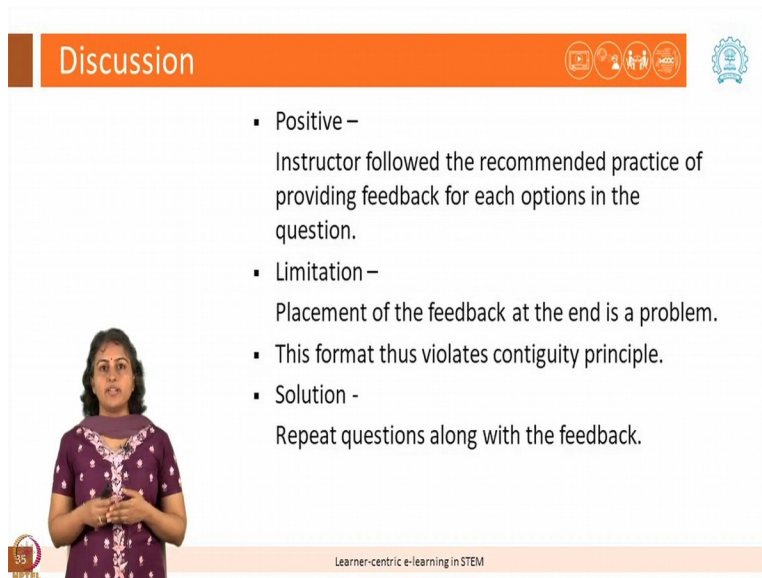
Feedback 3:  
While options A and C are appropriate as requirements to designing an effective (U), option B does not fit in as per requirement. Since learning outcomes describe what the learner can expect to do or have achieved as a result of engaging in a particular learning activity, the (U) should be expressed from the learner's perspective, and not from the instructor's perspective.

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Before we continue further here is another reflection spot. And instructor asks a series of questions to her students and she later provides feedback, but at the end of all the questions and in the next page. The feedback comprises only of the list of choices which were available and an explanation of why the choices were valid or invalid. Do you think that this format follows contiguity principle think carefully choose your answer and then we can proceed.

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




The slide is titled "Discussion" in an orange header bar. To the right of the title are four circular icons: a person, a group of people, a gear, and a document. Below the header, there is a list of four bullet points. To the left of the list is a video inset showing a woman in a purple patterned top speaking. At the bottom left is a small logo with the text "NPTEL". At the bottom right, the text "Learner-centric e-learning in STEM" is displayed.

- Positive –  
Instructor followed the recommended practice of providing feedback for each options in the question.
- Limitation –  
Placement of the feedback at the end is a problem.
- This format thus violates contiguity principle.
- Solution -  
Repeat questions along with the feedback.

Many of you must have noticed that the teacher followed the recommended practice of giving feedback for each of the options in the question. However, the placement of the feedback is a problem. The feedback comes at the end of a series of questions. The student very likely does not remember the question completely or probably remembers only parts of the question.

In the format that the teacher follows, the question is not repeated its only the choices and why the choices are valid and invalid. This may prove difficult for learners to connect what is being explained about the choices to the question. This format therefore, violates contiguity principle a simple fix would be to repeat the question before giving the feedback.

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## Takeaway

- **Multimedia principle**
  - Add visuals to words, instead of words alone
- **Contiguity principle**
  - Place printed words near corresponding graphics
  - Synchronize spoken words with graphics

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Before we wrap up let us have a quick look at the multimedia principle and contiguity principle. Multimedia principle says that add visuals and words instead of using words alone. Contiguity principle says that one place printed words near corresponding graphics; two synchronize the audio along with the graphics.

Thank you.