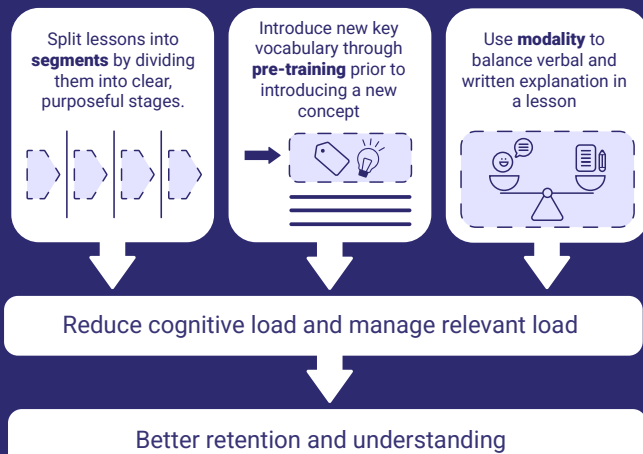


Designing Multimedia for Understanding

Mayer's Principles of Multimedia Learning draw on cognitive science to explain how learners make sense of words and pictures together¹. This matters in computing, where new concepts, diagrams, and code examples can overload learners' working memory. Using these principles helps teachers design learning experiences that manage this load, making it easier for learners to follow and process new ideas.

When creating and using multimedia...



Summary

Mayer's model of multimedia learning acknowledges that people process information through two limited-capacity channels – visual and auditory – and that learning requires active engagement². Designing learning around these limits helps learners select, organise, and integrate new information.

Key principles for managing essential processing:

- **Segmenting:** Present information in short, meaningful chunks
- **Pre-training:** Introduce key terms or concepts before full instruction
- **Modality:** Explain complex visuals verbally rather than in writing to distribute cognitive load across channels¹

The overarching design aim is to manage essential processing by controlling the amount and complexity of new information so learners can focus on core ideas without exceeding working memory limits². Applied effectively, these principles support deep engagement while maintaining cognitive efficiency in computing education³.

What is essential processing?

Mayer's Principles of Multimedia Learning, developed from the Cognitive Theory of Multimedia Learning (CTML)¹, build on three key assumptions: dual-channel processing, limited capacity, and active learning³.

Dual-channel processing: Learners process information through two separate channels: a visual channel for images and written text, and an auditory channel for spoken language. Each channel has a limited capacity and can only handle a small amount of information at any one time. When the demands placed on either channel exceed this capacity, learning is disrupted. Overload comes from two distinct sources: the unavoidable demands of the material itself, and poor instructional design.

Essential processing: The unavoidable mental effort required involves coordinating text, diagrams, symbols, or models to build accurate mental representations. This cognitive load is intrinsic to the subject matter and can't be removed.

When instructional design ignores channel limits, it adds unnecessary burden on top of this effort, pushing learners into overload. Effective instructional design balances what learners see and hear, helping learners with complexity and to focus on key ideas. This supports deeper understanding and the likelihood that new knowledge is successfully stored in long-term memory³.

These foundations underpin Mayer's Segmenting, Pre-training, and Modality principles, which help learners integrate new information efficiently².

Segmenting Principle

Learners understand more deeply when complex information is divided into manageable segments rather than presented all at once². Continuous instruction can quickly overload working memory. In computing, applying segmenting means structuring lessons or demonstrations into clear, purposeful stages. For example, when explaining how data moves across a network, each stage can be introduced separately before being combined into a complete model. Sub-goal labelling can highlight the purpose of each stage, helping learners recognise structure and recurring patterns across systems.

Segmenting applies equally to programming activities and non-programming processes. Complex processes, such as debugging, network communication, or system development, can be broken into smaller learning episodes that help learners identify key components and understand how individual steps fit together. Brief pauses between lesson segments allow for reflection and mental rehearsal before while scaffolding helps learners build understanding gradually. By pacing instruction and introducing natural pauses, educators reduce essential overload and promote deeper, more durable learning⁴.

Pre-training Principle

The pre-training principle states that learners grasp complex processes more effectively when they already understand the key terms, components, or goals². Without this preparation, learners spend valuable working memory decoding unfamiliar vocabulary instead of engaging with the lesson.

Before introducing a new topic, allocate time to introduce central concepts and how they relate. In computing, this might involve explaining ideas like inputs, processes, and outputs, or the roles of different devices within a simple network, before exploring how they work together.

Pre-training activates prior knowledge and builds schemas for new information⁴ supporting comprehension rather than just memorisation, and freeing cognitive effort for integrating the new concepts.

This principle is particularly important in computing education, where unfamiliar terminology can be a barrier. Displays and help sheets reinforce key vocabulary, and clear pre-teaching gives learners greater confidence when tackling complex topics.

Modality Principle

According to the modality principle, learners understand better when visuals are paired with spoken narration rather than written text¹. This distributes information across the auditory and visual channels, reducing the chance that either system becomes overloaded.

In computing education, learners frequently encounter diagrams, flowcharts, and code samples, all heavy on the visual channel⁵. When these are accompanied by written explanations, learners must process both visually, increasing cognitive load and reducing processing efficiency. Replacing written explanation with verbal narration offloads some of this demand to the auditory channel.

In practice, educators should explain visuals verbally, using narration or live commentary. For example, while displaying a system diagram, describe what each part does rather than including a written explanation with the diagram. This lets learners focus visually on the representation itself while listening to the explanation.

Offloading explanatory text to the auditory channel, helps learners follow the logic of computing processes without exceeding working memory limits, supporting deeper understanding of complex computational relationships³.

Applying the principles in practice

To manage essential processing effectively, educators should integrate segmenting, pre-training, and modality into their practice:

- Design lessons as short, focused segments rather than continuous explanations
- Pre-teach key vocabulary and concepts to activate prior understanding¹
- Pair graphics, code, or animations with spoken explanation, not redundant text⁵
- Avoid text-heavy content that duplicate narration or divide attention
- Scaffold worked examples to gradually increase cognitive challenge²
- Encourage pauses for reflection between segments

When explanations, examples, and visual materials align with how learners process information, the result is deeper understanding, stronger retention and more confident, independent problem-solving in future computing work³.



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