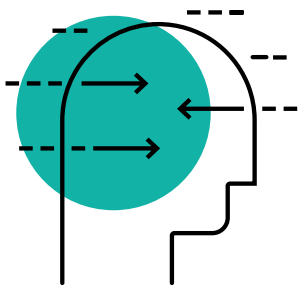
Pearson

Learning Design Principles

Minds in Mind

Attention & Cognitive Load



Summary

What are Pearson's Learning Design Principles?

Our Learning Foundations describe the optimal conditions for learning and reflect the learner experience we hope our products will create. We do this by incorporating our Learning Design Principles.

Each of our Learning Design Principles goes into detail about a key principle, supporting product design and marketing by describing:

- the research that informs the principle
- why it matters in learning
- how we can apply it in practice

Our portfolio of Learning Design Principles will continue to grow over time.

Welcoming Experience
- Motivation & Mindset
- Social & Collaborative Learning

Minds in Mind
- Developing Understanding
- Attention & Cognitive Load
- Active Learning, Memory & Practice
- Desirable Difficulty & Scaffolding
- Feedback for Learning

Learning Behavior
- Self-Regulated Learning & Metacognition

Purposeful Design
- Objective Design
- Assessment & Evidence-Centered Design
- Personalized Learning & Adaptive Systems
- Authentic Learning

Learn Anywhere
- English Performance Standards
- Digital & Virtual Learning

Attention & Cognitive Load

Learners struggle to stay engaged and focused while learning. How can we help learners avoid distraction and focus their attention on the things that matter?

Attention is a selective filter that allows sensory information from the environment to enter working memory. Attention selects information based on characteristics like how important, interesting, or new it is.

Cognitive Load is the amount of working memory ("brain power") needed to accomplish a task. Some of the functions are good for learning, and some can detract from learning.

Example: A math word problem

Tommy went to a farmers' market. He bought three red apples and four green apples. He also bought two pears and three oranges. How many apples did Tommy bring home?

- **Intrinsic load** is needed to handle the task itself, i.e., add 3 + 4
- **Extraneous load** is needed to understand everything around the task, e.g., Tommy's name, the color of the apples, distractions like the learner being hungry for lunch
- **Germane load** is needed to build understanding and solidify learning: making connections, integrating prior knowledge with new intrinsic information, filtering extraneous information

Why it matters

Good learning design can help learners pay attention to the right things by decreasing distractions and encouraging good learning practices.

- Being a good multitasker is a common misconception
- Learners need help pulling out the useful content when learning something new
- Learners can be trained to use attention wisely

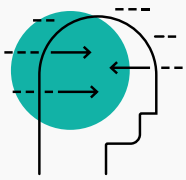
Categorizing the types of cognitive load is important for designing learning experiences, because some support learning and others get in the way. When we understand the principles of cognitive load, we can:

- identify and reduce extraneous information that may use up cognitive resources
- determine how design elements may compound and interact in the learning environment
- enhance germane cognitive load to better integrate new information into existing schemas

Impact

When we successfully incorporate this principle into learning experiences, we can have an impact on these learner outcomes:

- learners are interested and motivated because their attention has been engaged appropriately by relevant content
- learners persist in their learning because they engage in manageable blocks of focused study
- learners are proficient and can transfer their learning to new contexts because the experience is focused on efficient learning experiences without unnecessary distraction



Attention & Cognitive Load

The big ideas

1

Attention can be **guided towards the important information** using design layout and formatting.

I know what I should be paying attention to.

I can concentrate on the task and what I'm learning without any distractions.

2

Distractions can pull attention away from learning. Distractions in the learning content, the environment and in our own thinking influence what we attend to and take up processing power.

3

A learner can only pay attention to a **limited amount of information** at a time, and only for so long.

I can only handle so much learning at once, and only for so long.

4

The **way information is presented** can capture a learner's attention, but can also create distractions.

This looks interesting, and I know what I'm being asked to do.

Big Idea 1

Guiding attention

Attention can be guided towards the important information using design layout and formatting.

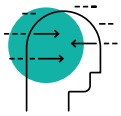
What it feels like for learners

I know what I should be paying attention to.

Learners need to pay attention to learning content to gain understanding, but their attention is constantly taking in information within the environment. Because working memory has limited capacity, information is better understood when broken up into segments. This limitation also means we need to guide attention towards the important parts of the learning environment.

- Break up and chunk information
  - Working memory can store five to seven items of information at once
  - Break up information into smaller sections to guide attention through a lesson
- Use unique features to draw attention
  - Attention acts like a spotlight that scans the environment for information
  - Use formatting, like headers or words in bold, to guide attention towards key ideas
  - Use images to signal information around key ideas, and to support reading or listening to text-based information
- Prime attention by giving clear objectives
  - Connecting new information to prior knowledge requires germane cognitive load
  - Present specific objectives at the beginning of a lesson
  - Pre-train the main concepts and definitions
  - Once smaller concepts are learned, working memory can relate new complex concepts using this pre-trained knowledge

See this Learning Design Principle: Objective Design



See this Learning Design Principle: Desirable Difficulty & Scaffolding

What it means for designing learning experiences

- Present content so that it guides attention towards important information
  - Present content in user-paced segments rather than a continuous unit.
  - Chunk information to represent meaningful elements of the lesson.
- Guide attention towards important elements through presentation
  - **Provide cues** that signal how essential material is organized.
- Start the lesson with the right information
  - Connect to learning objectives to draw out relevance.
  - **Pre-train learners** to direct their attention towards the important information.

See this Learning Design Principle: Objective Design

See these Multimedia Principles from Mayer (2020):

- **Signaling:** highlight essential words or graphics
- **Spatial contiguity:** place essential words next to corresponding graphics on the screen
- **Segmenting:** present multimedia lessons in user-paced segments

Big Idea 2

Minimizing distractions

Distractions can pull attention away from learning. Distractions in the learning content, the learning environment, and the learner themselves influence what learners attend to and take up processing power.

What it feels like for learners

I can concentrate on the task and what I'm learning without any distractions.

- **Distractions in the learning content**
  Information should be concise and purposeful. Unnecessary content in a lesson requires extraneous cognitive load. Decreasing extraneous load in the lesson means learners' attention can be focused on the important information.

  When a learner's attention is pulled in multiple directions by different streams of information, it requires effort to switch from one to another. The more complex or different each stream is, the more processing power is needed for germane cognitive load. Synchronizing the streams of information and reducing unnecessary content reduces extraneous cognitive load.

- **Distractions in the learning environment**
  Learning happens best when the learner doesn't need to multitask and isn't disrupted by distractions.

  Some learners believe that with practice, they can learn to multitask, e.g., by learning while a TV show plays or a conversation happens in the background. But this is not a skill that can be improved over time; it is a distraction that adds to cognitive load. To improve learning, learners need support to remove or avoid such distractions.

- **Distractions in the learner themselves**
  Attention operates most efficiently when the learner's physiological and psychological needs are met. For example, positive emotions and lower anxiety relate to better learning performance, whereas negative emotions and higher stress increase cognitive load.

What it means for designing learning experiences

- Organize content to avoid distractions
  - **Remove unnecessary information** that doesn't align with the objectives.
  - If possible, **avoid superfluous information** by replacing text with images.
- Recognize that distractions in the learning environment may influence attention
  - Explain to learners that **multitasking** can make performance suffer.
- Because learners may experience internal distractions, monitor and assess attention during learning
  - **Check in** with learners to assess whether basic needs are being met.
  - Carry out **comprehension check-ins** during the learning session.
  - Integrate **practice at spaced intervals** throughout the lesson to engage attention and decrease stress.

See these Multimedia Principles from Mayer (2020):

- **Coherence**: exclude extraneous material
- **Redundancy**: don't combine more modalities than needed
- **Image:** only put the speaker's image on the screenif there's a clear benefit

Big Idea 3

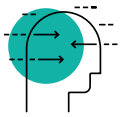
Managing cognitive load

A learner can only pay attention to a limited amount of information at a time, and only for so long.

What it feels like for learners

I can only handle so much learning at once, and only for so long.

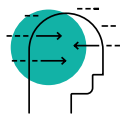
- **Working memory has limited capacity when learning new information**
  Scaffolding and sequencing new information (presenting it piece by piece) reduces the germane load needed to connect it to existing knowledge.
- **When processing power is used up, learners experience cognitive fatigue, which makes it more difficult to concentrate and easier to become distracted**
  Attention and processing power are restored by taking breaks. Spacing learning across multiple sessions depletes working memory less and improves memory retention.
- **When starting a new complex problem, learners need guidance about where to turn their attention first**
  Worked examples (step-by-step solutions to a task) guide attention towards the problem and the steps needed to reach a solution. Many different worked examples are needed for a learner to piece out the key themes. As the learner becomes familiar with the elements of the problem, similar problems can be integrated, and guidance can be faded out.



See this Learning Design Principle: Desirable Difficulty & Scaffolding

What it means for designing learning experiences

- Break up content to make sure attention is focused during the learning experience
  - **Scaffold** the learning content to guide attention and connect to prior knowledge.
  - **Isolate elements** of a problem until the learner can master each task.
- Monitor attention throughout the learning experience
  - Encourage **spaced practice** to optimize attention during learning.
  - Introduce **check-ins** during learning to encourage engagement.
- Reduce the complexity of the learning content
  - Use **guidance-fading** to guide attention towards key ideas.
  - Present **worked examples** to reveal parts of new concepts step-by-step.



See this Learning Design Principle:
Desirable Difficulty & Scaffolding

See these Multimedia Principles from Mayer (2020):

- **Pre-training:** teach the main concepts before beginning multimedia lessons

Big Idea 4

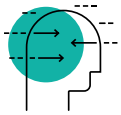
Engaging attention

The way information is presented can engage a learner's attention, but can also create distractions.

What it feels like for learners

This looks interesting, and I know what I'm being asked to do.

- **Learners' attention is engaged when they are actively learning**
  Engaging learners' attention by asking them to map, enact, draw, imagine, and explain can promote efficient and active learning patterns known as generative learning. (Active learning is often contrasted with passive learning, such as reading from a text or watching a video — it does not mean active as in physically moving around.)
- **Using informal, realistic human language during learning can improve outcomes**
  A conversational style of written information is associated with more active cognitive processing, and small changes like changing "the" to "your" result in better transfer.
- **Interactive materials can be engaging if used well**
  The most interactive, immersive experiences tend to be the most enjoyable and motivating — but also require the most processing power, potentially distracting from learning. Visualizations can aid working memory by guiding attention towards key ideas, and instructional guidance can minimize the cognitive load needed to construct the necessary frameworks to make use of a visualization.



See these Learning Design Principles:
Desirable Difficulty & Scaffolding
Active Learning, Memory & Practice

See this Learning Design Principle:
Digital & Virtual Learning

What it means for designing learning experiences

- Include learners in the learning experience
- Present learning content in a personalized way
- Be cautious when integrating immersive elements to improve engagement

See this Learning Design Principle:
Motivation & Mindset

See these Multimedia Principles from Mayer (2020):

- **Modality:** supplement graphics with narration, rather than on-screen captions
- **Generative learning:** provide opportunities to actively generate ideas
- **Multimedia:** use a combination of words and pictures, rather than pictures alone
- **Personalization:** use conversational rather than formal wording
- **Voice:** provide narration in a human voice, rather than a machine voice
- **Embodiment:** onscreen instructors should display a high level of embodiment
- **Immersion:** virtual reality is not necessarily better for learning than onscreen media

Authors

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Rachel Hopman-Droste is a researcher in the Learning Research & Design team at Pearson. Rachel earned her Ph.D. in Cognitive Psychology from the University of Utah and has spent the last 10 years translating research findings related to mental processes into real world insights.

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Katherine McEldoon is a research-to-practice connector. After earning her Ph.D. in cognitive and learning sciences at Vanderbilt University and a post at Arizona State University's Learning Sciences Institute, she has worked in academia, government, and industry to ensure the best scientific insights support student learning, no matter the context. Katherine has most recently worked as Lead Learning Scientist on Pearson's Efficacy & Learning team, bringing evidence-based insights to Pearson's world of learners.

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