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ADDIE Explained: Design

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Objectives

At the end of this chapter, you will be able to:

- Describe Bloom’s taxonomy and Gagne’s taxonomy and when they should be utilized.
- Demonstrate the ability to write Mager-style objectives for the cognitive, psychomotor, and affective domains.
- Apply the most appropriate sequencing strategy for instructional materials.
- Design instruction that adheres to the structure prescribed by Gagne’s Nine Events of Learning.
- Apply multimedia principles to instructional materials.

Introduction to Design

At this point in the ADDIE process, the instructional designer will have a basic idea of the existing gap in knowledge or skills from learner analysis, task analysis, or environmental analysis conducted previously. However, analyzing the current needs is not a sufficient foundation before selecting instructional materials. Instead, deliberate consideration of where the learners are now and where their educational journey needs to take them must happen first, after which the actual selection of instructional materials can occur. Both the examination of learners and the setting of goals are important features in the design portion of the ADDIE model. Based on the information gathered from the analysis, now is the time to start plotting the course to help learners be successful in the educational program through planning the objectives, determining the instructional sequence, and employing the educational strategies as will be discussed in this chapter.

Determine a Purpose

The first step in designing effective instruction is to think about exactly what type of learning needs to occur. For example, does the learner need to learn how to manipulate a forklift? Learn how to execute a logarithmic function? Learn to believe in global warming? Each of these goals will require a different approach to instruction. Gagne (1985) developed a classification system to help guide the instructional designer through deciding what type of learning needs to occur and what instructional strategies will best facilitate learning this type of content.

Gagne’s Taxonomy

Many instructional designers refer to Gagne’s taxonomy of learning (1985) as a theory that identifies the major domains of learning: cognitive strategies, psychomotor skills, attitude, intellectual skills and verbal information. These classifications indicate the differences between these learning domains must be accommodated in order to design effective instruction. Gagne recognizes five domains of learning and different internal and external conditions essential to facilitate learning in each domain. Gagne’s condition of learning matrix is summarized from Gredler’s (1997) in Table 1.

Table 1. Gange domains of learning.
<table>
<thead>
<tr>
<th>Domains of learning</th>
<th>Conditions</th>
<th>Instructional Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive strategies</td>
<td>The internal process in which learners plan, organize and observe their own learning.</td>
<td>Demonstrate the instructional strategy if general task. Explain the instructional strategy if specific task. Provide feedback and support.</td>
</tr>
<tr>
<td>Psychomotor skills</td>
<td>Ability to execute a series of physical activities, which involve these steps: Learn and practice to perform the movement. Improve the movement based on the feedback.</td>
<td>Set up regular practice. Plan for repetitions and provide feedback.</td>
</tr>
<tr>
<td>Attitude</td>
<td>The internal state which influences an individual’s choice of action.</td>
<td>Give good examples and enact positive behavior. When learner performs the modeled behavior, provide support.</td>
</tr>
<tr>
<td>Intellectual skills</td>
<td>Actions that allow individuals to react to the surroundings: Define concepts. Problem-solving approach. Employ the new skills.</td>
<td>Provide examples and regulations. In order to make sure the appropriateness of instruction for certain learners, items should be instructed to measure the skills in terms of entry behaviors written in the performance objective.</td>
</tr>
<tr>
<td>Verbal information</td>
<td>Recall information: the internal conditions to support this learning contain pre-existing of structured knowledge. Approach for processing the new information.</td>
<td>Organize information, therefore can be learned in chunks. Provide explanations, images, and encoding cues.</td>
</tr>
</tbody>
</table>

**Bloom’s Taxonomy**

Similar to Gagne, Bloom, Englehart, Furst, Hill, and Krathwohl (1956) created a taxonomy of cognitive objectives, which is commonly referred to as Bloom’s Taxonomy. In this schema, there are six levels related to knowledge or information: knowledge, comprehension, application, analysis, synthesis, and evaluation. To Bloom et al (1965), knowledge is the lowest level of intellectual activity, while evaluation is the highest, as illustrated in Table 2. It is important to integrate a variety of levels of engagement when designing the instruction; while it can be easier to only incorporate content and activities for the knowledge level, meaningful learning is more likely to occur at the higher levels when the learners are required to synthesize information.

Table 2. Bloom’s cognitive taxonomy.
For example, one student might learn that there are three learning theories: behaviorism, cognitivism, and constructivism. This student has knowledge that they exist, and could select these terms on a multiple choice test, but that is it. As they learn more about each learning theory, they gain comprehension. If this student intentionally teaches someone a new behavior and makes observations about how the learning occurred, they have achieved application of the concept. If this student compares and contrasts the three theories, then the student must deeply consider the facets of each theory and has conducted an analysis of the content. Finally, if the student evaluates which learning theory they prefer and is able to provide supportive logic, then evaluation has been achieved. According to this theory, the learner has had the most meaningful experience and learned the content most effectively by the time he or she reaches this stage.

It is important for the instructional designer to consider which degree of learning is necessary to achieve the overall goal of the educational curriculum. Is it enough for the learner to have knowledge? Or is it essential that the learner gain expertise over the content? Reaching the evaluation stage should not be considered inherently better than the other stages simply because it requires deeper understanding. Instead, the best level will be the one that is necessitated by the instructional objectives.

**Design Check Point**

**Writing Objectives**

Creating specific objectives is an important step to make sure the curricular material will help the learners achieve the goals defined in the goals analysis, as these objectives will specifically describe the final goals. Essentially, writing objectives serves as a connection to fill the gap between the current needs and the desired behaviors the learners will perform at the end of the training. Objectives are an in-depth explanation of what learners will be able to accomplish when they finish a set of instruction. Mager (1997) uses the term “behavioral objective”, which refers to the specific behavior, skill, or attitude the learner will be able to achieve by participating in the instruction.

According to Morrison, Ross, Kalman, and Kemp (2010), a well-written objective will guide the compilation of focused instructional activities and instruction, provide a framework for the evaluation of learning, and help students identify what they have or have not yet mastered. The following examples demonstrate how a poorly-written objective will not guide specific instructional practices or set concrete goals for the learner, but a well-written objective will.

- A poorly written objective: The learner will learn how to type.
- A well-written objective: Upon completion of the module, the learner will type 80 words per minute during the final test in the computer program, Mavis Beacon Teaches Typing.

As demonstrated in this example, a well-written objective contains several components: specified behaviors, conditions, and criteria.

**Behaviors**

Dick, Carey, and Carey (2009) proposed objectives should explain both the goal of the behavior and the actual behavior to be observed. Typing is the behavior in the example above. It should be possible to view and measure the desired behavior so the instructor can assess whether mastery has occurred.
Conditions

Conditions are related to a set of resources that can be accessible to the learner as they work to master new material. For example, a learner would need access to a computer in order to develop typing skills; in this scenario, the computer access would be considered a condition. An objective for this example could be: “Given access to a computer with a full keyboard, the learner must demonstrate an ability to type 80 words per minute.” This part of an objective should be included if there is a necessary tool or environment, but it is not always included.

Criteria

The last component of the objective is the criteria for evaluating appropriate skill performance. In some cases, responses from learners may be different. Therefore, instructional designers will have to analyze the difficulty of the assigned task and get suitable criteria in evaluating responses from learners. Mastery learning is evaluated according to whether responses from learners meet the criteria or not. Checklists and rubrics are some of the methods used by instructional designers to describe the difficulty of criteria for acceptable responses. In the example above, “80 words per minute” is the criteria as it clearly describes a measurable behavior that indicates mastery.

How to write objectives

While writing objectives is not a precise art or science, there is certainly a standard structure to help the instructional designer develop strong statements to guide instruction. In general, a well-written objective will start with an action verb then address the relevant content. There are three domains of objectives: cognitive, psychomotor, and affective.

Cognitive objectives are the most common in an academic setting; these objectives exist to determine how the learners can demonstrate they have gained new knowledge. Bloom’s taxonomy (Bloom, et al, 1956), explained earlier in this chapter, provides specific language to use to indicate the level of comprehension necessary for the specific task.

Psychomotor objectives can be used to define the ideal execution of a physical skill set. Heinich, Molenda, and Russel (1993) developed a schema to describe important features of a learned physical motion. The structure of this taxonomy is similar to that of Bloom’s taxonomy, progressing from least intensive to most. The domain for psychomotor objectives ranges from imitation as the most basic level of execution of the behavior to manipulation, precision, and articulation as seen in Figure 1.

<table>
<thead>
<tr>
<th>Engagement level</th>
<th>Psychomotor Objective</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least complex</td>
<td>Imitation</td>
<td>Repeat an observed motion</td>
</tr>
<tr>
<td></td>
<td>Manipulation</td>
<td>Performs desired action</td>
</tr>
<tr>
<td></td>
<td>Precision</td>
<td>Manipulation, but with accuracy</td>
</tr>
<tr>
<td>Most complex</td>
<td>Articulation</td>
<td>Coordinated and efficient execution of the new behavior</td>
</tr>
</tbody>
</table>

Figure 1. Engagement level, psychomotor objective, and description.
Affective objectives are the last major category of instructional objectives. These objectives pertain to attitudes and values. Krathwohl, Bloom, and Masia (1964) created an organizational schema for affective objectives describing the continuum for demonstrating the desired mindsets. The taxonomy ranges from receiving information at the least complex level to internalization of the concept as seen in Figure 2.

<table>
<thead>
<tr>
<th>Engagement level</th>
<th>Affective objective</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least Complex</td>
<td>Receiving</td>
<td>Give attention to new idea</td>
</tr>
<tr>
<td></td>
<td>Responding</td>
<td>React to an event</td>
</tr>
<tr>
<td></td>
<td>Valuing</td>
<td>Accept or reject an event based on a positive or negative attitude</td>
</tr>
<tr>
<td>Most complex</td>
<td>Organizing</td>
<td>Make a judgment based on values</td>
</tr>
<tr>
<td></td>
<td>Characterizing</td>
<td>Consistently acts in accordance with the learned value</td>
</tr>
</tbody>
</table>

Figure 2. Engagement level, affective objective, and description.

Considering what kind of objectives are the best fit for the content is an integral step in the instructional program development process. It is important for the instructional designer to review the analyses and work with the subject matter expert to determine to what level the learner needs to acquire the new behavior in order to meet the requirements of the environment. The instructional designer should ask questions to determine what is necessary for the learner to know versus what would be nice to know. One way to attempt this is by frequently asking the subject matter expert “But what would happen if the learner does not know this?” (Dirksen, 2011). By paring down the content in the lesson, the learners will be able to focus on the truly important content and potentially learn more effectively. Grouping similar goals and needs can also help pare down needs and guide effective instruction. In the end, it is important to remember instructional objectives serve the purpose of identifying the information necessary for a learner to acquire in order to solve an existing problem in performance.

At this point in the process, the analysis has been conducted, the important goals have been consolidated, and the domain of the objective has been identified. It is now time to actually write the objectives. Mager (1984) is known for developing a precise formula requiring an action verb, the content to be addressed, and an articulation of the desired level of achievement of the new behavior. The common Mager-style objectives can be applied to cognitive, psychomotor, and affective domains.

**Objectives in the Cognitive Domain**

Within the cognitive domain, the instructional designer must first consider what observable behavior can demonstrate the learner has mastered the new material or skill set. In addition, there are four key components to writing a strong objective in the cognitive domain, as depicted in Figure 3. Two of the components are necessary for a good objective, while the other two are supplements that make the objective more direct and specific.
Necessary parts of a cognitive objective.

1. Action verb: Selecting an action verb to start an objective is a critical part of creating an accurate objective. Under the behavioral learning theory paradigm, it is imperative the action verb is something observable. Examples of action verbs and categories are listed in Table 6.

Table 3. Action verbs for various levels of Bloom’s taxonomy.

<table>
<thead>
<tr>
<th>Category</th>
<th>Knowledge</th>
<th>Comprehension</th>
<th>Application</th>
<th>Analysis</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Arrange</td>
<td>Classify</td>
<td>Apply</td>
<td>Analyze</td>
<td>Appraise</td>
</tr>
<tr>
<td></td>
<td>Define</td>
<td>Convert</td>
<td>Change</td>
<td>Appraise</td>
<td>Argue</td>
</tr>
<tr>
<td></td>
<td>Describe</td>
<td>Defend</td>
<td>Choose</td>
<td>Assess</td>
<td>Attach</td>
</tr>
<tr>
<td></td>
<td>Duplicate</td>
<td>Describe</td>
<td>Compute</td>
<td>Attach</td>
<td>Choose</td>
</tr>
<tr>
<td></td>
<td>Identify</td>
<td>Discuss</td>
<td>Demonstrate</td>
<td>Compare</td>
<td>Compare</td>
</tr>
<tr>
<td></td>
<td>Label</td>
<td>Distinguish</td>
<td>Discover</td>
<td>Contrast</td>
<td>Contrast</td>
</tr>
<tr>
<td></td>
<td>List</td>
<td>Estimate</td>
<td>Dramatize</td>
<td>Criticize</td>
<td>Discriminate</td>
</tr>
<tr>
<td></td>
<td>Match</td>
<td>Explain</td>
<td>Employ</td>
<td>Diagram</td>
<td>Discriminate</td>
</tr>
<tr>
<td></td>
<td>Memorize</td>
<td>Express</td>
<td>Illustrate</td>
<td>Differentiate</td>
<td>discriminant</td>
</tr>
<tr>
<td></td>
<td>Name</td>
<td>Extend</td>
<td>Interpret</td>
<td>Discriminate</td>
<td>distinguish</td>
</tr>
<tr>
<td></td>
<td>Order</td>
<td>Generalized</td>
<td>Manipulate</td>
<td>Distinguish</td>
<td>examine</td>
</tr>
<tr>
<td></td>
<td>Outline</td>
<td>Identify</td>
<td>Modify</td>
<td>Identify</td>
<td>Evaluate</td>
</tr>
<tr>
<td></td>
<td>Recognize</td>
<td>Infer</td>
<td>Operate</td>
<td>Illustrate</td>
<td>Explain</td>
</tr>
<tr>
<td></td>
<td>Relate</td>
<td>Locate</td>
<td>Practice</td>
<td>Infer</td>
<td>Explain</td>
</tr>
<tr>
<td></td>
<td>Recall</td>
<td>Paraphrase</td>
<td>Predict</td>
<td>Model</td>
<td>Explain</td>
</tr>
<tr>
<td></td>
<td>Repeat</td>
<td>Predict</td>
<td>Prepare</td>
<td>Outline</td>
<td>Explain</td>
</tr>
<tr>
<td></td>
<td>Reproduce</td>
<td>Recognize</td>
<td>Produce</td>
<td>Interpret</td>
<td>Justify</td>
</tr>
<tr>
<td></td>
<td>Select</td>
<td>Rewrite</td>
<td>Relate</td>
<td>Rate</td>
<td>Justify</td>
</tr>
<tr>
<td></td>
<td>State</td>
<td>Review</td>
<td>Schedule</td>
<td>Predict</td>
<td>Select</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Select</td>
<td>Show</td>
<td>Rate</td>
<td>Support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Summarize</td>
<td>Sketch</td>
<td>Select</td>
<td>Support</td>
</tr>
<tr>
<td>Verbs</td>
<td></td>
<td>Translate</td>
<td>Solve</td>
<td>Separate</td>
<td>Summarize</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Use</td>
<td>Subdivide</td>
<td>Value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Write</td>
<td>Test</td>
<td></td>
</tr>
</tbody>
</table>

2. Subject content: The next part of the objective is identifying the specific subject content addressed by the objective. The combination of the action verb and target subject content must be observable.

3. Degree of achievement: This part of the objective should indicate necessary level of performance in order to solve the existing problem. For example, the level of achievement should determine the frequency or accuracy the behavior is executed.

4. Conditions: The conditional portion of an objective addresses outside forces impacting the learner’s success rate. For example, the learner might need to learn how to operate specific materials or tools to demonstrate mastery.
It is important to remember that a good objective focuses on the behavior or product demonstrating mastery of the knowledge or skill set and does not focus on the process of completing the behavior. According to Gronlund (1985, 1995, 2004), these cognitive objectives can measure learning by including two parts: a description of the desired behavior and the exact specifications to which the behavior needs to be executed.

**Objectives in the Psychomotor Domain**

A behavioral approach is important for learning psychomotor skills in which learners need to increase their expertise (Dick, Carey and Carey, 2009). Psychomotor skills, such as driving a car, require a repetition of a learning task to become proficient. Therefore, an experienced driver who has mastered this skill is able to drive without focusing on each step in the driving procedure.

Since psychomotor skills are inherently easy to observe, writing objectives for this domain is fairly easy. The four criteria for behavioral objectives in the cognitive domain apply to writing psychomotor objectives. Action verbs are easy to select as these are physical behavior; the degree of achievement and conditions often become more relevant. For example, a nursing student will need to learn how to measure a patient’s blood pressure. An objective of this lesson could be:

- Upon completion of the module, the learner will accurately measure a patient’s blood pressure using a sphygmomanometer in less than 60 seconds.

**Objectives in the Affective Domain**

In contrast to the ease of writing psychomotor objectives, affective behaviors tend to be more abstract and might require some creativity to measure. When trying to measure beliefs or ideals, an indirect approach is often the most feasible technique. For example, observing a learner’s behaviors or what the learner says might provide insight to his or her beliefs. The observer will often have to rely on generalizations to give insights to the learner’s attitudes.

**Evaluation of Objectives**

Test item construction is a method to assess the clarity of the objectives for evaluating the learners’ achievement, which should match the behavior and conditions specified. It is important to note that establishing criteria for cognitive and psychomotor skills is a lot easier than establishing criteria for affective skills. There is no absolute limit on the length of a written objective sentence and also does not include how behavior is learned. The objective statements with criteria then will be utilized to evaluate the instruction.

**Design Check Point**

**Sequencing of Instruction**

Considering the presentation of information is an important component of scaffolded instruction. Scaffolding involves supporting the learners as they acquire new skills or knowledge by guiding them through new information in a planned and logical manner. Posner and Strike (1976) and English and Reigeluth (1996) each published guidelines for how designers should sequence instruction for effective learning.
The Posner and Strike Sequencing Schemes

The first of the Posner and Strike (1976) theories, learning-related sequencing, is seen in many classrooms. This theory proposes that instructional designers must examine the learner’s current knowledge and base the course of instruction to guide the learner from his or her current state. One way to do this is through thinking about a logical flow to learn the information. For example, a math student needs to learn how to add before the learner can truly understand the concept of multiplication. In this scenario, adding would be considered an identifiable prerequisite to multiplication because it is assumed a learner needs to understand how to add numbers before he can master multiplying numbers. Another second technique for learning-related sequencing focuses on what is most familiar to the learner, and then uses this as a reference point while progressing the instruction to cover the most unknown concepts. Similar to this focus on familiarity, a lesson could begin with something that the learner is already interested in or something the learner could easily perceive as engaging. The fifth learning-related technique is to consider the difficulty of the tasks the learner needs to master. Beginning with the least difficult skills and progressing to the most difficult can be an effective way to design instruction for effective learning to really focus on the student.

Posner and Strike’s second theory about how to best sequence content is called concept-related sequencing. The components of this theory can seem similar to those of learning-related sequencing. However, the curricular pattern in learning-related sequencing is based on the learner analysis, while the pattern in concept-related sequencing is based on the type of content and the relationship between the tasks. In concept-related sequencing, it is important to order instruction in a similar way to how people naturally organize information in their memory. There are four possible different patterns to follow under this paradigm: class relations, propositional relations, sophistication, and logical prerequisite. Class-related sequencing groups similar items. The progression of instruction starts with the general concept and then teaches the subparts of the concept once the large picture has been communicated. An instructor using propositional relations would hook the learner by providing real-world examples of a concept before presenting the logical explanation behind it. Sophistication related sequencing will guide the learner through the simplest information first and progresses through the most challenging or complex concepts as the learner gains knowledge about the topic. Logical prerequisite sequencing is similar to sophistication, but recognizes that sometimes learners will need to master a complex concept before having the knowledge foundation for understanding more simple concepts later on.

World-related sequencing is another way to approach the presentation of instruction. This presentation technique is a different approach considering how the subject matter exists in the physical world either as a single physical object, a time period, or in relation to other objects. For example, spatial sequencing presents information in regards to its physical structures and progresses through the content in a logical manner. Temporal related sequencing considers the order in which the subject matter occurs and presents it in a chronological pattern. Physical related sequencing considers the information existing on a continuum and progresses through the content from one side to the other.

Elaboration Theory Sequencing

English and Reigeluth (1996) present a slightly different take on content sequencing, called elaboration theory. In this theory, the instructional designer must consider what type of expertise the learner must gain. If the learner needs to understand a body of knowledge, then the curriculum should consider the guidelines for content expertise. If the learner needs to develop a skill set for a specific task, then the instruction should follow the task expertise sequencing. The process for
content expertise sequencing considers the relationship of the concepts and organizes them in a logical progression, often starting with the items that can be physically observed by the learner then progressing to more abstract or complex concepts. For task expertise, a slightly different procedure should be followed. The instruction should follow the simplifying conditions method, which indicates the learner should begin with the simplest task, master this skill, then progress across the increasingly more difficulty continuum of behaviors.

**Instructional Strategies**

At this point in the ADDIE process, the instructional designer knows what content needs to be addressed as well as in the order in which the content should be presented. Now it is time to determine how the information should actually be presented to the learner to facilitate meaningful learning. Morrison, Ross, Kalman, and Kemp (2012) “consider the design of the instructional strategies as the most crucial step in the process that can contribute the most to making the instruction successful.” There is typically no “one right way” to present information; different strategies can be applied to teach each objective in order to best portray the content.

**Gagne’s Nine Events - Learning Components of Instructional Strategies**

Gagne’s Nine Events of Instruction (1985) is one of the major contributions to the theory of instruction. It relates to the mastery learning and provides a framework for selecting and creating effective instructional strategies. The events serve as a theoretical model for instructional designers to design lessons, to select instructional strategies, and to sequence instruction. The nine events of instruction are widely used in standalone training as well as computer-based learning environments, in which the learner controls the sequencing of learning activities. The nine events of learning are:

1. Gaining learner’s attention.
2. Informing learners of the objectives.
4. Delivering the content and stimulus.
5. Providing learning support and guidance.
6. Providing an opportunity to practice and eliciting performance.
7. Providing feedback.
9. Enhancing retention and transfer.

Even though there seems to be many complex steps to consider when planning a curriculum, it is important to remember that at its essence, “learning is an active process in which the learner constructs meaningful relationships between the new knowledge presented in the instruction and the learner’s existing knowledge” (Morrison et al, 2012). The whole point of a well designed instructional strategy is to motivate the learner to actively engage with the material and make connections between what he or she already knows and the new information, building upon previous knowledge to become even more proficient.

**How to design an instructional strategy**

First, determine the type of content by considering the six categories listed below. Each objective could be a different type of content.

- Facts
- Concepts
- Principles
Second, select a generative strategy for each objective. The purpose of a generative strategy is to encourage engagement with the material as the learners process the content and respond actively. Each generative strategy will require the learner to engage with the material to a different degree; recall requires the lowest degree of engagement with elaboration on the other end of the continuum, requiring the greatest amount of engagement and synthesis of information. Here is a list of generative strategies with examples, arranged from the least to the most amount of engagement required from the learner:

- **Recall**: helpful for learning facts and lists.
  - Mnemonics are a useful tool for recall
- **Integration**: the learner transforms the material into a form more meaningful and easily remember.
  - Paraphrasing the content can help learners make a personal connection to the content.
- **Organization**: identify how new ideas relate to existing idea.
  - Filling in tables or creating outlines requires learners to really think about the relationship between the concepts they are learning.
- **Elaboration**: Similar to organization, but learners must also incorporate their own ideas into what they are learning.
  - Generation of mental images or sentence elaborations are good strategies.

Consider where each objective falls in this matrix, shown in Table 4. Typically items in the “recall” column of this Performance-Content matrix require less intensive engagement with the material than the “application” column. For example, an objective necessitating the learner to recall a procedure requires less engagement and effort than an object requiring the learner to apply and perform the procedure.

<table>
<thead>
<tr>
<th>Content</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recall</td>
</tr>
<tr>
<td>Fact</td>
<td></td>
</tr>
<tr>
<td>Concept</td>
<td></td>
</tr>
<tr>
<td>Principles and Rule</td>
<td></td>
</tr>
<tr>
<td>Procedure</td>
<td></td>
</tr>
<tr>
<td>Interpersonal</td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td></td>
</tr>
</tbody>
</table>

Now the instructional designer must work on the actual presentation of the content. Different types of content require different presentation strategies. However, the presentation of each type of content should consist of an initial strategy and a generative strategy. The initial presentation of the content should include a direct and purposeful experience with the material. Hands on activities that require participation from the learner, good visuals, and realistic representations are all powerful ways to hook the learner. The generative strategy should encourage the learner to really engage in the learning process. The content should be designed for meaningful interactions using recall or application (integration, organization, and elaboration). For established heuristics and prescriptions
for teaching specific types of information, refer to Morrison, Ross, Kalman, and Kemp’s (2012) Designing Effective Instruction.

**Instructional Strategy Evaluation**

At this point, a sufficient amount of instruction has been developed. It is now time to package instructional units to both engage learners and emphasize the most important information. Essentially, the instructional designer needs to focus on the specific messages being sent to the learner. There are three components to sending effective educational messages: a pre-instructional strategy, signals during the instruction, and effective use of pictures and graphics. Pre-instructional strategies are used to prime the learner for the upcoming content. Common strategies include pretests, showing specific objectives, providing a module summary or overviews, or creating an advanced organizer. Signaling during instruction should be explicit and prepare the learner for the upcoming content. Types of signals include lists, comparisons, examples, and explanations of cause-and-effect. Another type of signaling involves the actual format of the text; headings, variation in fonts, and overall layout can all help the learner prepare for what content is to come. Pictures and graphics can also supplement the instructional strategy, but the selection of media should be executed deliberately and with care. Multimedia principles provide guidance for selecting media that enhance learning.

**Design Check Point**

**Multimedia Learning**

Multimedia learning is based off constructivist learning theory, cognitive load theory, and dual coding theory (Moreno & Mayer, 2000). Heavy emphasis is derived from dual coding theory stating cognitive structures contain two distinct channels, verbal and nonverbal, to process information (Clark & Paivio, 1991). These two channels take in information and, if the information can be separated during the intake stage, they assist each other in knowledge acquisition. Notwithstanding, if information is only being registered on one channel, there is a high likelihood of overloading, which will decrease knowledge acquisition due to cognitive load. Cognitive load asserts the mind is a limited capacity processor, and acquiring new knowledge has the ability to overload working memory and decrease learning (Paas, Tuovinen, Tabbers & Van Gerven, 2003). For this reason, it is important to not overload a single channel during the learning process.

Multimedia instruction from Mayer (2009) has been defined as, “the presentation of material using both words and pictures, with the intention of promoting learning (p.5).” Empirical evidence has shown words and images carry a higher retention rate than from words alone (Fletcher & Tobias, 2005). For this reason, educators are instructed to provide learners with information that activates both channels as opposed to one. For example, imagine an educator has a nephew located across the country who is struggling with algebra. The educator could call the nephew and explain the steps and concepts of algebra over the phone; or the educator could make a YouTube video of him working out the specific problems and explaining the process as he goes. The YouTube video is providing dual channel activation, which makes it easier to learn.

Figure 1 (below) represents the process of multimedia learning. Mayer recognizes two forms of information, words and pictures, displayed in multimedia presentations. Once the information is presented, sensory memory is activated and pictures are seen by the eyes. Words can either be heard or seen depending on the method they are displayed. Note: If words are displayed on-screen with pictures, and there are no sounds, only the picture presentation is being activated. Vice versa
for a multimedia display of only narration without visual representations. Once passing through sensory memory, working memory takes over by selecting words and images. If both presentations are present, information is changed between word and visual bases in organizing the meaning of those bases. Those bases create mental models that are combined with the information that is contained in the long-term memory of what is already known.


**Instructing Content Types**

There are multiple types of representations used with multimedia principle and instruction. Clark and Mayer (2011) present graphic organizers with words such as “drawings, charts, graphs, maps, or photos, and dynamic graphics such as animation or video (p.54).” These graphics are visuals with words conveying messages to learners in unique ways. A map without words to represent street names or places can quickly lead to confusion and being lost. Likewise, just words with no image representations will be equally ineffective. Clark (1999) also recommends graphics to teach content types in Table 5.

<table>
<thead>
<tr>
<th>Content Type</th>
<th>Instructional Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fact</td>
<td>Statements of fact</td>
</tr>
<tr>
<td></td>
<td>Pictures of specific forms, screens, or equipment</td>
</tr>
<tr>
<td>Concept</td>
<td>Definitions</td>
</tr>
<tr>
<td></td>
<td>Examples</td>
</tr>
<tr>
<td></td>
<td>Non-examples</td>
</tr>
<tr>
<td></td>
<td>Analogies</td>
</tr>
<tr>
<td>Process</td>
<td>Stage tables</td>
</tr>
<tr>
<td></td>
<td>Animated diagrams</td>
</tr>
<tr>
<td>Procedure</td>
<td>Step-action tables</td>
</tr>
<tr>
<td></td>
<td>Demonstration</td>
</tr>
<tr>
<td>Principle</td>
<td>Guidelines</td>
</tr>
<tr>
<td></td>
<td>Varied context examples</td>
</tr>
</tbody>
</table>

Multimedia instruction uses graphics and pictures in different ways such as showing relationships, organizing topics, and as interfaces. For example, a website on the health of sea life in oceans may use all three. Showing relationships might include a graphic representing an animal and the food chain. This will allow learners and users to understand how the depletion of one segment of the food chain has consequences for an entire system. The organizing graphics on this website may be a sidebar containing various aspects of the ocean such as animal, plant, pollution, and so forth. These organizing graphics allow learners and users to click on topics of information that may or may not
follow patterns. Lesson interface graphics can be a backdrop to present information. On a website of sea life, it could use a plain white or black backdrop to present information; however, a better interface graphic may be an ocean backdrop of plants and fish as seen in Figure 5.

![Figure 5. (Source: www.aqua.org). Interface graphic used as a background for the National Aquarium in Baltimore, Maryland. The image of the background matches the information users will find if they click on the exhibit.](image)

The use of graphics and words are important to learning, but the haphazard use of either can create confusion or not be beneficial to learning. Displays need to be well thought out to convey the message the educator is sending to the learners.

**Contiguity Principle**

In the previous section, the multimedia principle, words and pictures play an important role in learning. The brain is believed to have two channels that nonverbal and verbal information use to deliver knowledge. Overloading one channel exclusively can cause a decrease in learning. The contiguity principle is stated as, “the effectiveness of multimedia instruction increases when words and pictures are presented contiguously (rather than isolated from one another) in time or space” (Mayer and Anderson, 1992, p.444). In other words, the words and pictures must be in close proximity to be connected and used by the learners.

The contiguity principle defines two effects: temporal-contiguity effect and spatial-contiguity effect (Moreno & Mayer, 1999). Temporal-contiguity states the timing of animation and spoken words have an enormous effect on the understand/learning of knowledge. Mayer and Anderson (1992) conducted a study to test the temporal-contiguity effect of how a bicycle pump works on three groups of participants. One group heard the narration and then watched the animation. Another group watched the animation and then heard the narration. The last group heard the narration and saw the animation at the same time. Not surprisingly, the group hearing the narration and seeing the animation at the same time outperformed the other two groups. The spatial-contiguity effect suggests that text and the related graphics or animation be placed in close proximity to one another. Mayer (2002) labeled this spatial-contiguity effect, whereas Sweller, Merrienboer, Paas (1998) defined this concept through earlier studies as “split-attention.” When text and related graphics or animations are too far apart, the learner’s attention has to navigate between two separate representations of information, which can overload the channels of input as seen in Figure 6.
Figure 6: Tarmizi, RA and Sweller, J (1988). The figure on the left does not conform to the contiguity principle as it splits the learners attention away from the diagram while looking for corresponding information. This type of split attention decreases learning. The figure on the right is easier to understand as attention can be focused on one area and both pieces of information can be understood simultaneously.

**Types of Problems with Contiguity Principle**

Below are categories to some of the common issues faced with the contiguity principle as related to online or e-learning.

**Corresponding Graphics**

As discussed previously, text and graphics or animations should be placed in close proximity to text on the graphic to increase learning. For example, if a learner is studying the heart in an online science class, it is better to have an image of the heart with corresponding names placed on the area of the heart (see Figure 7), than placing numbers on the heart and having learners look away or scroll down to find the name.

Figure 7: Borrowed from www.dmu.edu.ua. An
example of corresponding graphics with terminology inline with the parts. The learner does not have to look away from the graphic to connect information.

**Scrolling Screen**

The scrolling screen problem occurs when either text or graphics are placed on separate portions of the screen where neither is visible when viewing the other. For example, learners have to provide directions between two places while using a map. While viewing the map, the questions are not visible, and when viewing the questions, the map is not visible. This becomes a problem as the learner must scroll down to view the question, scroll up to view the map, try to remember the directions in working memory, and then scroll down to answer.

**Separation Useful Information**

Separation happens when information that is useful to one another is not held or used in the same proximity. For example, learners take an online test providing them answers after they finish the test. The screen only displays the answers, but not the questions. In this example, the learners are not able to connect the correct answers to the questions they missed. A better system would show the question, all possible answers, and the correct answer and why in the same area.

**Modality Principle**

The modality principle suggests words are better presented in narration than on-screen text. Research has shown that dual channel activation (narration and graphics) increases results over single channel activation (on-screen text and graphics) as a form of modality (Allport, Antonis, & Reynolds, 1972; Rollins & Thidadeau, 1973).

The modality principle is designed to free some of the mental processes learners may use to assist learning. Brooks (1967) found reading text passages interfered with the learners’ mental creation of spatial relationships from text; whereas, listening to the same passages did not produce the same results. Alesandrini (1982) suggests reading and mental imagery is problematic because both presumably rely on visual information processing. In other words, the channel is being overloaded, which decreases the learner’s ability to maximize learning.

**Conflict of Principles**

In the continuity principle, it was suggested to place words and graphics together to assist learning, so does the modality principle contradict this notion? No. The continuity principle is great for graphics and text which is static or not quickly changing such as a graphic and notation on the anatomy of the heart. The modality principle is concerned with overloading the visual channel by attending to quickly changing words and/or graphics. In the Brooks’ (1967) study above, the learners were reading words and trying to build a mental representation or graphic in their minds at the same time. Since the learners were constructing this mentally, it overloaded the visual channel. Another example of violating the modality principle would be creating an online video with graphics or animation and having learner read along as the words and graphics/animation quickly change.

**Redundancy Principle**

The redundancy principle is concerned with multiple representations at the same time. One study by Sweller (1999) showed providing the same information in an illustration and text increased the cognitive load of participants. Likewise, Moreno and Mayer (2002) compared two groups of participants regarding information on the scientific topic of lightning through multimedia. One
group received animation and narration, while the second group received the same animation and narration, but with redundant on-screen text. The group receiving no redundant on-screen text performed higher on retention and transfer questions than the group receiving redundant on-screen text. Other studies such as Kalyuga, Chandler, and Sweller (1999) have shown the same effects with redundant on-screen text through the topic of how to join metals together through soldering.

**When to Use Redundancy**

If the redundancy principle could be applied to all situations, life would be easy. Unfortunately, the process of learning cannot be refined to a simple black and white construct of a never do philosophy with redundancy. Clark and Mayer (2011) provide instances where narration and redundant on-screen text are beneficial for the learner, such as when:

- The screen is void of pictures, graphics, animations, illustrations, and so on. When the screen is blank, there are no visuals to compete with the learner’s attention and overload the visual channel.
- The screen does have pictures, graphics, animations, illustrations, but the pace of the presentation is slow enough for the learner to mentally attend to all information being presented.
- When presenting information to individuals who may have problems processing spoken words properly. For example, non-native speakers of the language being used or individuals with learning disabilities where this assistance is helpful.
- When the information being presented is comprehensive with unfamiliar language.

**Coherence Principle**

The coherence principle is concerned with eliminating irrelevant material or information distracting and/or overloading the learner’s cognitive abilities to process the essential information. Moreno and Mayer (2000b) suggest the coherence principle can be violated by the use of extraneous sounds, pictures, graphics, and words. For this reason, instruction should eliminate peripheral information so the learner can focus attention on the key content being learned (Morrison, Ross, Kalman, Kemp, 2010). Extraneous information can have adverse effects on learning and problem-solving. For example, one experiment had two groups of students read passages with corresponding illustrations on how lightning formed. One group received passages and illustrations containing extraneous content, while the other group did not. The group receiving the extraneous content performed 50% worse than the group not receiving extraneous content (Mayer, Bove, Bryman, Mars & Tapangco, 1996). Presentations are precise to allow the learner to process key information and organize it in a way beneficial to learning (Mayer & Moreno, 1998).

**Types of Extraneous Content**

**Sounds**

Sounds refer to the background music or sounds accompanying content in the online learning environment. Background music and sounds may increase the extraneous load on working memory, which can compromise the learner’s ability to comprehend and learn. Clark and Mayer (2011) identified situations where sound causes extraneous load such as with unfamiliar material, rapid depiction of material, and when the learner cannot control the rate of the presentation.

The use of sounds comes from arousal theory. Arousal theory suggests sounds increase the learner’s interest and arouses the learner (Weiner, 1990). This arousal helps the learner focus more attention on the materials being learned. However, most of the studies on arousal theory have been conducted
on television watching and not on online learning. The low level of engagement with television allows sound to direct attention to meaningful material (Kozma, 1991). For example, dramatic music tends to build and climax during a conversation, reaching its critical point of information. The building of the music grabs attention, while the climax of the music focuses attention on what is being said.

Moreno and Mayer (2000a) performed experiments on lightning formation and how hydraulic braking systems work with background music. The two groups of participants for each experiment, one group received narrated animation with no background music, while the other group received narrated animation with background music not impeding the narration in any fashion. Across both experiments of lightning formation and hydraulic braking systems, participants in the group with no background music performed 20 percent to 67 percent better than the group with a musical background. Even music at lower levels seems to have an effect on mental processing of information.

Pictures and Graphics

Pictures violating the coherence principle are those adding no useful information to the presented material. Some designers use pictures to improve the aesthetics of the content, but these pictures either relay information, not in the scope of what is being learned or not related the information. Mayer (1993) notes many math and science textbooks fail in providing corresponding illustrations to the theme or content of the lesson being covered. Figure 6 shows a picture violating the coherence principle. Figure 8 shows a boy speaking, but the content revolves around classroom seating, which is a clear violation of this principle.

![Figure 8: The picture does not conform to the coherence principle. The article is about classroom seating arrangements, so the picture does not match the content. Glancing over the information, one could think it is solely about seating arrangements for speaking, but the article contains more information than that. A better choice of the picture would be desks arranged in a certain pattern.](image)

Words

Many online content designers may think adding interesting additional text is a good way to increase attention and promote learning. Mayer, Heiser, and Lonn (2001) conducted a study on lightning formation with two groups of participants, like the ones mentioned previously. One group was given the normal presentation, while the other group received additional sentences that fit with the material but did not fit with the understanding of the material. The group not having the extra words performed 35 percent better on retention and explanation tests than the group with extra words.

Extra words have the ability to distract learners from the key information being presented. Although it may be tempting to add interesting information, if learners do not have previous knowledge or the content is difficult, extra wording can decrease learning as learners try to understand how the information flows together as a concept.
**Personalization Principle**

The personalization principle suggests that the use of conversational style with text and narration will provide better understanding than the use of formal style. The use of “you,” or any related form, provides learners with a means to personalize information. Mayer, Fennell, and Farmer (2004) conducted three different experiments on participants and found retention was not enhanced with personalization, but transfer was greatly impacted. This is very important as transfer is regarded as a better measure to learning than retention (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, & Wittrock, 2001). Figure 6 shows the difference between formal language versus informal language.

**Figure 9. Personalization example.**

| From Moreno and Mayer, 2000a |
| Introductory Portion of Text Spoken in Botany Computer Game |
| **Formal Version** |
| “This program is about what type of plants survive on different planets. For each planet, a plant will be designed. The goal is to learn what type of roots, stems, and leaves allow the plant to survive in each environment. Some hints are provided throughout the program.” |
| **Personalized Version** |
| “You are about to start a journey where you will be visiting different planets. For each planet, you will need to design a plant. Your mission is to learn what type of roots, stems, and leaves will allow your plant to survive in each environment. I will be guiding you through by giving out some hints.” |

**Agents**

There is a lot of emphasis on online learning with the help of pedagogical agents. Clark and Mayer (2011) define pedagogical agents as “onscreen characters who help guide the learning process” (p.39) during an online learning environment. In tests conducted by Moreno, Mayer, Spires, and Lester (2001), there was no discernable difference between learning with pedagogical agents who are cartoon-like or human-like. However, Moreno et al (2001) found modality effect and personalization effect apply to pedagogical agents in assisting learning. Likewise, Atkinson (2002) reports learners perform better on word problems when the voice sounds like that of a human than a machine generated voice. Overall, experiments show agents have 24 to 48 percent more solutions than non-agent participants in transfer tests.

**Design Check Point**

**Chapter Summary**

Once the analyses have been conducted, it is important to take the time to plan out the design of the instruction. The instructional designer needs to create objectives that will guide the curriculum in a meaningful and deliberate way towards concrete goals. Next, the instructional designer must develop a plan for sequencing the presentation of the material. Sequencing strategies include learning-related sequencing, world-related sequencing, concept-related sequencing, and elaboration theory. Once the plan for the order of the material is established, the instructional designer needs to pick instructional strategies to determine how the content will actually be presented. This is done
by determining the type of content that will be presented to the learner and matching it with a generative strategy for each objective; the performance-content matrix is a useful tool for planning purposes at this stage. In order to create great instruction, it is important to incorporate multimedia and to do it correctly. Adhering to multimedia principles will help ensure that using audio, visuals, and videos to supplement text will improve the course content instead of distracting or confusing the learner.

**Discussions**

- How do you choose a sequencing strategy that best fits your content? [Post](#)
- Is it important for objectives to be based on observable criteria? [Post](#)
- Are instructional goals that require application inherently better than goals that only require recall? When would you use each style? [Post](#)
- What are the differences between Bloom’s Taxonomy and Gagne’s Taxonomy? Do you think that one is better than the other? Why? [Post](#)
- Which multimedia principle do you think is the most important to adhere to? Why? [Post](#)

**Design Practice Assessment**

The end-of-chapter practice assessment retrieves 10-items from a database and scores the quiz with response correctness provided to the learner. You should score above 80% on the quiz or consider re-reading some of the materials from this chapter. This quiz is not time-limited; however, it will record your time to complete. The scores are stored on the website and a learner can optionally submit their scores to the leaderboard. You can take the quiz as many times as you want.

[Start quiz](#)

**Assignment Exercises**

1. Write an objective for an assignment that requires a student to learn a new value (for example: learning to believe in global warming). This objective will be in the affective domain. Consider how you would measure different levels of learning the value when you write this objective. Write one objective and justify your action verb choice.
2. Imagine that we have two separate objectives. One falls into the Fact-Recall domain of the Performance-Context matrix and one falls into Procedure-Application domain. Write an objective for each one to demonstrate the differences in practical application.

<table>
<thead>
<tr>
<th>Contents</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recall</td>
</tr>
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<td>Fact</td>
<td></td>
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<tr>
<td>Concept</td>
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<tr>
<td>Procedure</td>
<td></td>
</tr>
<tr>
<td>Interpersonal</td>
<td></td>
</tr>
</tbody>
</table>
3. Consider Gagne’s Nine events of instruction. Write out a lesson plan that follows this structure. The topic can be in the cognitive, affective, or psychomotor domain.

4. Think about the Redundancy principle. Next, think about the average lecture with powerpoint. Now, create a lecture-style presentation that adheres to this principle.

5. Create a personalized introduction to a module. Try writing something fun and engaging instead of the commonly used “By the end of the module, the learner will be able to…”

**Group Assignment**

Gather your group members and the analyses that you conducted for the Group Assignment in the Analysis Chapter. Complete the following steps using the content presented in this chapter to guide you.

1. Create a set of objectives based on the analyses that will guide the instruction. Consider the types of skills that the learners will need to accomplish as well as what the end behaviors will look like when the learners have mastered the desired skills. Include at least one objective for the cognitive domain, the behavioral domain, and the affective domain. Use all four parts of the Mager-style objectives for at least two objectives. Incorporate the action verbs in Table 6 to ensure that the objectives for the cognitive and affective domains will result in a measurable behavior.

2. Determine the sequence of the instruction. Make decisions about the sequence of the modules as well as the sequence of learning and presentation of materials within each module. Make sure that all parts of the instruction will help students accomplish the objectives.

3. Develop design specifications for the multimedia that will be created to supplement the instructional materials to facilitate learning. Be mindful of the multimedia principles presented in this chapter.

**References**


