Part 4: E-learning in Action

20
Instructional Strategies

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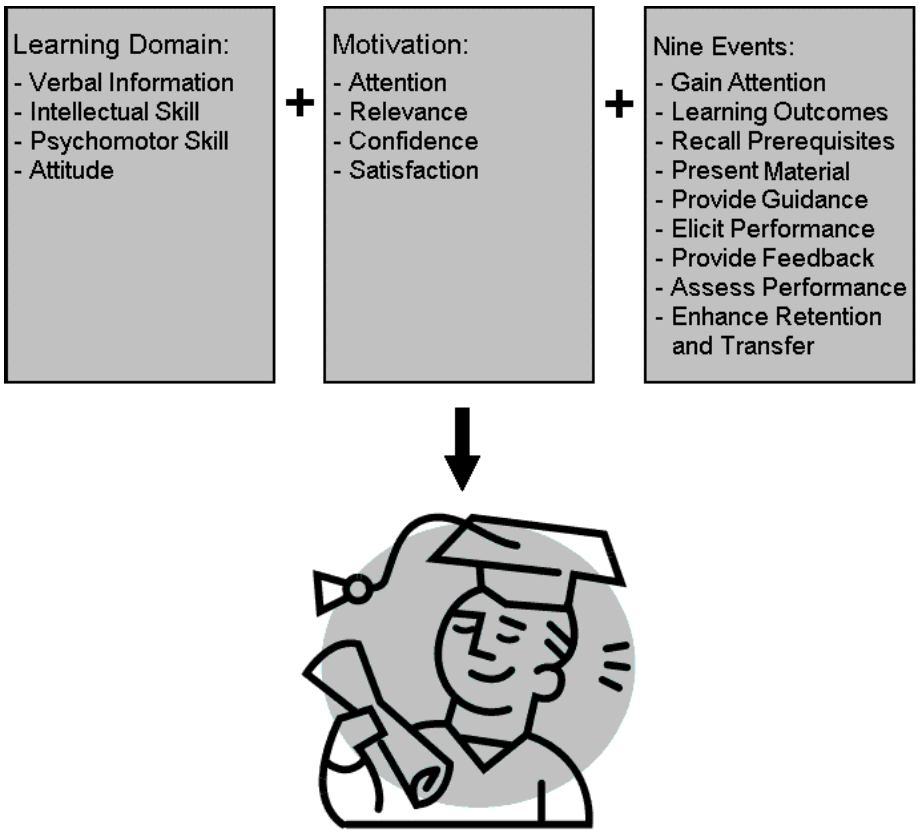
For the things we have to learn before we can do them, we learn by doing them. – Aristotle



Learning outcomes

After completing this chapter, you should be able to:

- Develop instructional strategies for verbal information, intellectual skills, psychomotor skills, and attitudes.
- Sequence learning outcomes to best facilitate learning.
- Motivate learners in online courses.
- Design lessons that include all of the instructional events.
- Develop and select instructional materials.

Introduction

An instructional strategy describes the instructional materials and procedures that enable students to achieve the learning outcomes.

This chapter first introduces instructional strategies for verbal information, intellectual skills, psychomotor skills, and attitudes. It then describes how to sequence learning outcomes and motivate learners in online courses. It then presents instructional events, the foundation for course design. The chapter closes with comments on developing and selecting instructional materials.

Description

Your instructional strategy should describe the instructional materials' components and procedures used with the materials that are needed for students to achieve the learning outcomes. The strategy should be based on the learning outcomes and information from the other previous instructional design steps. You can even base your strategy on how you or others have solved similar problems. You can save time and money by not re-inventing the wheel. However, be careful; a lot of existing instructional material is designed poorly.

At the end of this process, you should have a clear set of specifications describing how the material will be taught. This can include a flowchart representing the instructional pathway. You will use the instructional strategy as a framework for further developing the instructional materials or evaluating whether existing materials are suitable or need revision. As a general rule, use the strategy to set up a framework for maximizing effective and efficient learning. This often requires using strategies that go beyond basic teaching methods. For example, discovery-learning techniques can be more powerful than simply presenting the facts. One common pitfall in creating online lessons is teaching in the same way as was done with traditional methods. If this is done, then there may only be minimal value in transferring the material to an online system. As Emile Chartier said, "Nothing is more dangerous than an idea, when it is the only one you have." Note that you can address a variety of learning styles if you teach with a variety of different methods and media. No one single teaching method or medium is ideal for all learners.

As you proceed through developing an instructional strategy, start specifying the media that would most effectively teach the material. (Read Chapter 21, Media Selection, for more information.)

Learning domain strategies

Each learning domain classification (i.e., verbal information, intellectual skills and cognitive strategies, psychomotor skills, and attitudes) is best taught with different instructional strategies.

Tip
Different classifications of skills require different instructional strategies.

VERBAL INFORMATION

When teaching verbal information:

- Organize the material into small, easily retrievable chunks. This is based on the cluster analysis shown earlier, in Table 20.1. The cluster analysis framework helps learners retrieve information from their memory as it provides cues to finding the information.
- Link new information to knowledge the learner already possesses. For example, use statements such as "Remember how", or "This is like …". Linking information helps the learner to store and recall the material.
- Use mnemonics and other memory devices for new information. You may recall that the musical notes of the treble clef staff lines can be remembered with the mnemonic Every Good Boy Deserves Fudge.
- Use meaningful contexts and relevant cues. For example, relating a problem to a sports car can be relevant to some members of your target audience.
- Have the learners generate examples in their minds, such as create a song or game with the information or apply the knowledge to the real world. If the student only memorizes facts then the learning will only have minimal value.
- Avoid rote repetition as a memorization aid. Rote learning has minimal effectiveness over time.

- Provide visuals to increase learning and recall.

INTELLECTUAL SKILLS

When teaching intellectual skills:

- Base the instructional strategy and sequencing on the hierarchical analysis done earlier. Always teach subordinate skills before higher-level skills.
- Link new knowledge to previously learned knowledge. You can do this explicitly (e.g., the bones in your feet are comparable to the bones you learned about in your hands) or implicitly (e.g., compare the bones in your feet to other bone structures you have learned about).
- Use memory devices like acronyms, rhymes, or imagery for information such as rules or principles. You can use the first letters of words to help memorize information. For example, "KISS" means "Keep It Simple Stupid". General rules can often be remembered through rhymes such as "i before e except after c". Remember that rules often have exceptions. Tell your learners about the exceptions. Memory devices are best for limited amounts of information.
- Use examples and non-examples that are familiar to the student. For instance, when classifying metals, iron and copper are examples while glass and plastic are non-examples.
- Use discovery-learning techniques. For example, let students manipulate variables and see the consequences.
- Use analogies that the learners know. However, be careful that learners do not over-generalize or create misconceptions.
- Provide for practice and immediate feedback.

PSYCHOMOTOR SKILLS

When teaching psychomotor skills:

- Base the instructional strategy on the procedural analysis done earlier.
- Provide directions for completing all of the steps.
- Provide repeated practice and feedback for individual steps, then groups of steps, and then the entire sequence.
- Remember that, in general, practice should become less dependent on written or verbal directions.
- Consider visuals to enhance learning.
- Consider job aids, such as a list of steps, to reduce memory requirements. This is especially important if there are many procedures or if the procedures are infrequently used.
- After a certain point, allow learners to interact with real objects or do the real thing. How much can you learn about swimming without getting wet?

Note that some skills involve other learning-domain classifications. For example, when learning how to operate a camcorder, many of the skills are psychomotor. However, deciding how to light an image is an intellectual skill. Also, note that the required proficiency level can affect the instructional strategy. There is a big difference between being able to imitate a skill and being able to automatically do a skill.

ATTITUDES

When teaching attitudes:

- Base the instructional strategy on the instructional design steps done earlier.
- If you can, show a human model to which the students can easily relate. One consideration is that it may be better if the model is of the same socio-economic group.
- Show realistic consequences to appropriate and inappropriate choices.
- Consider using video.
- Remember that attitudes taught through computer technology are **not** guaranteed to transfer to the real world. If appropriate and possible, consider arranging for practice opportunities to make the choice in real life. Alternatively, use role-playing to reinforce the attitudes taught.

Note that it can be difficult to test whether the attitudes taught have transferred to real situations. Will learners behave naturally if they know that they are being observed? If learners have not voluntarily permitted observations, then you must consider whether it is ethical to make the observations.

Sequencing learning outcomes

Using the subordinate skills analysis done earlier, determine the sequence of how the learning outcomes will be taught. In general, to best facilitate learning, you should sequence the learning outcomes from:

- lower to higher-level skills
  - For example, teach verbal information and then intellectual skills. Cover multiplying decimals with a calculator and then manually.

- easy to hard
  - You could teach adding fractions with common denominators and then with different denominators. Your lesson could first deal with writing complete sentences and then writing paragraphs.
- simple to complex
  - As an example, teach recognizing weather patterns and then predicting the weather. Cover replacing a washer and then replacing a faucet.
- specific to general
  - You could teach driving a specific car and then transfer the skills to driving any car. Similarly, you could cover adjusting the brakes on a specific mountain bike and then generalize the procedure to other mountain bikes.
  - Note that some students like to learn through an inductive approach (that is, from the general to the specific). For example, students could be presented with a number of simple examples, and based on those, be asked to generalize a rule. That general rule can then be applied to solving specific examples. Since some students will not enjoy an inductive approach, do not use it all of the time. Rather consider an inductive approach as a way to provide some variation and occasionally address other learning preferences.
- concrete to abstract
  - As an example, teach measuring distances with a tape measure and then estimating distances without a tape measure. Cover writing learning outcomes and then evaluating learning outcomes.
- the known to the unknown
  - You could do this by starting with concepts learners already know and extending those concepts to new ideas. In other words, build on what has been previously taught.

Tip
Be sure to teach learning outcomes in the order that best facilitates learning.

Each of these methods of sequencing learning outcomes enables students to acquire the needed knowledge base for learning higher-level skills. Note that these guidelines are **not** black and white rules.

Motivating students

As Lao Tzu observed, "You can no more teach without the learner than a merchant can sell without a willing buyer." Follow the ARCS motivation model to ensure that students will be motivated to learn.

Tip
Motivate learners because without motivation learning is unlikely to occur.

ARCS MOTIVATIONAL MODEL

As described by Keller, motivation can be enhanced through addressing the four attributes of *Attention*, *Relevance, Confidence*, and *Satisfaction* (ARCS). Try to include all of the attributes since each alone may not maintain student motivation. Your learner analysis may have provided useful information for motivating students.

You should build motivational strategies into the materials throughout the instructional design process. This is challenging since each learner is an individual with unique interests, experiences, and goals.

Tip
Carefully determine your motivational strategies since each learner has unique interests, experiences, and goals.

ATTENTION

Gain attention and then sustain it. You can gain attention by using human-interest examples, arousing emotions such as by showing a peer being wheeled into an ambulance, presenting personal information, challenging the learner, providing an interesting problem to solve, arousing the learner's curiosity, showing exciting video or animation sequences, stating conflicting information, using humour, asking questions, and presenting a stimulus change that can be as simple as an audio beep. One way to sustain attention is by making the learning highly interactive. Figure 20.1 shows an attention-grabbing strategy.

Figure 20.1. Gaining attention with an explosion

RELEVANCE

Relevance helps the student to want to learn the material. For example, when teaching adult students how to solve percent problems, having them calculate the gratuity on a restaurant bill may be more relevant than a problem that compares two person's ages. You can provide relevance through testimonials, illustrative stories, simulations, practical applications, personal experience, and relating the material to present or future values or needs. Relevance is also useful in helping to sustain attention.

For material to be perceived as being relevant, you must strive to match the learner's expectations to the material you provide.

CONFIDENCE

If students are confident that they can master the material, they will be much more willing to attempt the instruction. You will need to convince students with low confidence that they can be successful. You can do this through presenting the material in small incremental steps, or even by stating how other similar students have succeeded. Tasks should seem achievable rather than insurmountable.

You should also convince students who are overconfident that there is material that they need to learn. You can do this by giving a challenging pre-test or presenting difficult questions.

SATISFACTION

Satisfaction provides value for learning the material. Satisfaction can be intrinsic from the pleasure or value of the activity itself, extrinsic from the value or importance of the activity's result, for social reasons such as pleasing people who's opinions are important to them, for achievement goals such as the motive to be successful or avoid failure, or a combination of these. Examples of intrinsic satisfaction include the joy or challenge of learning, increased confidence, positive outcomes, and increased feelings of self-worth. Examples of extrinsic satisfaction include monetary rewards, praise, a certificate, avoidance of discomfort or punishment for not doing it, and unexpected rewards. Some evidence suggests that extrinsic motivation, such as a certificate for completing a course, does not last over time. Nonetheless, it is better to assume that some students need extrinsic motivation. To be safe, try to provide your learners with both intrinsic, which should have more of the focus, and extrinsic rewards. If the intrinsic motivation is high for all learners, you will not need to plan as much for extrinsic motivation. Note that satisfaction can be provided by enabling learners to apply the skills they have gained in a meaningful way.

Remember to let the students know that the material to be learned is important. Consider increasing extrinsic motivation through quizzes and tests.

Instructional events

As Robert Gagné described, the instructional events (gaining attention, informing the learner of the learning outcome, stimulating recall of prerequisites, presenting the material, providing learning guidance, eliciting the performance, providing feedback, assessing performance, and enhancing retention and transfer) represent what should be done to ensure that learning occurs. If you address each instructional event, you will have a solid foundation for creating effective instructional materials. You will need to determine what will be done for each instructional event for each learning outcome.

GAINING ATTENTION

Gain attention by getting the students involved and motivated. Ideas for gaining attention were presented earlier within the ARCS model of motivation above.

Consider using an interesting animation or video on the title page and first screen of each lesson. This is called an attract sequence. Note that video tends to be more effective than still images in gaining attention.

Remember that you also have to keep the learners attentive throughout the entire lesson. You can maintain attention by using different media, leading lively discussions, asking questions, providing different learning activities, etc.

INFORMING THE STUDENT OF THE LEARNING OUTCOME

Help students focus their efforts in this event. You can do this with simple statements or thought-provoking questions. If possible, also make the students feel that they need to learn the knowledge and skills.

You can let the learner know about the learning outcome in an introduction or overview. This can be a good use for video, since some students skim over text as they find it boring.

STIMULATING RECALL OF PREREQUISITES

Prepare students for what is to come in this event. One strategy you can use is simply stating the needed prerequisite skills. Alternatively, pre-tests can remind learners of the prerequisites and also help to determine a student's current skill level. You should advise students who do not have the prerequisite skills to learn the skills before continuing. Stimulating recall of prerequisites should be done before major learning occurs. This is often done in an introduction or overview.

The learner analysis should have previously determined the relevant knowledge and experiences that typical students will bring into the learning situation.

PRESENTING THE MATERIAL

When presenting material to the students in this event, in general, you should sequence the material in increasing difficulty and in small incremental steps. This helps ensure success and increases learner confidence.

A variety of methods can inspire interest. No single approach can be used to teach all learning outcomes, but the activities you choose must effectively address the learning outcomes and different learning styles. As much as possible, the activities learners do online should match what will be done in the real world. Learning by doing is very powerful. As the Buddha said, "Teach you? I cannot teach you. Go, experience for yourself."

Tip
Use a variety of methods to teach.

Where appropriate, the instructional activities you create should include fun ways to learn. However, remember that some learning is simply hard work. Every instructional activity can have strengths and weaknesses, depending on the learning outcome being taught. Incorporating a variety of creative instructional approaches can help maintain student interest and motivation as well as ensure that each student occasionally has a match between their learning style and the teaching style. Many effective lessons include more than one type of instructional activity.

Tip
Try to make learning fun.

Remember to provide examples that are meaningful, relevant, and realistic. Base some of the content on the potential for making mistakes. Get this information by asking subject-matter experts about typical mistakes students make after they are taught the content in the traditional way. If you only teach what is correct, the learner may never learn what can go wrong. For example, teaching what can go wrong is important in teaching physicians how to make an accurate diagnosis.

Tip
Consider teaching both the correct material and what can go wrong.

Base the total amount of material presented in a lesson on the learners' age and assumed attention span, the material's complexity, the activities needed, and the time needed for all of the instructional events. A rough estimate of the proportional amount of effort needed to cover a learning outcome should be based on the learning outcome's frequency, importance, and difficulty.

- Frequency—How often is the behaviour needed?
- Importance—How significant is the behaviour to job performance?
- Difficulty—How hard is the behaviour to master?

For each learning outcome, give a rating (e.g., a number out of five) for the frequency, importance, and difficulty and then add the total. Base the estimated amount of content (e.g., a percentage of the number of screens) proportionally for each learning outcome. Table 20.1 shows an example.

You can gain ideas for presenting the material through brainstorming with all team members, other instructors, resource personnel, and even target audience learners. You can also review existing materials for ideas. You should not be responsible for generating all of the creative ideas yourself. When thinking about ideas, remember that people are social. Collaboration and discussions can be powerful in enhancing learning and can easily be done through computers and the Internet. In groups, students can discuss, debate, and explore many things. Imagine how much can be learned

if students discuss issues or explain concepts to each other. As Giambattista Vico said, "One only knows something if one can explain it". Also through computers, it is possible to tap into real data or tools such as those used by scientists. Wouldn't students enjoy learning about climate, for example, if they could use real data and models to predict the weather?

Table 20.1

Objective	Frequency	Importance	Difficulty	Total	Percent
Number 1	2	1	1	4	10%
Number 2	4	3	5	12	30%
Number 3	2	3	3	8	20%
Number 4	3	1	2	6	15%
Number 5	1	5	4	10	25%
Total				40	100%

Depending on the learning outcome, you may need to teach some of them or support them through computer-based resources when the more common online strategies will not suffice. Computer-based resources include drill and practice, tutorials, simulations, online labs, educational games, intelligent tutoring systems, and virtual reality. These are described in Chapter 22, Computer-Based Resources for Learning. Some drill and practice activities can be effectively provided within Learning Management Systems. However, depending on the learning domain, thinking level required, complexity of the problem presentation, and feedback that needs to be provided, some drill and practice activities will need to be created with specialized tools such as Macromedia Flash.

PROVIDING LEARNING GUIDANCE

In helping students to learn the material, you can provide ways to categorize materials, provide memory devices, and link new knowledge to previously learned knowledge. You can also emphasize differences between related skills. As an example, you might explain that adding two digit numbers is similar to adding single digit numbers, except that a value may have to be "carried". You can also provide students with strategies for recalling information and encourage them to create their own memory recall techniques. Providing guidance is particularly important because many students have not learned how to learn effectively.

Remember that learning is minimal if you simply provide information. As Paulo Freire said, "To teach is not to transfer knowledge but to create the possibilities for the production or construction of knowledge".

This event is usually integrated with "presenting the material".

ELICITING THE PERFORMANCE

Learners must know how well they are progressing. You can do this by asking questions or providing opportunities to practise the skill being taught and then giving feedback. This event is also usually integrated with "presenting the material".

It is better to provide a little bit of practice often as compared to a lot of practice given seldom. Allow for practice as learners logically need it after each concept of a lesson has been presented, rather than at a fixed interval such as at the end of each lesson after many concepts have been presented. This is even more important when learners need to practise sub-skills before proceeding to higher-level skills. In other words, help learners learn the material as the content is taught. Learning effectiveness can be compromised if you wait too long.

Make the difficulty level of the practice proportional to the difficulty of the task. Practice should not be so easy that it is trivial nor so difficult that it is frustrating. Remember to also check whether the learner makes expected mistakes.

Metacognition is an important step in eliciting the performance. Metacognition can be defined as your knowledge and understanding about your own mental processes, as well as how you actively control and monitor your memory, comprehension, and other thinking processes involved in planning to learn, learning, and assessing your learning. In simple terms, metacognition is a self-questioning strategy that entails "thinking about thinking".

To address metacognition, learners can be prompted to answer questions such as:

- "How do I learn best?"
  - Answers to this question relate to the individual's learning style. For example, the learner may study best in a quiet area.
- "How does the nature of the task affect my decisions regarding learning the material?"
  - The learner needs to think about issues such as the difficulty of the task. This can impact the time needed for learning the material.

  - The type of task is also a factor. A common situation is that learning material needed for answering multiple-choice questions is different from studying for long-answer questions.
- "Do I have the time needed to do the task?"
- "For this type of task, what strategies work best for me?"
- "Am I motivated to do the task? If not, what needs to change?"
- "What related skills do I already know how to do or need to learn?"
- "How do I know that I have learned the concept?"
- "What did I learn from making that error?"
- "How well am I progressing?"
- "What do I still need to learn?"
- "How well is my plan and learning strategy working?"
- "Should I change my plan and learning strategy?"
- "What could I have done differently?"
- "What should I have done differently?"
- "How can the mental processes I used work for learning other content?"

PROVIDING FEEDBACK

Your feedback should be positive, constructive, and immediate. It should provide complete information as to why their answer and other possibilities are right or wrong, and/or guide students towards attaining the learning outcome. Detailed feedback is important to ensure understanding, especially if the learner's answer was simply a guess or if the learner's answer was correct but the reasoning was wrong. This event is coordinated with eliciting the performance.

ASSESSING PERFORMANCE

Students are tested in this event. This step is basically more formal than the "elicit the performance" event. As much as possible, the tests you create should approximate real situations. Test all learning outcomes and only the learning outcomes. Tests should be criterion-referenced (that is, performance based on achieving the specified learning outcomes).

You should provide the students with their test results as soon as possible. The feedback you provide should pinpoint areas in which the student had difficulties.

ENHANCING RETENTION AND TRANSFER

In this event, ensure students retain the information and that the information can be transferred beyond the specific ideas presented in the lesson. More exposure leads to more retention. You can increase retention through questioning, giving reviews, paraphrasing, and providing summaries. Retention activities should occur at spaced intervals and occur before more complex skills are learned.

Tip
Increase retention by exposing the learner to the material in a variety of ways.

You can facilitate transfer by providing links to related situations, related information, or novel problems and solutions. If possible, transfer should focus on real-world situations.

Develop and select instructional materials

Based on the instructional strategy for each learning outcome, and information from the other steps of the instructional design process, you need to determine whether materials should be gathered or developed. The main reason for using existing materials (those owned by your institution or purchased) is to save time and money.

GATHER EXISTING MATERIAL

Some but likely not all of the needed material may exist. Potential resources can be found in learning-object repositories, other Internet resources such as Wikipedia, and on DVD-ROMs. Learning-object repositories may be found within your institution or at provincial/state, national, and international sites. Compare any existing material to the instructional strategy. Determine whether it is suitable and cost-effective. You may prefer existing materials if the content you would develop will be obsolete before or soon after you complete it. You may have to deal with the "if we didn't make it, it can't be any good" syndrome.

Determine whether the existing material can be adapted or supplemented. One alternative is to get permission to repurpose existing materials for your own needs. Remember, if you include work done by others, you may not have permission to earn money from your product. However, you may be able to work out a revenue-sharing agreement.

Note that not all copyrights will be cleared, and some promised materials might not be provided.

Remember to check all digital materials for viruses.

DEVELOP THE NEEDED MATERIAL

The instructional strategy of the materials you develop should consider the learning domain, motivational techniques, each event of instruction, and all of the information gained through the systematic instructional design process. It is wise to create a paper-based version (storyboard) of what will appear on each screen that a student will see. The screen sample is shown in Figure 20.2. Storyboards are easier to review and edit than content within a learning management system.

Tip
Thoroughly evaluating a storyboard can help prevent the team from wasting a significant amount of time making revisions.

The following storyboard example shows that two video clips need to be created for the question. The first video clip needs to be seen to answer the question. The second video clip is presented as part of the feedback. The text stating "Answer: False" is information needed for answer, judging when the storyboard is transferred to the computer-managed learning system. The feedback is presented after the learner answers the question.

Video for the question:

A teacher being animated and talking energetically while **standing still** and saying:

"Lao Tzu stated, 'You can no more teach without the learner than a merchant can sell without a willing buyer.'"

Video for the feedback:

The same teacher being animated and talking energetically while **moving around** and saying:

"Lao Tzu stated, 'You can no more teach without the learner than a merchant can sell without a willing buyer.'"

Review Question 8

True or false? The teacher effectively presented the quote.

Click on "Play" to watch the video to answer the question.

Answer: False

Feedback:

This example does NOT show the most effective way to present the quote because the teacher was standing still. You should create energy by moving around as you speak, being animated, and showing your enthusiasm.

Click on "Play" to see how the quote should have been presented.

Figure 20.2—Storyboard for a sample screen

The storyboard must be written and designed for the computer screen. If this is not done well, time must be spent adapting the material. If possible, follow standardized specifications to help with consistency. Consistency is important as it makes it easier for learners to learn. A lack of consistency can lead to learner frustration. Attain consistency by using design templates but ensure that the templates do not inhibit creativity or compromise learning.

Leave room for visuals on the screen or insert digitized images and try to estimate the amount of text that is reasonable for each screen. A problem with trying to exactly match storyboards to computer screens is that the video images, visuals, and text can take more or less space than expected. It is not necessary to have the media at this point. For example, text and dialogue scripts can describe what video and audio will contain while text can be used to describe photographs.

Initially work with one typical learning outcome and evaluate the storyboard before continuing with other learning outcomes. This helps prevent problems from being perpetuated throughout a course. After the entire storyboard is written, distribute the storyboard or pin it up and ask for feedback from other subject-matter experts, especially others who will use the product, and from potential learners. Thoroughly evaluate the material for flow, clarity, accuracy, completeness, pace, interaction, and length. As a general rule, if the storyboard has problems, then the material will have problems when it is transferred to the learning management system. Remember that the final version will be inherently better when the media is added.

Tip
If you develop, review, and revise one learning outcome at a time, you can prevent problems from being copied throughout the course.

Expect to make revisions. After the first learning outcome has been transferred to the computer, thoroughly evaluate it. After revisions have been made, continue developing subsequent learning outcomes and lessons. Repeat the revision and evaluation process as often as is needed for each learning outcome, group of learning outcomes, and lesson.

Based on the storyboard, make final decisions about the media needed to effectively teach the material. These decisions are based on what will most effectively teach the material as well as practical considerations such as cost and available expertise. Once you make the decisions, start creating the media. You must consider the file formats that will be used and where the media will

be stored, such as DVD-ROM, CD-ROM, Internet, or intranet. (Practical considerations for this and media selection are presented in Chapter 21, Multimedia.)

A final storyboard must be created for the person who transfers the material to the learning management system. An accurate storyboard will reduce the number of subsequent revisions needed. After you develop the media, individual pieces can be incorporated into the system. After this, you can begin the final formative evaluation.

The components of a complete instructional multimedia package can also include:

- an easy-to-use student manual with directions, strategies, learning outcomes, and summaries
- remedial and enrichment material
- an easy-to-use instructor's manual

Summary

An instructional strategy should describe the instructional materials' components and the procedures used with the materials needed for students to achieve the learning outcomes. Your instructional strategy should be based on your instructional analysis, the learning outcomes, and other previous instructional design steps, or on how others have solved similar problems. At the end of this process, you should have a clear set of specifications describing how the material will be taught. You will use the instructional strategy as a framework for further developing the instructional materials or evaluating whether existing materials are suitable or need revision.

Consider strategies that go beyond basic teaching methods. Remember that you can address a variety of learning styles if you teach with a variety of different methods and media. No single teaching method or medium is perfect for all learners. As you proceed through developing an instructional strategy, start specifying the media that would most effectively teach the material.

Each learning domain classification is best taught with different instructional strategies.

When teaching verbal information:

- Organize the material into small easily retrievable chunks, based on the cluster analysis done earlier (see Table 20.1).
- Link new information to knowledge the learner already possesses.
- Use memory devices like forming images or using mnemonics for new information.
- Use meaningful contexts and relevant cues.
- Have the learners generate examples in their minds, do something with the information, or apply the knowledge to the real world.
- Avoid rote repetition as a memorization aid.
- Provide visuals to increase learning and recall.

When teaching intellectual skills:

- Base the instructional strategy and sequencing on the hierarchical analysis done earlier.
- Link new knowledge to previously learned knowledge.
- Use memory devices like forming images or mnemonics for new information.
- Use examples and non-examples that are familiar to the student.
- Use discovery-learning techniques.
- Use analogies that the learners know.
- Provide for practice and immediate feedback.

When teaching psychomotor skills:

- Base the instructional strategy on the procedural analysis done earlier.
- Provide directions for completing all of the steps.
- Provide repeated practice and feedback for individual steps, then groups of steps, and then the entire sequence.
- Remember that, in general, practice should become less dependent on written or verbal directions.
- Consider visuals to enhance learning.
- Consider job aids, such as a list of steps, to reduce memory requirements.
- Allow learners to interact with real objects or do the real thing.

When teaching attitudes:

- Base the instructional strategy on the instructional analysis done earlier.
- If you can, show a human model to which the students can easily relate.
- Show realistic consequences to appropriate and inappropriate choices.
- Consider using video.
- Remember that attitudes taught through computer technology might not transfer to the real world.
- Note that it can be difficult to test whether the attitudes taught have transferred to real situations.

Based on the subordinate skills analysis done earlier, sequence the learning outcomes from lower to higher-level skills, easy to hard, simple to complex, specific to

general, concrete to abstract, and/or the known to the unknown.

It is important for your lessons to motivate learners because without motivation learning is unlikely to occur. Motivation can be enhanced through addressing these attributes: Attention, Relevance, Confidence, and Satisfaction (ARCS). Try to include all of the attributes since each alone may not maintain student motivation. You should build motivational strategies into the materials throughout the instructional design process.

The instructional events represent what should be done to ensure that learning occurs:

- To gain attention, involve and motivate the students. Do this throughout the lesson.
- Inform the student of the learning outcome, before major learning occurs, to help them focus their efforts.
- Stimulate recall of prerequisites by stating the needed prerequisite skills or giving a pre-test.
- When presenting the material, sequence the material in increasing difficulty and in small incremental steps. Use a variety of methods to maintain interest. Provide examples that are meaningful, relevant, and realistic. Base some of the content on the potential for making mistakes. The proportional amount of effort needed to cover a learning outcome should be based on the learning outcome's frequency, importance, and difficulty.
- While presenting the material, provide learning guidance to help students learn the material.
- While presenting the material, elicit the performance so that learners can find out how well they are doing. Do this by asking questions or providing opportunities to practise the skill. Remember to address metacognition within this activity.
- When eliciting the performance, provide detailed feedback. Your feedback should be positive, constructive, and immediate. Your feedback should provide complete information as to why the answer and other answers are right or wrong or guide students in how to attain the stated learning outcome.
- Formally assess the students' performance. Tests should approximate real situations. Test all learning outcomes and only the learning outcomes. Tests should be criterion-referenced.
- Enhance retention and transfer so that students retain the information and can transfer the information beyond the specific ideas presented in the lesson.

Each type of instructional activity has strengths and weaknesses depending on the problem being solved. Incorporating a variety of creative instructional approaches can help maintain student interest and motivation as well as ensure that each student occasionally has a match between their learning style and the teaching style. Many effective lessons include more than one type of instructional activity, some fun ways to learn, and social activities like collaboration and discussions.

Based on the instructional activities for each learning outcome, and information from the other steps of the instructional design process, you need to determine whether materials should be gathered or developed. The main reason for using existing materials (those owned by your institution or purchased) is to save time and money.

The instructional strategy of the materials you develop should consider the learning domain, motivational techniques, each event of instruction, and all of the information gained through the systematic instructional design process. It is wise to create a paper-based version (storyboard) of what will appear on each screen that a student will see. Storyboards are easier to review and edit than content within a learning management system. Based on the storyboard, make final decisions about the media needed to effectively teach the material. After you develop the media, individual pieces can be incorporated into the learning management system. After this, you can begin the final formative evaluation.

Glossary

ARCS. Refers to the attributes Attention, Relevance, Confidence, and Satisfaction. The ARCS model promotes student motivation.

Attitudes. Tendencies people have to making particular decisions or choices under specific circumstances.

Cluster analysis. Used to organize verbal information into logical groupings that are small enough to be learned successfully.

Discovery learning. A method of teaching where learners learn information, such as a concept, that has not been directly stated. For example, by allowing learners to change one of two related variables and see the consequence on the other, learners can discover the relationship on their own.

Feedback. Any message or display that you give to a learner based on his or her input.

Hierarchical analysis. Used to determine the subordinate skills required to learn each intellectual skill.

Instructional events. Events that ensure that learning occurs. These events include gaining attention, informing the learner of the learning outcome, stimulating recall of prerequisites, presenting the material, providing learning guidance, eliciting the performance, providing

feedback, assessing performance, and enhancing retention and transfer.

Instructional strategies. Components of a set of instructional materials and the activities that the students must do to achieve the learning outcomes.

Intellectual skills. Skills that require learners to think (rather than simply memorize and recall information).

Learning outcomes. Specific measurable skills.

Learning styles. Characteristic behaviours that indicate how students prefer to learn. Also known as cognitive styles or learning preferences.

Metacognition. An individual's knowledge and understanding about their own mental processes; how one actively controls and monitors their memory, comprehension, and other thinking processes involved in planning to learn, learning, and assessing their learning.

Procedural analysis. Used to derive subordinate psychomotor skills.

Psychomotor skills. Those skills that enable learners to carry out muscular actions.

Storyboards. Paper-based scale replica drafts of each screen that will appear on the computer.

Subordinate skills analysis. A process for determining the skills that must be learned before performing a step.

Verbal information. Material, such as names of objects, that students simply have to memorize and recall.

Wikipedia. A web-based, multilingual, free content encyclopedia.

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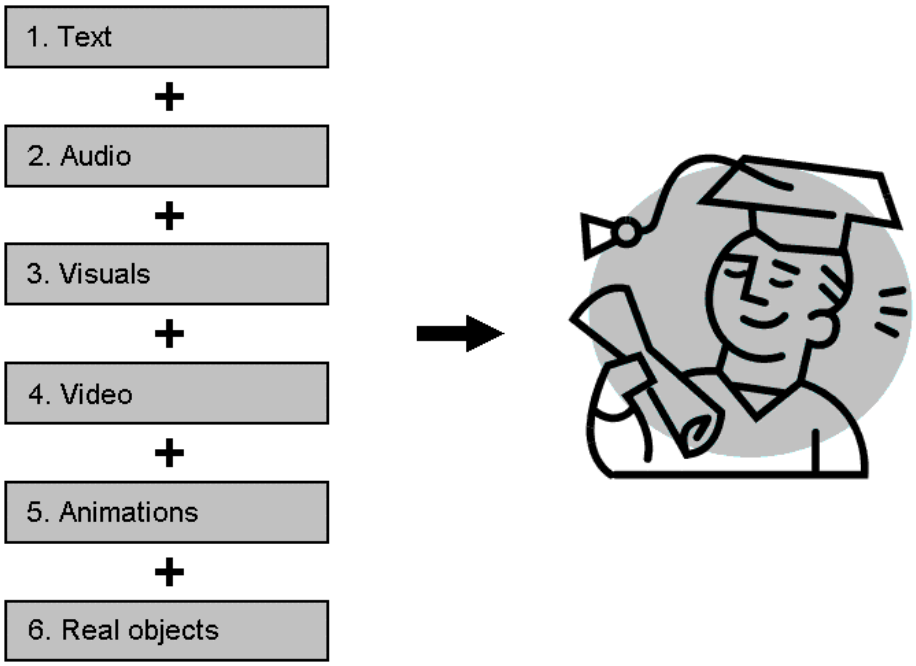
21
Media Selection

Peter Fenrich

If the Grand Canyon, one of the world's most spectacular sights, holds a viewer's interest for an average of 90 seconds then imagine how long your video clip can hold your learner's attention. – Peter Fenrich (2005)



Learning outcomes

After completing this chapter, you should be able to:

- Select the best media mix for increased learning and maximum cost-effectiveness.
- Know the different media categories: text, audio, visuals, video, animations, and real objects.
- Understand how each medium relates to learning.
- Describe how different media can affect a learner's motivation.
- Have ideas about how to keep the message clear.

Introduction

A major part of instructional design is selecting the appropriate media mix to effectively teach the learning outcome(s). Selecting the best media mix increases learning and maximizes cost-effectiveness. Some concepts are extremely difficult to teach without the correct media mix.

This chapter introduces you to the different media categories: text, audio, visuals, video, animations, and real objects. The chapter explains how each medium relates to learning and describes how media can affect a learner's motivation. The strengths and weaknesses of each medium are presented with respect to the different learning outcome classifications, as previously discussed in Chapter 10, General Principles of Instructional Design. This chapter also provides ideas on how to keep the message clear.

Media categories

The media categories you can include in an online course are:

- text
  - Text is typically presented on computer screens but the resources you provide can also include print-based materials.
- audio
  - Audio can be heard from DVD-ROM/CD-ROM disks, computer hard drives, an intranet, and the Internet. However, an online course can also include resources like tapes (audiocassettes), radio, television, and live commentary.
- visuals
  - Visuals can be stored on DVD-ROM/CD-ROM disks, computer hard drives, an intranet, and the Internet. Other resources can include slides, photographs, overhead transparencies, and paper-based material.
- video
  - Video can be retrieved from DVD-ROM/CD-ROM disks, computer hard drives, an intranet, and the Internet. Other sources can include mini-DV tapes, film, and VHS tapes.
- animations
  - Animations can be stored on DVD-ROM/CD-ROM disks, computer hard drives, an intranet, and the Internet. Film, VHS tapes and other sources can also contain animation resources.
- real objects
  - Real objects include actual equipment and models.

Note that:

- Video typically includes natural images recorded with video equipment, whereas animations are usually created artificially with computers and/or other tools.
- Video materials often include an audio component.
- There are major differences between video and film. This chapter uses the terms film and video synonymously.

Media and learning

The media you select do **not** determine whether learning will occur. The media simply carry your message to the learner. However, the media you use can influence the amount of learning that occurs. If you combine the media's strengths with instructional methods that take advantage of these strengths, you can positively influence learning.

Complete instructional packages can, but should not necessarily, include all of the different media. Note that:

- Learning from course content that includes more than one medium is usually more effective than content using only one medium. This is partly because different parts of the brain process different information. For example, some parts of the brain process text, while others process visuals. When instructional materials activate more regions of the brain, there are increases in learning and retention compared to materials that require fewer parts of the brain to process information.

Practical Guideline
Teaching with more than one medium is usually more effective than teaching with only one medium.

- In many situations, you can and should use more than one medium to teach the skill. You will need to determine the media that will complement the intended instructional strategy.
- If you use too many media at one time, you can impede learning.
  - Although multi-sensory learning experiences tend to be effective, learners can only process a limited amount of information at one time. Imagine trying to read text while a supporting animation is being shown on the screen.
  - Media should support and enhance each other.
- Base your media mix decision on what is being taught, how it is being taught, how it will be tested, and the characteristics of your target audience.
  - Different media may be needed for different learning outcomes. For example, video may be appropriate for the attitude component but may not provide the corrective feedback necessary for the intellectual skills component.
  - Do **not** select media simply to dazzle or for convenience.

Media and motivation

Consider a student's experience with each medium. For example, if the students have typically struggled in text-based programs, then consider using other media. Students must have expectations of success with the selected media and have the skills to extract information and learn from the media. This is **not** always a safe assumption. For example, many learners are used to watching video passively and do not know how to focus their learning or take effective notes while watching video.

Depending on a student's learning preferences or learning style, the media you choose could be liked or disliked. If the selected media are **not** preferred, enhance motivation through:

- explaining how lthe material will fulfill the student's needs;
- illustrating how the material is important; and
- reminding students that the test will be based on the material.

Text

You can use text to teach many skills (most verbal information and intellectual skills, and some psychomotor skills and attitudes) unless the target audience has a poor reading ability or low motivation. However, text alone cannot adequately represent the richness of the world and, for instructional effectiveness, you will often need to combine text with other media.

Practical Guideline
Remember that students may later want to refer to notes. Ideally, they should be able to print content and summaries.

Text is better than video and audio when the topic is complex (e.g., forecasting economic trends), abstract (e.g., balancing chemical equations), or has structure (e.g., solving word problems). Text is especially effective for verbal skills such as describing, listing, and naming. With proficient readers, verbal information can usually be learned faster with text than with other media. For higher-level skills, remember that practice and feedback are particularly critical. Text is often a major component of effective practice and feedback.

GUIDELINES FOR CREATING TEXT

Text often forms the foundation of online courses. For your course to be effective, the text has to be written well. Use the following guidelines for creating effective text:

- Make text understandable.
- Minimize reading.
- Develop a good writing style.
- Follow the basic rules of writing.

As with many generalizations, there are exceptions to the following guidelines. For example, a writing or communications course where rich prose is encouraged should not be done as suggested below.

Make text understandable

It is particularly important for you to make text understandable when students are learning at a distance. Make text understandable by ensuring there is message clarity, keeping wording to a minimum, and keeping sentences and paragraphs short. Most subject-matter experts need support in writing materials in this way. Consider using a professional writer if it is not too expensive.

Keep the text clear and concise. Message clarity is critical for effective and efficient learning. Simple words help ensure that the message remains clear. Use simple words such as "pay" rather than "compensation" or "begin" instead of "initiate". Do **not** try to impress with a difficult vocabulary as this can lead to failure. Similarly, unnecessary and complex jargon can also cause compre-

hension problems. Also, keep sentences short. As a rule, as sentence length increases, comprehension decreases.

Practical Guideline
Text should be short, clear, concise, and simple.

Keep paragraphs short enough to break up large chunks of information into manageable pieces. This is also useful for enabling the material to fit onto computer screens. Short paragraphs also help learners who are choosing to skim the material. Short paragraphs also increase the amount of white space.

Minimize reading

It is important for you to minimize reading since it is generally more tiring and time-consuming to read from computer screens than printed material. People tend to read printed material 20 to 30 percent faster than the same content on a computer screen. Minimizing reading also helps students with weak reading abilities and those with disabilities. Minimizing reading makes writing for computer screens fundamentally different from writing for printed materials. Be sure that you have this skill or that it is available on the team.

There are a number of ways you can minimize reading:

- Use simple and clear wording.
  - Students with better reading abilities usually do not find simple clear writing offending. They simply read it faster.
  - Highlight key words. This makes important information easy to find.
- Ensure smoothness.
  - Read the text aloud to hear if it flows smoothly.
- Be consistent.
  - Keep screens predictable and regular to minimize searching. There should be a clear underlying structure. Facilitate this with organizational landmarks such as headings.
  - Use a standardized and consistent "template" to format your pages.
- Use tables to organize information.
  - This makes the information easy to find and understand.
- Use lists instead of paragraphs.
  - This makes the information easy to find and understand.
  - List items should follow the same grammatical structure.
  - Highlight lists with bullets or dashes.
  - Make lists clear by creating logical groupings.
- Use flow charts and diagrams where possible to illustrate your points.

Develop a good writing style

Your writing style should follow these guidelines:

- Use active verbs, and eliminate unnecessary words.
  - For example, write "Your software choice will affect your efficiency" rather than "Your efficiency will be impacted by your choice of software". Similarly, write "text colour", not "colour of the text".
- Keep your writing natural and conversational. Address your reader directly by using the second-person voice (e.g., "you").
  - Vary sentence lengths. Note that this page has a variety of sentence lengths.
  - Begin sentences in a number of different ways.
  - Use effective connecting techniques. For example, start succeeding sentences with "However" or "Similarly" or include key words of the preceding sentence.
  - Use many common one or two syllable words.
  - Include colloquial and idiomatic expressions (but be sure the audience will understand them).
  - Use a minimal amount of abbreviations, proper nouns, and numerals.
- Use the second person (i.e., you rather than we).
- Be unbiased.
  - Eliminate sexist, stereotypic, ethnic, and lifestyle comments (see Chapter 4, Addressing Diversity).

Follow the basic rules of writing

You need to follow the many rules of effective writing. Some of these rules include:

- Use correct writing mechanics (e.g., spelling, grammar, and punctuation).
  - Errors affect credibility, lead students to take the material less seriously, and can teach poor writing habits.
  - Use a spell-check program but remember that spell-checkers might not consider sentence context and meaning.
- Avoid hyphenating words at the end of lines.
  - Hyphenated text is harder to read.
- Define all acronyms on first usage.
  - For the first instance, write the full term and then put the initialism in brackets. For example, write Computer-based Training (CBT). Repeat the full term if it has not been used for several pages.
- Minimize punctuation. For example, in acronyms use CBT not C.B.T.
- Use upper and lower case letters.

  - Sentences written in upper case letters take longer to read. Reading speed increases when learners can recognize word shapes.
  - Most students find that text written only with capital letters is hard and somewhat uncomfortable to read.
  - THINK ABOUT WHAT IT FEELS LIKE TO READ THIS SENTENCE. Does it bother you? Compare it to other sentences. Imagine a whole page written in capital letters.
- Only use symbols **every reader** understands (e.g., $ for dollar).

SPACING

The spacing you use can greatly affect the "look and feel" of your product. As a guideline:

- Use lots of white space.
  - Crowding reduces readability and can make a screen "feel" unpleasant. If in doubt, use more screens and less text per screen but try to keep complete "thoughts" on one screen. Remember that on computers, extra screens are essentially "free".
  - Since screens should only contain a limited amount of text, take special care to make smooth transitions between related screens.
  - It is easy to find and focus on text that is isolated by white space. Note that white space can be overdone. If there is too much white space (i.e., too little text on each screen) then the learner will spend too much time moving from screen to screen. As a guideline, squint at the screen. Determine whether you focus on the message or the space.
  - Single line spacing can work well but separate paragraphs with a blank line.
- Keep the top and left margins for text locations constant.
  - This reduces searching time.

People read English from left to right and top to bottom. Since people tend to focus on a curved path along the screen, you should try to place key points along the curve. The best location for a key point, such as a formula, is the screen's upper left area. Poor areas for key points are the screen's top right and bottom left. Place non-critical or unimportant information in the top right and bottom left. These areas are illustrated in Figure 21.1.

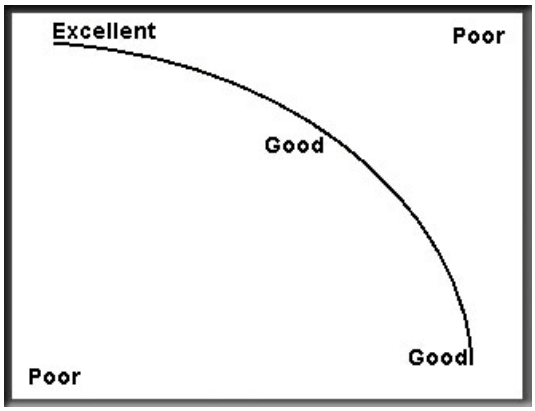


Figure 21.1. Screen focus points guidelines

There are cases where this curve cannot be used. For example, this can happen if a visual occupies the top half of the screen and supporting text fills the bottom half.

JUSTIFICATION

For the best readability, you should left justify paragraphs. Some materials are written with full justification in order to keep the right margin neatly aligned. Full justification is where spaces are added between words so that the text starts on the left margin and ends at the right margin. In general, you should avoid full justification. Full justification is harder to read than left-justified text. With full justification, a reader's eyes move more because of the large spacing between words.

Practical Guideline
Left justify text.

Centre-justified paragraphs are also hard to read. Right-justified paragraphs are mainly useful for aligning numbers. The various types of justification are shown in Figure 21.2.

FONTS

Most systems have an adequate selection of fonts. It is safest for you to use standard system fonts like 'Arial' that are available on every machine running Windows. If you use an uncommon font then the user's computer could substitute a font that may not be appropriate. If you do not use a system font, determine whether there is copyright clearance for distributing the font with the software. A fee or royalty may need to be paid in order to distribute the font. If there is any doubt, use the system fonts. It can be time-consuming but you could create a unique font if the supplied fonts do not meet your needs.

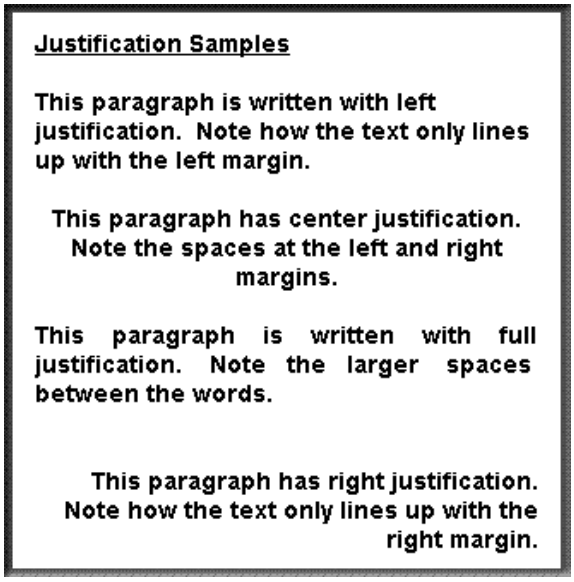


Figure 21.2. Variations of justification

Choose a font that is clear and easily readable such as Arial, Helvetica, or Times New Roman. Although some people may call these fonts "boring" or "unattractive", readability is critical for online applications — especially when students will read text for longer time periods. Italic, serif, sans serif (non-serif), script, decorative, and small fonts (see Figure 21.3) can be hard to read depending on their size and the monitor's clarity. Some people prefer serif over sans serif fonts since the "feet" of serif fonts helps the eye move horizontally. People tend to read faster with serif fonts than with sans serif fonts. Regardless of what font you use, it is impossible to please everybody.

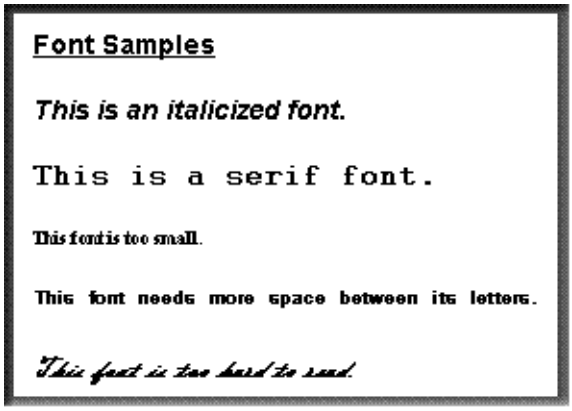


Figure 21.3. Variations of fonts

Be sure that you keep the font constant. If a second font must be used, choose one that appears similar to the first. Too many fonts can be distracting, confuse the learner, and reduce the reading speed. This sentence with only three different fonts proves the point.

Practical Guideline
Use an easy-to-read system font and keep the font constant.

You can use font sizes to organize information, such as in headings, and to indicate importance. Headings should be in upper and lower case letters as uppercase text is less legible. Headings can also help learners quickly find pertinent information, especially when the headings make sense on their own. You can use a slighter smaller font size for labels.

Use larger font sizes for children and seniors. For other audiences, the font size used should not allow for more than 60 characters on a 6-inch (15 cm) line. This helps increase readability, decrease fatigue, and maintain a student's patience and attention. As a proportional guideline, use a 14-point bold Arial font for the main text given an 800 by 600 screen size. This is only a starting guideline since readability is affected by the screen size and font used. If there is any doubt, ask typical learners for their opinion.

VARIABLE SPACING

Variable spacing (see Figure 21.4) reduces the space between letters. This is especially noticed with the letters "i" and "l". Variable spacing allows you more characters per line but is not as "neat" as fixed spacing (see figure 21.4) where all letters use the same amount of horizontal space and consequently line up vertically.

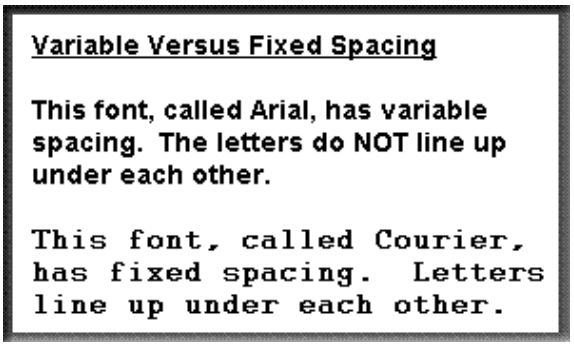


Figure 21.4. Variable versus fixed spacing

For practical reasons, such as screen size limitations and a faster reading speed, you should use fonts that have variable spacing, such as Arial. Note that if the letter spacing is too tight, the letters can be hard to distinguish from each other. Spacing that is too wide can

prevent learners from grouping letters into meaningful forms and consequently decrease reading speed.

Practical Guideline
Use fonts that have variable spacing.

SCROLLING

Scrolling adds new text lines to the bottom of the display while the top lines disappear. User-controlled scrolling text boxes are time-consuming and cumbersome for students to use. Many readers find scrolling frustrating. Where appropriate and possible, do **not** force students to scroll text in order to read all of the material. Rather than using scrolling, you should use more screens to show the text or allow learners to click on buttons to instantly see previous or subsequent information. Another reason to avoid scrolling is that some viewers only read to the point where scrolling is required.

HYPERTEXT AND HYPERMEDIA

Hypertext is text that is linked to other information. Hypertext allows learners to quickly get more information by activating, such as by clicking a mouse over highlighted parts of the screen. Highlighted active words are sometimes called "Hot words". Hypermedia goes beyond hypertext by providing access to a variety of media. Since links often lead to other links, the links are like a three-dimensional web.

Hypertext and hypermedia are useful for Internet-based research projects in that they allow learners to access information in which they are interested, pursue unique ideas, and learn in unplanned ways. Hypertext and hypermedia can also be used for simple information retrieval such as searching an encyclopedia, creative writing projects including a hyper-novel or hyper-report, and specialized reference materials like automobile repair procedures that require a variety of media.

In general, hypertext and hypermedia applications simply provide access to information rather than teaching specified learning outcomes. There are a number of reasons why hypertext and hypermedia can be weak from an instructional perspective. Students may **not**:

- learn effectively if there is no interaction that requires them to think about the material
- be able to differentiate between accurate and inaccurate information (both of which are found on the Internet)
- know how to find needed information if it is not obviously presented
- choose important linked information
- understand the logic or links used to organize the material
- have the spatial visualization ability needed to effectively navigate through the content
- be capable of choosing their own paths to acquire specific knowledge
- have the cognitive capacity to deal with the content, especially if there is poor screen design
  - If the learner thinks too much about too many fonts and font sizes, objects, navigation aids, and screen layouts, the learner may not be able to mentally process the content.
- see important information
  - Learners are more likely to miss information if scrolling is needed to find the information or if the information is "deeper" than they searched.
- prevent themselves from getting lost
- prevent themselves from accessing more information than they can mentally process
- spend much time on the content, as learners tend to skim material that they find on the Internet rather than reflect on the material

Practical Guideline
Do not assume that a hypertext or hypermedia application will result in effective learning.

In other words, for learning to occur in hypertext and hypermedia environments, learning should be specifically planned and guided. Follow the principles of instructional design.

Audio

You can use audio for obvious things like music, poetry, and sound effects and, more importantly, when real sounds, such as heart, animal, and normal and defective equipment sounds, are an integral part of the learning outcome. You can use audio to effectively teach many skills such as attitudes, especially if you personalize the material. Audio is also effective for teaching intellectual skills such as learning languages. You can also use audio to gain attention, give feedback, give directions, personalize computers, provide realism such as through presenting actual speeches, make annotations, teach the pronunciation of new words, provide multilingual support, accommodate non-readers, and provide meaning for images.

Many instructors record their face-to-face lectures and make them available online. A recorded version of a lecture has limitations, if only because the recorded version does not allow the listener/viewer to ask questions. A compounding problem is that many lectures are delivered poorly (i.e., students are passive recipients of information). It can be argued that recorded lectures benefit those who cannot attend or want to review key points. However, some students will choose to not to attend lectures when a recording is available. It is debatable whether recorded lectures do more harm than good. [Author's note: My personal view is that recorded lectures should only be used if it is the only option, such as it being the only way to hear a renowned speaker. Typical non-interactive lectures have been proven to be one of the worst ways to deliver content. A streamed lecture of this type can only be worse.]

Audio is more effective when the topic is simple, concrete, and has little structure, as can be the case with foreign language vocabulary. However, you can effectively teach many skills with audio, such as intellectual, psychomotor, and attitudes, when the audio is supplemented with other media such as text, especially when providing practice and feedback. You should also supplement audio with effective preparatory and follow-up activities. An advantage of audio over text is that listening is much easier than reading.

Practical Guideline
Audio can be particularly effective when combined with other media.

You can use audio effectively for students who are visually impaired and those with poor reading abilities. For those with poor reading abilities, one solution is to provide text but let students click on an audio button whenever they want to hear a narration of the text. One strategy is to display text and simultaneously play a matching narration. Although this strategy is useful for some students, many learners find this annoying. Audio can be problematic when played at a different speed than the student is able to read. For example, if the audio is played at a slower speed than the learner's reading speed, as is true in most cases, the learner can be frustrated as they continually wait for the audio while they read. If the audio is played at a faster rate than the learner can mentally process the information, learning can be compromised. Alternatively, they may try to ignore the audio—which is not easy to do. Note that it is unlikely that all students in a target audience will have similar reading speeds.

To help learning and facilitate reviewing, let students have control over the audio. For example, many students may want to repeat audio clips. This can be easily done in online applications.

For audio to be effective for learning, you need to ensure that the students pay attention, as with all media. If a student is not listening, audio becomes a part of the environment. Keep students involved by posing questions that make students think and keeping the audio clips short. This is critical since aural memory is **not** particularly retentive. You can aid a student's aural memory by enabling them to control the audio, such as repeating it as needed. Students must also be able to understand the audio. Consider developing parallel audio versions in other languages.

Practical Guideline
Design audio to keep the students attentive.

For online courses, speech and sounds can be used to enhance learning.

SPEECH

You can use speech in the form of a narration or dialogue to teach effectively. To enhance what is directly said, you can also convey meaning through:

- emphasis
  - You can add emphasis through stressing a word.
- inflection
  - Add inflection by altering the pitch or tone, such as raising the pitch at the end of a sentence to indicate a question.
- aural mood
  - Establish aural mood through choosing specific words such as crashed versus hit or fantastic versus good.

To avoid confusion when using narration with text, ensure that the audio exactly matches the text. However, matching the audio to the text can be problematic since changes or edits are common. Since it can be difficult to change the audio, record the audio **after** the narration has been thoroughly evaluated.

Practical Guideline
Record narration after the narration text is finalized.

Although using professionals will increase those specific budget items, consider hiring professional actors,

narrators, and others like scriptwriters. Their quality will show through and ensure that the audio is effective. After reading the script and context, professionals tend to be able to quickly understand the overall approach and deliver the appropriate style at the right pace. Also, they will complete the recordings in less time than amateurs will need through requiring fewer retakes. They do this by quickly making modifications after you give them feedback.

When you select actors and narrators, ensure that they are credible and appropriate for the audience. For example, be sure that the audience will identify with them. Peers or respected professionals are often good choices. Actors and narrators need to have an appropriate accent, sound the right age, and be of the appropriate sex (if it makes a difference). As a rule, male voices tend to be more authoritative and credible while female voices tend to be friendlier. Note that two or more voices can add variety and thus increase interest and attention.

SOUNDS

Sounds can be very effective and even necessary to teach certain skills. For example, these include fixing equipment when a sound indicates a specific malfunction as well as diagnosing medical problems such as lung diseases.

Practical Guideline
Sound will not save a weak presentation!

You can use sound effects to:

- add realism
- generate emotions
- define space (e.g., distance and direction)
- establish a locale or create an environment (e.g., crashing waves for a beach scene)
- emphasize an action (e.g., screeching tires indicate hurrying)
- intensify an action (e.g., time length or loudness of the emphasis action)
- depict an identity (e.g., slurred speech for a drunk)
- set the pace (e.g., roar of an engine)
- provide a counterpoint (e.g., using unexpected sounds as is done in comedies)
- symbolize meaning (e.g., church bells symbolizing a funeral or wedding)
- unify transitions (e.g., providing continuity between scenes)

Base your sound design on sounds heard in the real world. Sound effects that do not sound right can be distracting.

To decide whether you really need sounds, take the sounds out. If the audience still understands the messages, you probably do not need the sounds.

Note that you should adjust the sound's volume to suit the content. For example, do **not** let sounds overpower a narrator. Also, do **not** use sounds repetitiously. Students sometimes enjoy sounds the first time they hear it but with repetition the sound can become obnoxious.

Music can be used to achieve the same purposes as sound effects. You can also use music to set and change moods, feelings, and atmosphere. You can add music to slide shows and other applications to provide ambience for the viewer. You may want to add music to an opening screen or a menu.

Visuals

Visuals can be considered to be "real" as in photographs and slides. Visuals can also be pictorial or diagrammatical representations of "real" objects.

For instructional purposes, you can use visuals to illustrate objects and ideas, identify objects, show relationships between objects and ideas, classify objects, show spatial relationships, teach psychomotor skills that do **not** need to be recognized or copied, and help teach attitudes. You can also use visuals to make abstract concepts concrete. For example, you can do this by graphically showing the relationship between interest rates and the time required to pay off a mortgage. When you design online lessons follow the old adage, "A picture is worth a thousand words." You should consider combining visuals with text to provide practice and feedback, as text alone does not suffice in many cases. If you teach with visuals, you should likely include visuals in practice and feedback as well as testing.

Note that some learners have difficulty learning from abstract sources such as text, numbers, and symbols. Visuals are an alternative that can help these learners. Similarly, you can help these learners by presenting data with graphs and charts.

Compared to only using text, visuals combined with text reduce the learning time and help students acquire and retain information. Visuals provide an alternate learning path since certain parts of the brain process visuals while different parts process text.

Practical Guideline
In general, adding visuals leads to increased learning.

Visuals are particularly valuable when you direct learners to focus their attention on specific details, which you can do through concise prompts or captions. A combination of text and visuals can result in a 15 to 50 percent increase in recall over either alone. Recall is increased for both simple skills, such as recalling facts, and complex skills, like performing operations. Lessons with visuals result in higher retention over long time periods (i.e., months). Visuals particularly benefit weak learners. Also, they can be mentally processed much faster than text. Students may be better able to transfer the skills learned to other situations.

In general, visuals can be valuable learning tools. Some ideas cannot be adequately expressed in words but can be readily depicted with visuals. How could you adequately describe the surface of Venus or the structure of DNA without a visual? Look at Figure 21.5. Think about the words you would use to describe what this rhinoceros looks like. If the learner has not seen one before, with those words and without seeing a visual, could learners accurately envision the rhinoceros? For online applications, visuals can be particularly effective if students can control the length of time the visual remains on the screen, in other words proceed when they are ready.

Figure 21.5. Hard to describe visual

Note that in some cases, a visual drawn by an artist may be more effective than a real image. Some learners may not be able to focus on all of the details that real images sometimes provide. In a related way, people will usually recognize a cartoonist's sketch of a hand as being a hand faster than a digitized image of a hand, even if a cartoonist's sketch of a hand has three fingers. Simultaneously look at Figures 21.6 and 21.7. Which do you more quickly recognize as a hand? Since complex visuals require more time to mentally process than simple images, provide simple images (where appropriate).

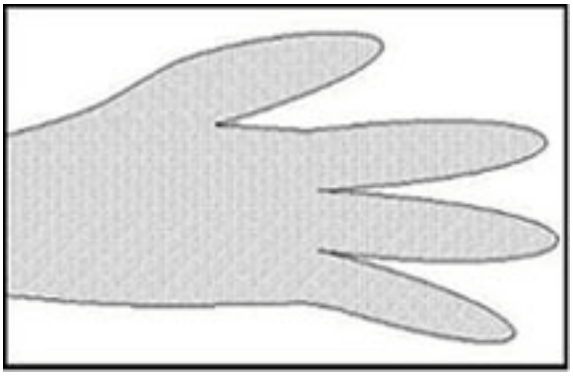


Figure 21.6. Cartoon hand

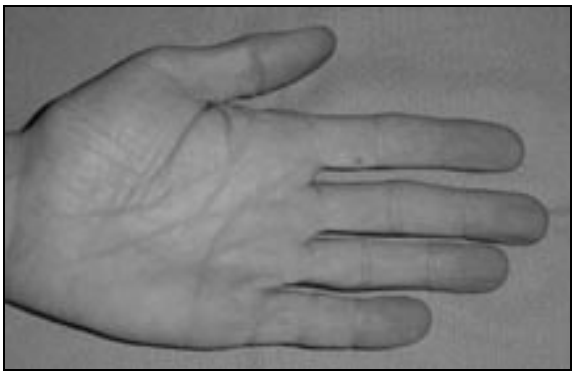


Figure 21.7. Digitized hand

On screens with text and visuals, learners are naturally drawn to the visuals. As a minimum, your visuals will add variety to screens. Although irrelevant visuals do not help students learn relevant content, some images (e.g., humorous) can help "lighten" the material. Screen variety can increase attention and motivation and consequently indirectly affect learning positively.

KEEPING THE MESSAGE OF YOUR VISUAL CLEAR

To keep the message clear, your visuals should be self-explanatory, have labels, and only include relevant information!

Visuals should be self-explanatory

Self-explanatory visuals illustrate the message. If the image is not self-explanatory then you should determine how it could be done. At times, this goal may not be possible but you should at least aim for it. However, be sure to provide an explanation to link the visual to the idea you are conveying.

Practical Guideline
As a rule, ensure your visuals are self-explanatory.

You should use the following methods to ensure message clarity:

- Keep the visual simple and only include essential information. For example, crop images to eliminate unnecessary details. Complex visuals can weaken the instruction by confusing or distracting the students.
- Match the visual's complexity to the learner's skill. Overly complex visuals are often ignored.
- Consider using simple diagrams instead of realistic images. Realistic images sometimes contain so much detail that the learner is distracted from understanding the message.
- Use a series of diagrams rather than a single complicated diagram. When explaining a process, use one visual per step. One technique you can use is to gradually build the visual from screen to screen.
- Add labels to diagrams to highlight key points. Horizontal labels are the easiest to read.

Only include information relevant to the visual

If you include extra information, you could clutter the visual and can cause confusion. On screens that build, some of the previous information may need to be erased or de-highlighted so that new key points are easily found. Build the visuals in logical straightforward sequential steps. Plan to allow the learner the capability to reverse the steps for easy review.

Video

With respect to teaching, you can use video, which is usually combined with audio, effectively for:

- demonstrating procedures, changes, and processes
  - Learning can be especially effective when the learner can control the video with features, including playing when ready or replaying as needed.
- teaching attitudes and values
  - Emotional material and/or real-life examples can be shown.
  - Text may be needed to help explain the attitudes and values.
- making abstract concepts concrete
- classifying and comparing information
  - For classifying and comparing information, video is particularly valuable when the information can be quickly accessed.

Video can also be useful for:

- gaining and holding attention as well as motivating learners
  - This can be done through special effects, colour, motion, audio, and historical clips.
  - This can lead to increased retention and recall of information.
- introducing topics or procedures
  - This can be easy and pleasant for students especially when the alternative is lengthy text.
- presenting visually rich material that would otherwise be hard to explain (e.g., chemistry and physics experiments, how an amoeba moves, heart valves opening and closing, and human interactions)
  - Information that needs to be visual or have realism can be presented. Examples of these include the courtship rituals of animals and human behaviours for changing attitudes.
  - Audio, such as lung and heart sounds, can also be presented.
- testing
  - Testing with video can be much more realistic than testing via text.

Practical Guideline
Use video to teach skills that are difficult to explain with other media.

The strengths of video are more evident if you tell the students what they are going to learn and what they should focus upon before they view the video. A video's effectiveness also relates to how well the material attracts and directs the learner's attention. Learners tend to have a short attention span for video. If the Grand Canyon, one of the world's most spectacular sights, holds a viewer's interest for an average of 90 seconds then imagine how long your video clip can hold your learner's attention. You can minimize this problem by presenting short clips, as short sequences are helpful in maintaining student attention and interest. This also helps keep the message focused on the learning outcome being taught.

Practical Guideline
Prepare students before they watch a video. Let them know where to focus their attention.

There can be problems with video. Most students remember generalities rather than details. Also, video sometimes provides information at a fast rate. So, you should likely plan activities to help learners retain the material and also keep the video available to students for studying. In some situations, you should let the learners

control the video (e.g., slow forward, step forward, step backward, slow backward). This is particularly helpful for reviewing psychomotor skills such as studying procedures and noting detailed information.

VIDEO COMBINED WITH OTHER MEDIA

If you combine video with audio, you can effectively teach attitudes and provide elaborations. Note that video combined with audio requires more mental processing than either alone. Consequently, you can overwhelm students with more information than they can mentally process. One solution is to put pauses after complex elements to allow learners to mentally "catch-up" before you present new material.

Video combined with audio can depict events faster than can be done with only text. However, students perceive video as being easier than text and tend to spend less effort in learning from video than text. Consequently, students may learn less from video than from comparable text. You can enhance learning with video by cuing the learner, providing interaction, and keeping the video clips short.

Since video tends to be weak at teaching detailed information, provide video control and text-based summaries to help with this problem. Consider combining video with text to provide practice and feedback.

Practical Guideline
Video has many effective uses but is weak at providing detailed information.

DIFFICULTIES WITH PROFESSIONAL QUALITY VIDEO

Professional quality video usually requires a large amount of storage space when digitized and significant costs, time, and expertise to develop.

Digitized video (for both professional and non-professional productions) requires a large amount of storage space. Expect to make some compromises.

- Modern video cameras automatically digitize video. However, if you are working with old sources, you may need to convert analog (smooth and continuous) signals into a finite amount (depending on the sampling rate or number of measurements taken) of digital or binary information (1s and 0s) that computers store and process. The large amount of storage space needed for digital video can be a significant problem, especially for CD-ROM distribution, unless compression techniques are used.
- Minimize digital storage requirements by using short clips and only use the amount of video that is necessary. Some video clips, such as interviews, may not require full-motion, full-screen, or full-colour presentations. Although video is typically shown at a frame rate of 30 frames or images per second, as a rule, action sequences should play at a minimum of 20 frames per second while you can reduce non-action clips (e.g., "talking heads") to 10 frames per second if you need to save disc space or reduce bandwidth requirements. Screen sizes for video generally range from 640×480 down to very small sizes, depending on the computer system and/or speed of the Internet connection.
- Depending on the computer's speed, computer's memory size, and the file size, there may be a significant delay while large video files are loaded. Short video clips are often preferable.

Practical Guideline
Estimate the amount of data your final product will need to hold to ensure that your data will fit on the selected storage medium.

Producing professional quality video particularly needs justification since you will incur significant costs for their production:

- Justification can be from the motion needing to be taught being unfamiliar or difficult to perform.
- Justification can arise from concepts being easily and best understood with video.
- Justification is easier if the material will be useful for a long time. This is particularly important with video since it can be expensive to update the video. Filming and editing can have significant costs.
- Typical costs per day for a camera operator, other personnel such as a sound person and actors, a quality camera, and other equipment such as lights tend to be expensive, especially when paying for talented individuals.

Projects requiring professional video can take a large amount of time to produce. For example, a relatively simple project, such as creating a resource that covers each step of disassembling and assembling an aircraft engine, can require 200 hours of development time. Many projects need specific expertise such as media specialists and instructional designers who specialize in multimedia applications.

Professional productions also require relatively expensive filming equipment.

- Although consumer-level digital video equipment tends to be affordable, professional-level equipment can be costly.
- Better filming equipment has high sensitivity (this is a measure of the minimum amount of light to make a usable picture—measured in units of lux), high resolution (this determines the picture's sharpness), and dynamic response (this is the ability to detect rapid changes in a scene's light intensity).

Practical Guideline
High-quality video takes time and expertise to develop.

GATHERING EXISTING MATERIALS

Before you go to the effort of recording any video, determine whether any suitable materials exist. Gathering existing materials can save you significant time and money if you do not have to "re-invent the wheel". For any materials you can get, be sure to:

- get copyright clearance **in writing**
- get original materials
  - Each succeeding generation has poorer quality.
- get materials in the format you will use, such as mini DV tapes
  - If you transfer material from one format to another, some image quality will be lost. It also costs time and money to transfer material between formats.
  - Existing materials are often found in a variety of formats (e.g., HD, mini DV, film, one inch, 3/4 inch, Betacam SP, 16 mm, Hi8, 8mm, S-VHS, and VHS).
- determine whether the material's quality is acceptable
  - Sometimes poor quality is better than students never seeing the material.

Practical Guideline
Using existing materials can save you time and money.

Note that many high-quality generic clips are available for a fee in a variety of formats. If it is important to you, ensure that you can distribute the clips royalty-free.

You may have problems in gathering existing materials, in that:

- copyright clearance may cost money
  - Costs can range from being expensive to free.
- it may not be possible to locate the copyright owner
- the materials may not arrive or it could take a long time to receive the materials
  - Sending materials can be a low priority of copyright owners.
- copyright clearance may not be granted for some needed materials
- some materials may not be exactly as you need
  - For example, video materials designed to be played linearly, such as in movies, often have audio that overlaps scenes in that the audio may start before or end after the specific video is seen. Also, the video is usually not designed to be shown in a series of short clips, as can be preferred in online courses.

Animations

Animation is another medium that you can incorporate into your online courses. It is important for you to consider using animations as a part of the instructional strategy since animations can significantly enhance learning, motivation, and attitudes as well as reduce the time needed for learning.

Animation means "to give life to" something. Animations, which are a series of visuals that change over time, are like video sequences except that animations are created with a computer, other tools, or manually rather than by filming real objects in motion. For this reason, a video can be easier to make than an animation.

You can effectively use animations for:

- showing relationships between objects and ideas
  - For example, animations can illustrate pressure changes in a pressure regulation system or how mechanical systems work.
- simulating the results of actions
  - As an example, animations can show the effects of drug dosage on heart rates.
- showing sequential steps in a procedural task
  - For example, animations can be used to explain how to adjust a camera.
- explaining difficult concepts
  - As an example, you can use animations to illustrate how the body responds to changes in oxygen demand.
- making abstract concepts concrete
  - For example, animations can show how electrons move in orbits around the nucleus of atoms or how information flows in an electronic system.
  - This is important since some learners have difficulty learning from abstract sources such as text, numbers, and symbols.

With respect to learning, you can use animations to:

- enhance performance and retention
  - Note that learning generally requires cues and guidance to specifically direct a student's attention to the pertinent point. This is particularly important for younger and immature students.
  - Ensure that students are not presented with more information than they can handle.
  - In general, animations with text are more effective than visuals with text. This is especially true when the concept involves directional characteristics or changes over time. In these situations, animations can help simplify an abstract idea into a concrete idea.
- reduce the time needed for learning
- gain attention and improve student attitudes
  - This is partly due to animations simply adding variety to the presented content.

KEEPING THE MESSAGE OF YOUR ANIMATION CLEAR

To keep the message clear, your animations:

- should be self-explanatory, as a guideline
  - Students do **not** necessarily know how to interpret animations. The ease of interpretation can depend on their age and maturity. Evaluate your animations with target audience students.
  - You can help make the animation clear by providing supporting text and/or labels. Alternatively, focus the student's thoughts on the pertinent information.
  - If it is not self-explanatory, consider redesigning the animation.
- must match the learning outcomes
  - Some animations have been used to impress rather than teach.
- should be set up to allow learners to control when they see the animation
  - Students should be able to repeat animations since it is easy to miss significant points during minor distractions.

Practical Guideline
Self-explanatory animations illustrate the message.

DISPLAYING ANIMATIONS

You should only display animations when the learner is ready to view them. Students can do this by clicking an "Animate" button when they are ready. Before showing the animation, provide guidance to ensure that the students will focus on the important point!

Practical Guideline
Animations should only begin when the learner is ready to view them.

Your animation will appear more realistic if the object's speed, size, and relative motion are accurate. Base the animation's speed on real time rather than the computer's speed. Otherwise, due to a wide variation in computer speeds, animations may run at different speeds on different hardware configurations.

You can make animations appear three-dimensional.

- Use 3D for realistic effects.
- 3D animations can be more powerful than 2D animations, especially if the learner can view the animation from different perspectives such as front, side, and top views. For example, this can be useful for training students to repair equipment.

Real objects

Imagine learning how to create an online course without ever using a computer or seeing real examples or learning how to juggle without touching any real objects.

Real objects are excellent when teaching psychomotor skills and when the skill must be practised and mastered. There is no guarantee that the skill learned on a simulator or other format will be transferred to the work place. So, remember the old saying, "Practice makes perfect".

For some training needs, such as those taught through simulations, you will also need to provide for real experience. A truism illustrates this: "There is only so much you can learn about skydiving while standing on the ground." At certain points within or after the online learning activities, simply direct the student to real objects (or models) or exercises.

Practical Guideline
Consider including real objects as a part of the entire online instructional package.

Selecting media

The media mix you choose must be able to meet the requirements of the instructional strategy and address all of the instructional events. In particular, the media mix must effectively teach all of the learning outcomes and should allow for practice and feedback. Use the following general guidelines for selecting the appropriate media mix for the learning domains of verbal information, intellectual skills, psychomotor skills, and attitudes. (Learning domains are discussed in more detail in Chapter 10, General Principles of Instructional Design.)

For verbal information such as knowledge and comprehension, you should use text and visuals. Remember to use the computer to provide interaction as that can be difficult or cumbersome to do with paper-based materials.

For intellectual skills such as applying skills to new examples, you can effectively use each medium depending on the skill being taught. Following the instructional design process will help you determine the best media mix.

For psychomotor skills such as those requiring muscular actions, you should use real equipment although, for practical reasons such as cost and safety, you may need to create a simulation that incorporates a variety of media. Video with audio or text support can be superb for teaching psychomotor skills. Similarly, a series of images with text can also be very effective.

Although you can use video and audio to effectively teach attitudes, for example, choosing to say "no" to drugs, your complete instructional strategy should consider other methods such as role-playing.

Remember to consider learner characteristics as discussed in Chapter 10, General Principles of Instructional Design.

Transferring material to other formats

If you simply transfer material from one storage format to another, the second's advantages may not be exploited and the first's limitations may be kept. For example, some analog videotapes have been transferred to CD-ROM. If the video clip is specifically designed to be played linearly, it may only be educationally sound to play the video linearly. In this case, the CD-ROM's advantage of instant access capabilities and interaction are not being utilized. There may only be minimal value in having video contained on a CD-ROM instead of a videotape. In general, if material is designed specifically for one format, be careful about transferring it directly to another format. However, with modifications, transferring material from one format to another can be justified and effective.

Note that there is often a quality loss in the image and sound clarity when transferring materials between formats. Working with original materials can minimize losses.

Accessing media

You will need to consider whether the students should access the media data (e.g., large video files) from a DVD-ROM, a CD-ROM, an intranet, or the Internet. This is summarized in Table 21.1.

Summary

A major part of the instructional design process you need to do is select the appropriate media mix to effectively teach the learning outcome(s). Selecting the best media mix will enable you to increase learning. The different media categories are: text, audio, visuals, video, animations, and real objects.

The media you use can influence the amount of learning that occurs. If you combine the media's strengths with instructional methods that take advantage of these strengths, you can positively influence learning. Learning from course content made with more than one medium is usually more effective than content comprised of only one medium. In many situations, you can and should use more than one medium to teach the skill. However, remember that if you use too many media at one time, you can impede learning. Base your media mix decision on the learning outcomes, how they are being taught, and how testing will be done. To be successful, students must also have the skills to extract information and learn from the media. You may also need to motivate your students to learn from the media selected.

You can effectively use text to teach many skills (most verbal information, intellectual skills, and cognitive strategies and some psychomotor skills and attitudes) unless the target audience has a poor reading ability or low motivation. You will often need to combine text with other media.

Text often forms the foundation of online courses. Write text well by making text understandable, minimizing reading, developing a good writing style, and following

the basic rules of writing. In general for text, use lots of white space, left-justify text, use a font that is easy to read and has variable spacing, use font sizes to organize information, and avoid the requirement for scrolling.

Hypertext is text that is linked to other information. Hypertext allows learners to quickly get more information by activating highlighted parts of the screen. Hypertext is useful for Internet-based research projects and simple information retrieval. Remember that hypertext can be weak from an instructional perspective unless you specifically plan and guide the learning.

You can use audio when real sounds are an integral part of the learning outcome and to teach skills such as attitudes and intellectual skills. You can also use audio to gain attention, give feedback, give directions, personalize computers, provide realism, make annotations, teach the pronunciation of new words, provide multilingual support, provide meaning for images, and accommodate non-readers and learners with poor reading abilities. Remember that audio narration can be problematic when played at a different speed than the student is able to read. You can use speech in the form of a narration or dialogue, especially when done by professionals that the audience can identify with, to teach effectively.

Audio is more effective when the topic is simple, concrete, and has little structure. For many skills, audio should be supplemented with other media such as text. You should also supplement audio with effective preparatory and follow-up activities. Also, for audio to be effective for learning, you need to ensure that the students pay attention. Keep students involved through posing questions that make students think and keeping the audio clips short.

Visuals can be considered to be "real" as in photographs and slides. Visuals can also be pictorial or diagrammatical representations of "real" objects. For instructional purposes, you can use visuals to make abstract concepts concrete, illustrate objects and ideas, identify objects, show relationships between objects and ideas, classify objects, show spatial relationships, teach psychomotor skills that do **not** need to be recognized or copied, and help teach attitudes. You should consider combining visuals with text to provide practice and feedback as well as testing. Remember that visuals can help many learners.

Table 21.1. Differences between data storage and retrieval options

	DVD-ROM	CD-ROM	Intranet	Internet
Amount of data	Up to 4.7 gigabytes, enough for most applications	Up to 700 megabytes, enough for many applications	Limited by space on the host server. If needed, servers can be upgraded.	Limited by space on the host server. If needed, servers can be upgraded.
Learner access	Not found on old computers	Found on all but the oldest computers	Many organizations provide employees and/or students limited access to their intranet	Many learners are not connected but this number is decreasing yearly
Reliability	Very high	Very high	High but there are occasional system crashes	High but there are occasional system crashes
Bandwidth	Enough for most applications, faster than CD-ROMs	Enough for most applications, although high-quality video can push the limits	Enough for most applications although there can be problems with programs that are video intensive when there are numerous concurrent users	A high-bandwidth connection is preferred for most online courses, especially when quality video needs to be seen
Updating information	In general, this cannot be done unless combined with an intranet or Internet connection	In general, this cannot be done unless combined with an intranet or Internet connection	Can be done	Can be done
Developer costs	Copying and distribution costs	Copying and distribution costs	Need a server that can meet the demand	Need a server that can meet the demand
Student costs	One-time relatively low cost of the drive that is usually included when the computer is purchased	One-time relatively low cost of the drive. Most computers are sold with a DVD drive. DVD drives can read CD-ROM disks	Usually none	Monthly fee that can increase with the amount of bandwidth

Compared to only using text, visuals combined with text reduce the learning time and help students acquire and retain information. Visuals are particularly valuable when you direct learners to focus their attention on specific details. To keep the message clear, your visuals should be self-explanatory, have labels, and only include relevant information.

With respect to teaching, you can use video, which is usually combined with audio, effectively for demonstrating procedures, changes, and processes, depict events, teaching attitudes and values, making abstract concepts concrete, and classifying and comparing information. Video can also be useful for gaining and holding attention as well as motivating learners, introducing topics or procedures, presenting visually rich material that would otherwise be hard to explain, and testing. Since video tends to be weak at teaching detailed information, provide video control and text-based summaries to help with this problem. Consider combining video with text to provide practice and feedback.

The strengths of video are more evident if you tell the students what they are going to learn and what they should focus upon before they view the video. A video's effectiveness also relates to how well the material attracts and directs the learner's attention. Do this with short clips. Plan activities to help learners retain the material and also keep the video available to students for studying.

Remember that professional quality video usually requires a large amount of storage space when digitized and significant costs, time, and expertise to develop. Before you go to the effort of recording any video, determine whether any suitable materials exist.

Animation means "to give life to" something. Animations, which are a series of visuals that change over time, are like video sequences except that animations are created with a computer, other tools, or manually rather than by filming real objects in motion. For this reason, a video can be easier to make than an animation.

Consider using animations as a part of the instructional strategy since animations can significantly enhance learning, motivation, and attitudes as well as reduce the time needed for learning. You can effectively use animations for showing relationships between objects and ideas, simulating the results of actions, showing sequential steps in a procedural task, explaining difficult concepts, and making abstract concepts concrete. With respect to learning, you can use animations to enhance performance and retention, reduce the time needed for learning, gain attention, and improve student attitudes.

Like visuals, animations should be self-explanatory. Animations must match the learning outcomes and should be set up to allow learners to control when they see the animation. In general, animations appear more realistic if the object's speed, size, and relative motion are accurate.

Real objects are excellent when teaching psychomotor skills and when the skill must be practised and mastered. There is no guarantee that the skill learned on a simulator or other format will be transferred to the work place.

The media mix you choose must be able to meet the requirements of the instructional strategy and address all of the instructional events. In particular, the media mix must effectively teach all of the learning outcomes and should allow for practice and feedback. For verbal information, you should use text and visuals. For intellectual skills, use each medium depending on the skill being taught. For psychomotor skills, you should use real equipment although for practical reasons you may need to create a simulation that incorporates a variety of media. Video with audio or text support can be superb for teaching psychomotor skills. Similarly, a series of images with text can also be very effective. Although you can use video and audio to effectively teach attitudes, your complete instructional strategy should consider other methods such as role-playing.

If you simply transfer material, especially video, from one storage format to another, the second's advantages may not be exploited and the first's limitations may be kept.

You will need to consider whether the students should access the media data from a DVD-ROM, a CD-ROM, an intranet, or the Internet. Each has different advantages and disadvantages.

Glossary

Fixed spacing is present when the spacing between letters is constant. Fixed spacing requires more space than variable spacing.

Hot words are highlighted words that indicate active links to other material.

Hypermedia is media that is indexed and linked in a logical manner to other information.

Hypertext is text that is indexed and linked in a logical manner to other information.

Intellectual skills are those that require learners to think (rather than simply memorizing and recalling information).

Learning outcomes or objectives are specific measurable skills.

Psychomotor skills are those that require learners to carry out muscular actions.

Scrolling is a process for displaying more text than a screen can display by adding new text lines to the bottom of the display while the top lines disappear.

Variable spacing is present when the spacing between letters is reduced. Variable spacing requires less space than fixed spacing.

Verbal information is material, such as names of objects, that students simply have to memorize and recall.

References

Fenrich (2005) provides much more detail on media. For example, there are tips for producing professional quality video, digitizing, and compression/decompression that are beyond the scope of this book.

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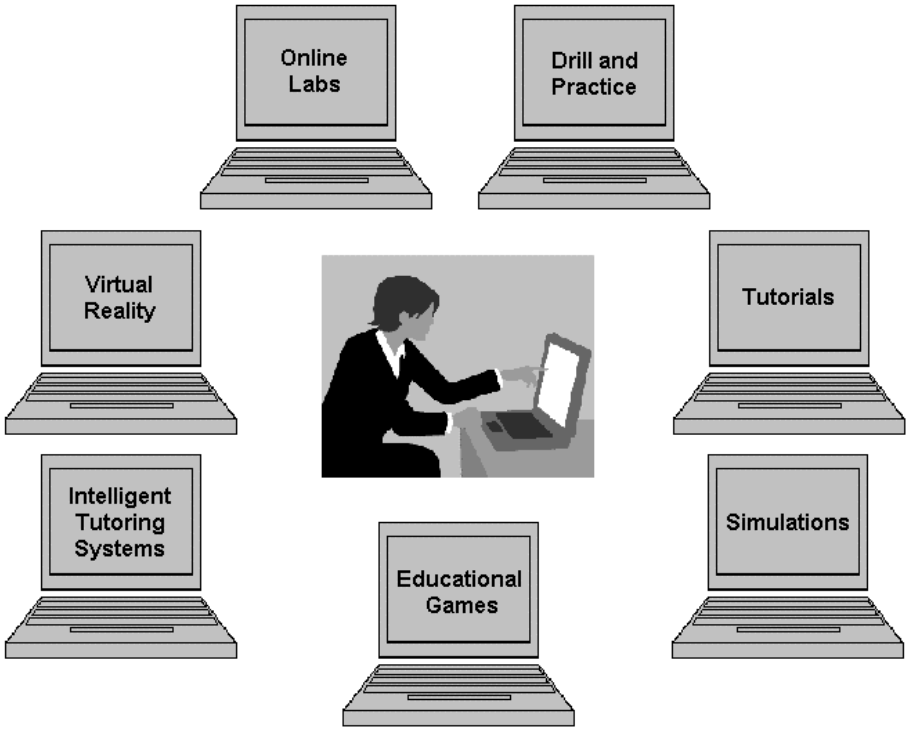
22
Computer-Based Resources for Learning

Peter Fenrich

To create an effective online lab, you may have to think differently than everyone else. Sometimes everyone else is wrong. – Irwin DeVries and Peter Fenrich



Learning outcomes

After completing this chapter, you should be able to:

- Teach practical skills effectively.
- Describe typical problems you may encounter when teaching practical skills in labs.
- Describe pros and cons of virtually controlling real equipment.
- Design effective lab tests for online learners.
- Gain acceptance for online labs.
- Discuss the future of online labs.
- Discuss the strengths and weaknesses of drill and practice programs, tutorials, simulations, educational games, intelligent tutoring systems, and virtual reality applications.
- Develop and select instructional materials.

Introduction

This chapter first focuses on the viability of teaching lab, shop, and other practical skills in a virtual environment. I discuss instructional design considerations for online labs as well as how educational technology can support online learners, especially given problems with "live" labs. I also discuss ideas regarding controlling real equipment, how lab tests can be handled, and ideas with respect to articulation. I also share some thoughts on the future of online labs. The instructional design topic will address learning outcomes that focus on important skills, content areas that will be stronger or weaker than traditional labs, and strategies for effectively teaching lab skills online. I will present a variety of computer-based resources that can support learners beyond more common online strategies. These resources include drill and practice programs, tutorials, simulations, and educational games. The chapter will conclude with brief notes on intelligent tutoring systems and virtual reality applications.

Online labs

Online (or virtual) labs simulate traditional settings, and sometimes take students beyond what can be done in a traditional lab. In general, there are two types of labs. One simulates real experiments, equipment, or procedures, while the other lets learners access and control real equipment from a remote location. These are different from software simulations that emulate real-world scenarios such as investing money, controlling power plants, and flying airplanes. An online lab is not created simply by transferring a lab workbook to a website, allowing students to access software from different campus or off-campus locations or enabling them to submit assignments via the Internet. In this chapter, the term "lab" is used generically for any setting where practical skills are taught, such as in labs, shops, and classrooms.

Some online labs let you simulate lab procedures or equipment. For example, using the computer's mouse, students can get a beaker, put a precise amount of a specific chemical in it, and virtually carry out all of the needed procedural steps. This is useful for preparing students to carry out lab procedures efficiently in a real-life lab. One problem is that online labs are much more valuable if the learner can also see the results. It would be ideal to let learners virtually mix chemicals and to provide opportunities that would be too costly or dangerous to carry out in a real lab. However, as the number of variables increases, the complexity of online lab design and possibilities increase. Imagine all of the possibilities with all of the different chemicals mixed together in different volumes, concentrations, combinations, and sequences. You could theoretically state what would happen for each case but, for practical reasons, students would not be able to see a video clip or animation of each possibility.

PROBLEMS WITH TEACHING LAB SKILLS IN TRADITIONAL WAYS

There can be numerous problems when teaching practical skills in typical face-to-face labs:

- When a demonstration is done, some students, such as those in the back of the class, may not be able to clearly see what is being demonstrated.
- Many instructors will not show all of the possible demonstrations, due to time, cost, or equipment limitations.
- Dangerous, expensive, or unavailable equipment or materials may limit what learners can see or do.
- The costs of building and maintaining labs are high.
  - Even if a lab can be built, funds are still needed to run labs. Staff, materials, and equipment replacement due to breakage as well as wear and tear are significant. Equipment upgrades are also a costly, important consideration.
- It may not be possible or practical to teach some skills.
  - For example, one way to teach troubleshooting involves taking components out of functioning systems, breaking them, putting them back in, and letting students determine the problem. However,

this is impractical because of the time it takes to remove, break, and install components, cost of later repairing the components, problem that this needs to be done to many components, and time required to have all of the students individually determine the problem for each broken component.
- In many cases, if a student misses a lab, they will not have the opportunity to do it later.
- Students are often not able to repeat a lab if something goes wrong. This is often due to time constraints.
- Existing media, needed to teach practical skills, may not be easily available.
  - A common illustration of this is where a repair person may need to see a series of video clips or photographs while working on equipment.
- Some existing traditional teaching materials that are used in labs are not effective.
  - In one case, a 20-minute videotape was created to train student mechanics how to disassemble and assemble an aircraft engine. However, the total disassembly and assembly requires approximately 200 steps. The videotape did not provide the details that the students needed.
- It may not be possible to offer live training.
  - Logistical challenges can arise when experts do not have enough time to travel to reach learners or even to simply have the time to teach (i.e., there is no extra time in their full-time job).
- Learners may not be able to attend live training locations.
  - This is an inherent problem in distance education. Many learners can learn the theory online or through other distance education solutions. However, they may not be able to learn the needed practical skills at a distance. Yet, these practical skills are often essential for enhancing learning.
- Costs to attend live training can be high.
  - This can be seen when numerous participants are required to travel to a workshop.
- There may be a need for just-in-time learning.
  - There are many times when a learner needs immediate training and cannot wait for a course or workshop to become available or be completed.

Given sound instructional design strategies, technology has solved these problems. For example, online labs can:

- show close-ups of procedures that all can see
- show extra demonstrations
- contain an individual's expertise
- offer alternative instructional approaches
- eliminate the costs of travelling to face-to-face labs
- be available when and where a student wants
- show expensive or dangerous procedures as the procedures would only have to be done once for the recording session and would then be available as needed
- include media, especially short, step-by-step video clips to illustrate specific concepts or procedures such as disassembling and assembling an aircraft engine.
- provide "just-in-time" learning

INSTRUCTIONAL DESIGN FOR ONLINE LABS

The general principles of instructional design apply to all educational materials. However, when designing online labs, there are other things to consider. These are discussed below.

Learning outcomes

Consider what the learner really needs to learn rather than what you want to teach or have traditionally taught. More specifically, for practical skills, determine what the learner actually needs to do. One way to do this is by imagining what skills the learner needs in the real world. To illustrate this, in some cases in the laboratory portion of chemistry, the learner does not really need to pour one chemical into another. The important skills relate to the observations, data analysis, and conclusions that are drawn. For teaching practical troubleshooting skills, the needed skill may be the ability to analyze the interrelationships between components of the system. Regardless, of the application, an online lab should simulate the actual practical skills needed to ensure that learning is authentic. In other words, online labs should focus on skills needed in the real world.

Tip
Focus on what the learner really needs to learn. Previously taught skills may not be relevant.

Creating the instructional strategy

The instructional challenge is to ensure that the practical skills taught via the computer transfer to the real world. Evidence supports that, with solid instructional design, this can be done. The foundation for the instructional design is the learning outcomes. The learning outcomes, lead to the design of the instructional strategy—what needs to be done to ensure that the students will effectively and efficiently learn.

For the instructional strategy, determine how to ensure that most all learners will learn effectively. This is a particular challenge when students are on their own

and cannot have their questions immediately answered. Think outside the box to guarantee learning. Consider simulation, discovery-learning techniques, and active experimentation. Page-turning activities will not suffice for learning many practical skills. Use the technology for its strengths rather than simply transferring content from one format to another.

Tip
The key is to determine what needs to be done to ensure effective learning will occur.

Think about the limitations of teaching each skill online. You will have to realistically determine what level of skill you can achieve. For example, in an online biology lab, how would you teach a student to learn how to use a microscope? This is a limitation of using online technology. However, a lot can be done with visual media. You could show the coarse adjustment being used to focus an image, then show what would be seen inside the ocular lens, then show fine adjustments being made, and then what the learner would see inside the ocular lens. A practical activity could have the learner clicking on arrows to move the coarse and fine adjustments (clockwise and counter-clockwise) and see the corresponding image of what would be seen. The goal would be to find the clearest image. Video clips and activities can similarly be used for demonstrating other microscope components, such as the condenser lens. This would not be as good as what is done in a real lab, but would definitely give a sense of how a real microscope works.

Other activities could potentially lead to better results than a real lab. As a comparison, in a real lab, students see specimens and are then asked to draw what they see so that they can later study from their drawings. In an online lab, students will see full-colour video clips and photographs that they can later study for their lab test. One key in creating a successful online lab is getting as close as possible to reality (given constraints of time and money).

A part of the instructional strategy is to organize the information into small enough chunks for the students to successfully learn. A typical need for this is when a procedural skill has numerous steps. If so, consider teaching the entire process in logical groups of three to six steps. Many instructional resources provide too much information or too many steps for students to learn at one time.

Instructional strategies should include some content on the potential avenue for making mistakes. Ask the content expert about typical mistakes made after the content is taught in the traditional way. If one only teaches what is correct, the learner may never learn what can go wrong. Teaching what can go wrong is helpful in teaching students about safety in chemistry labs.

Tip
Address potential mistakes that learners make in live labs.

Teaching practical skills via computer usually requires a variety of specific media to enhance learning as well as to test skills. It is often difficult to test practical skills with only text. Plan in advance to record photographs and video clips of skills done incorrectly. These become excellent resources for testing. One challenge will be in creating the media needed since live labs typically depend on some copyrighted material. It is not safe to assume that you can get copyright clearance from the originators, especially if you plan to sell the product.

Determine whether assessment is realistic as a true measure of performance. This is particularly important for practical skills. When testing, consider all difficulty levels. Many existing technology-based resources are weak in that they only address low-level thinking skills rather than the actual skills needed.

Make the program highly interactive throughout. Interactivity requires the learner to actively think while learning. Creating interactions in the virtual environment is easily done. You can have students drag and drop items, increase and decrease settings to observe results, make decisions and see consequences, and answer questions based on video clips and photographs showing correct and incorrect procedures or results. Remember to always provide detailed feedback, even when the answer is right. This is in case the student guessed the correct answer or answered correctly for the wrong reason(s).

Tip
Ensure that you keep the learner engaged and thinking throughout.

CONTROLLING REAL EQUIPMENT

Virtually controlling real equipment can be challenging. One problem is enabling control across computer platforms. Although it is not trivial, it can be solved with web-based tools that are designed for interoperability and machine-to-machine interaction over a network. However, this is a major problem if the equipment is not designed for remote access. Virtual control may require a lab technician for some tasks such as preparing and

loading samples. Will this need to be done 24 hours per day and seven days per week? It is hard to generalize whether the overall labour, materials, and facilities costs will be higher for live labs or virtual labs that enable remote control of real equipment.

There may be some logistical problems with allowing remote access to equipment. Imagine if 100 students signed up for a course that included remote access to equipment. Consider 1,000 virtual students. Can large numbers of virtual students be supported? What if "live" students also need to access the equipment? What happens if a virtual student wants to access equipment that another virtual student is using? How does a lab technician support more than one virtual student at a time? When will the equipment be available for virtual students? How many units will be available for remote control?

Tip
Determine the logistics, benefits, and costs of virtually controlling real equipment before taking on such a project.

HANDLING LAB TESTS

Lab tests can be done any way you want. You can:

- Have students come to campus to be tested in a live lab. However, this would prevent some students from being able to complete an online program.
- Require students to write paper-based exams. It may be that only a portion of the skills could be adequately tested in a paper-based format. Invigilation may need to be addressed.
- Have learners complete a computer-delivered test. The test could be wholly or partially based on learning objects, especially video clips and photographs, already used in the online lab. Invigilation may need to be addressed.

ARTICULATION

Articulation may be an issue. Some people will simply be adverse to change, or assume that an online lab is inferior to a live lab. Other people will argue that you cannot replace the real thing, or that some things cannot be simulated online. (Sometimes the sense of touch and smell play important roles in learning.) Since most online labs only show the correct results, some will resist online labs because an advantage of actual labs is that significant learning takes place through mistakes that students make. (You can disarm that argument by addressing typical errors in your designs.) Yet others will need research confirmation of effective results before accepting the technology. The good news is that some are claiming that online labs can be rigorous enough to be equivalent to actual labs. An online lab you create might initially only be approved for a limited group of students (e.g., non-science majors).

You will need to gain the support of all stakeholders. You can foster initial acceptance by involving articulation committee members in the formative evaluation and later conducting a summative evaluation. With successful results in a summative evaluation, it is more likely that there will be approval for any student to learn via an online lab.

Articulation is more fully discussed in Chapter 12, Articulation and Transfer of Online Courses.

Tip
Do what you can to ensure you get the support of the articulation committee.

THE FUTURE OF ONLINE LABS

It is difficult to predict the future of online labs. However, the reality is that online labs will continue to be created. Some will be of minimal value while others will effectively meet the needs of distance learners and solve the previously mentioned problems of live labs. Some questions will need to be answered:

- Can all labs, ranging from introductory to advanced, be delivered online?
  - In some courses, all of the lab skills can be successfully delivered online, while in others the labs should only be offered live. There is a limit to how much can be conducted online. Would it be reasonable for a student to get a biology degree without ever working with real specimens and a real microscope and other lab equipment? It is likely that everyone would answer this question with a resounding "No".
- Will administrators of post-secondary institutes or the government require the use of online labs to save costs?
  - Only time will tell. Already many institutions have opted to have labs every second week. The official rationale is that this enables students to be better prepared for labs. The reality is that it is to save costs. One option is to conduct every second lab online. This would accommodate a larger number of students when there are limited lab resources. Note that some governments have already applied pressure to eliminate some labs.

– Another option is to use online labs to speed up lab time. If students know exactly what procedures they will be doing online, they can spend less time in the live lab, thus freeing up room for more students.

Tip
Be ready to answer questions about the effectiveness and economy of an online lab.

Computer-based resources

The following computer-based resources for learning (drill and practice, tutorials, simulations, educational games, intelligent tutoring systems, and virtual reality) are sometimes needed to support learners when more common online strategies, described in other parts of this book, will not suffice. Some drill and practice activities can be effectively provided within learning management systems. However, depending on the learning domain, thinking level required, complexity of the problem presentation, and feedback that needs to be provided, some drill and practice activities will need to be created on tools such as Macromedia Flash. In general, all of the other resources described below need to be created on software that is not found within learning management systems.

Drill and practice programs

Drill and practice is a common computer-based training strategy that provides repeated activity (drill) and opportunities (practice) to try skills or concepts learned elsewhere. This is shown in Figure 22.1. The aim is often to achieve mastery.

Drill and practice:

- Usually takes place after the content has been taught.
- Does not teach new material.
- Can, and often should, include extensive diagnostic feedback.
- Can be used for many skills such as learning language, learning factual information, and solving problems in mathematics, physics, chemistry, electricity, nursing, etc.
- Should usually have a varied difficulty level that is based on the student's ability in order to enhance learning.
- Can be boring.
  – You can counter boredom with competition, using visuals, providing variety, stating the progress made, or giving a reward if a target is met.

Tutorials

Tutorials are programs in which the computer imitates a human tutor. This is shown in Figure 22.2. In tutorials, information or concepts are presented, questions are asked, responses are judged, and feedback is provided.

Tutorials:

- Should include frequent questions and/or other activities that require the learner to think, as well as provide detailed feedback.
- Can be used for many low- and high-level skills.
- Can include drill and practice.
- Can include solving problems.
- Often include branching to remediation and enrichment.
- Often include testing.

Simulations

Simulations present or model the essential elements of real or imaginary situations. This is shown in Figure 22.3. Computer-based simulations (e.g., flight simulators) allow students to learn by manipulating the model in similar ways to real world situations. Simulations can immediately respond with consequences to learner decisions. However, some consequences may not initially be apparent, depending on when the effect is normally seen (e.g., the effects of changes in interest rates may be seen years later). Students can learn by observing results and relationships (this can be through a discovery-learning strategy) or receiving specific diagnostic feedback, especially when detailed feedback is provided for both right and wrong answers.

Ideally, simulations should approximate real systems as closely as possible. This helps facilitate transferring the knowledge learned to the real world and can make the simulation particularly meaningful to the learners. How closely a simulation must approach reality depends on the complexity of the real situation, how well the skills learned will transfer to the real situation, and the benefits and costs of making the simulation more realistic. Conduct a detailed analysis to determine all of the relevant skills needed and their importance.

Simulations can be used for teaching many skills including:

- Properties of physical objects such as a comet in its orbit
- Rules and strategies such as in war games, making predictions about forest fire behaviour or avalanche potential, or building a city
- Processes such as laws of supply and demand
- Procedures such as diagnosing illnesses
- Situations such as teaching instructors how to deal with student behaviour and attitudes

Simulations are often used when real situation training is:

- Dangerous (e.g., nuclear power plant procedures and police maneuvers)
- Expensive (e.g., landing a space shuttle)
- Unethical (e.g., when it is not appropriate to use humans)
- Not easily repeatable (e.g., avoiding a run on a bank)
- Unavailable (e.g., historical events such as the economics of the Great Depression, how to respond in a robbery, or operating a business)
- Not conducive to learning (e.g., when learning is difficult because the learner must consider too many stimuli at once, such as in the cockpit of a modern airplane)
- Affected by reality such as time (e.g., simulations can provide genetic data about successive generations immediately, where reality could take months or years)
- Inconvenient (e.g., experiencing Arctic survival, undersea, and outer space conditions).

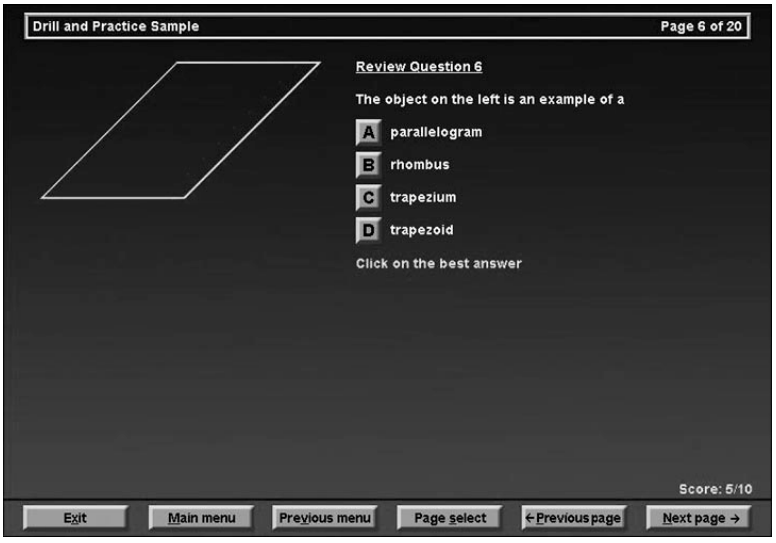


Figure 22.1. Drill and practice sample

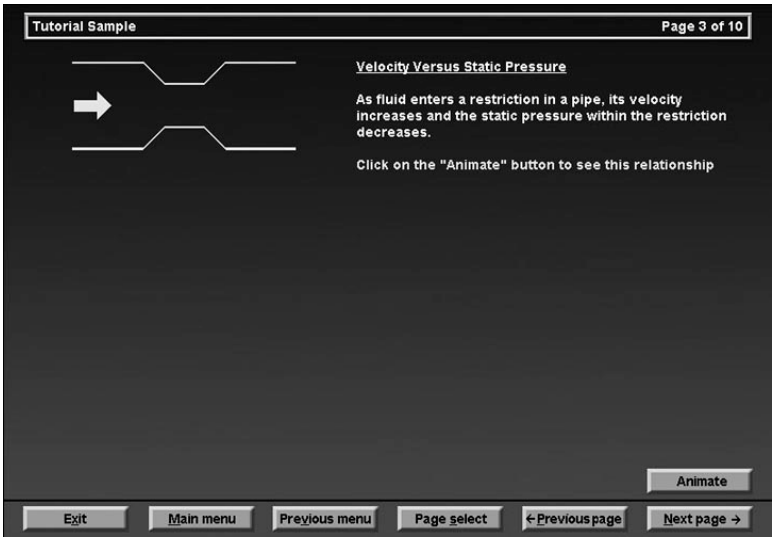


Figure 22.2. Tutorial sample

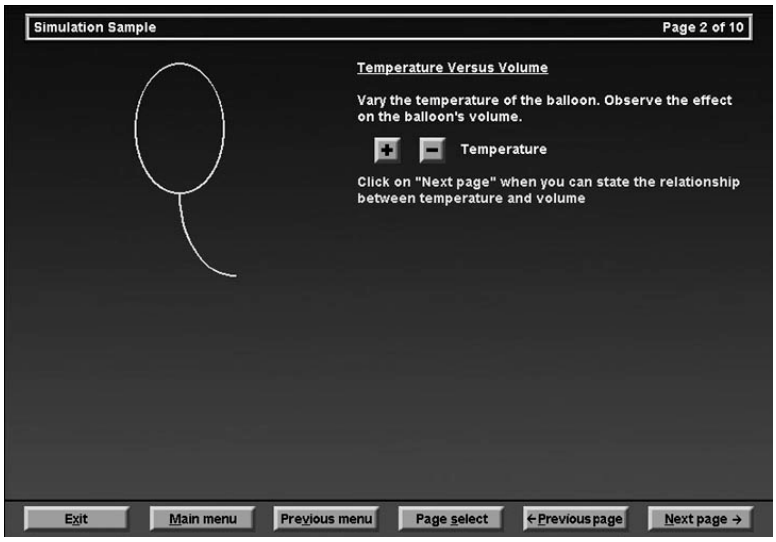


Figure 22.3. Simulation sample

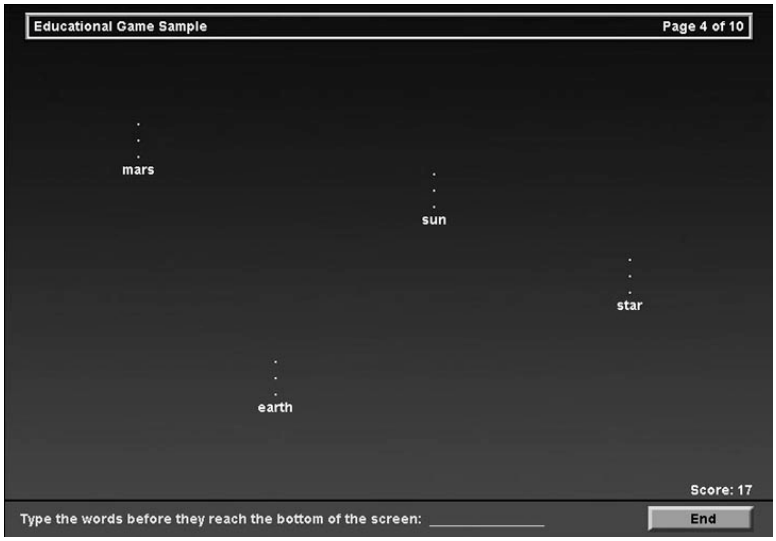


Figure 22.4. Educational game sample

Simulations can be very effective.

- The knowledge gained tends to transfer well to real situations if students can apply their existing knowledge and experience. Active student participation is critical.
- Effectiveness increases if the simulation is logical or comparable to real situations.
- Effectiveness is enhanced if students are aware of the learning outcomes.
- Effectiveness increases if students can gradually build their skills. For example, when first learning how to operate a nuclear power plant, the student should first learn each system independently, then combinations of dependent systems, and then the entire system.
- Effectiveness can stem from students being very motivated to learn. Imagine your motivation if you are involved in a life and death situation, or investing your life savings.

Attaining excellent results requires more explanations of the goals, learning outcomes, and directions than tutorials or drill and practice methods. Some learners, such as young or immature students, will have trouble explaining what has happened in a simulation, or transferring the knowledge to real situations.

Note that students may not necessarily believe the results of a simulation. As an example, in a simulation, students may end up in a car accident if they chose to drink and drive. However, there is no guarantee that students believe that could happen to them in real life.

Simulations can be very efficient for relatively quick learning. The efficiency increases if:

- the model or simulation closely represents reality.
- learners receive useful feedback with respect to the learner outcomes.
- the model or simulation is aimed at the appropriate learning level.
  - Novices may learn best when only some of the variables can be manipulated, and experts when presented with the entire model.
- the level of detail is appropriate.
  - If too much detail or too many parts of the system are shown, learning may be hindered since the learner may not be able to mentally process all of the information.
- supplementary material is provided.
  - Text summaries and checklists can be very beneficial.

Effective, efficient simulations are usually expensive and time-consuming to create. Cost-justification is particularly important before creating a simulation.

Educational games

Educational games are usually decision-making activities that include rules, a goal, conditions or constraints, competition, challenge, strategies, and feedback. Games can be as simple as answering questions to win Tic-Tac-Toe or filling in crossword answers to more complex games that require interactions with other learners.

Educational games:

- should encourage the development of specific skills
  - The skills can be in specific subject areas such as science and math or general skills like literacy, problem solving, critical thinking, and decision-making.
  - Success should be based on whether the specific learning outcomes have been met, rather than on good hand-eye coordination.
- can be used to teach many different skills
  - The example shown in figure 22.4 illustrates how a game can be used to teach keyboarding skills.
  - One difficulty is that games tend to require more explanations of the goals, learning outcomes, and directions than tutorials or drill and practice methods. Without guidance, learning is less effective.
- can be an effective, motivational, and fun way to learn
  - To be effective, the game must be challenging, students must be actively involved, and students must be given feedback and guidance with respect to the learning outcomes.
  - Research has shown that many learners like to learn through educational games.
  - Some educational games are a part of simulations that involve competition and/or cooperation.
  - Both males and females can enjoy and learn from games suited to their interests.
- are sometimes a waste of time
  - Some products are fancy but do not teach well.
  - Evaluate a game before purchasing it to ensure that the game teaches an important skill effectively. Some games may lead to violent and aggressive behaviours.
  - Some people erroneously believe that games cannot be effective teaching tools.

Intelligent tutoring systems

Intelligent tutoring systems attempt to mimic the "perfect instructor". The basic requirements of an intelligent tutoring system include the ability to:

- model the learner
- track misunderstandings
- generate appropriate responses.

None of these basic requirements have been perfectly resolved.

Although it is possible to incorporate a model or two of student learning into a computer-based training application, a fixed model does not represent intelligence. How can a "typical" student be modelled when students and their learning preferences are so diverse? It is not sufficient to simply categorize students into one of two types and then create two ways for students to learn the material. This has been the premise in some "intelligent" tutoring systems. A compounding factor is that learner preferences vary depending on the situation and material being taught. It is impractical to create a different teaching strategy for every individual. See Chapter 20, Learning Strategies, for more information on learning styles.

Although intelligent tutoring systems should be adaptable, based on the learner's previous successes and failures, it is a challenging goal. It is simple to record where students make mistakes, but a challenge to know

when there is a misunderstanding, what caused it, and what to do about it. In a sense, the computer would have to be able to read each student's mind.

Generating the appropriate response would be difficult even if the first two needs were met. How can a designer determine all of the response possibilities? Every possibility must be based on a known rule. Intelligent tutoring systems can and should have responses for expected misunderstandings but this is, at best, limited to the finite expressed problems.

There are some excellent intelligent tutoring systems available. However, these tend to be labour-intensive and expensive to develop. Although the potential of intelligent tutoring systems is exciting, the reality is that much research still needs to be done. In other words, instructors need not worry about being replaced by an intelligent tutoring system. Given the present state of the technology, it can be argued that well-designed instructional multimedia applications are essentially the same from a student's perspective.

Virtual reality

Virtual reality (VR) allows people to be totally immersed in an artificial or simulated environment, while experiencing the environment as real. This happens because the participant has a first-hand or personal experience of the events, distractions are minimized since only virtual images are seen, and the participant can interact naturally in real time, such as by pointing and looking, rather than by using a joystick, mouse, or keyboard. VR can feel so real that some people experience vertigo when sensory inputs to the brain are in conflict. VR systems can include a variety of media such as video, visuals, animation, and audio. In a sense, VR is an extension of simulations that can be created with readily available hardware and software. Commercial flight simulators are examples of this.

A distinctive feature of VR is that learners are an integral part of the synthetic VR world. Users can simultaneously interact with computers in complex ways. Computers can sense body movement and voice commands and respond almost naturally. For example, for teaching students about interior decoration, you could let students walk through a house and allow them to change colours of walls, rearrange furniture, change the lighting, and remove a painting and place it elsewhere. To interface with the virtual world, learners must wear specialized equipment such as body suits, goggles, and/or gloves.

Although most applications are found in the entertainment industry, numerous educational products have been and are being developed. Since VR allows participants to feel that they are in another place in which they can move and look around based on a prescribed set of rules, VR offers incredible educational potential. Imagine how much doctors, army field surgeons, soldiers, firefighters, and law officers, could safely learn in a virtual environment. Abstract ideas, such as the movement of electrons in an atom that cannot be physically presented, can be taught with VR. Since virtual objects can behave as their physical counterparts and be manipulated by the learner, students can experience natural laws such as the law of gravity. Alternatively, learners can experience unnatural laws created by developers. In a virtual world, energy could be created or destroyed. With the ability in VR to manipulate abstract information, the potential exists to improve a student's understanding and memory of complex ideas.

Learning can be by discovery, experimentation, through guidance using a variety of instructional approaches, or by practice and feedback. The potential for testing in a virtual environment is exceptional. For example, students could virtually perform an operation, put out a fire, or apprehend a thief.

For practical reasons, it can be risky to develop an educational VR system at this time:

- There are few experts in VR design and programming.
- The authoring software is mediocre but getting better.
- Extra equipment is needed for developing and using these programs.

A key to effective VR design is to focus on the potential to teach and learn rather than on the hardware and software tools.

Given the potential of multimedia technology, where is the boundary between computer-based simulations and virtual reality applications?

Summary

Online labs simulate and teach what learners must do in traditional settings. In general, there are two types of labs. One simulates the real experiments, equipment, or procedures; the other lets learners access and control real equipment remotely. There can be numerous problems when teaching practical skills in typical labs. Online labs can solve many of the problems.

Online labs will continue to be created. Some will be of minimal value while others will effectively meet the

needs of distance learners. Some questions will need to be answered:

- Can the labs of all courses, ranging from introductory to advanced, be delivered online?
- Will administrators, of post-secondary institutes or the government, require the use of online labs to save costs?

The instructional challenge is to ensure that the practical skills taught via the computer transfer to the real world. The foundation for the instructional design is the learning outcomes, which should be based on what the learner actually needs to do. Based on your learning outcomes, the design phase leads you to creating an instructional strategy that guarantees effective learning. To do this:

- Consider simulation, discovery-learning techniques, and active experimentation.
- Determine what level of skill you can achieve.
- Organize the information into small enough chunks for the students to learn successfully.
- Include some content on the potential for making mistakes.
- Include media, as needed, to enhance learning as well as to test skills.
- Determine whether testing is realistic enough and a true performance measure.
- Make the program highly interactive throughout.

Some online labs enable learners to control real equipment. Virtually controlling equipment can be challenging and may save some money.

For lab tests, you can:

- have students come to campus to be tested in a live lab
- require students to write paper-based exams
- have learners complete a computer-delivered test

Articulation may be an issue. Many will find reasons to resist the technology. You can increase acceptance by involving articulation committee members in the formative evaluation. You can also gain support if a summative evaluation proves successful results.

The following computer-based resources are sometimes needed to support learners when the more common online strategies will not suffice:

- Drill and practice is a common computer-based training strategy that provides repeated opportunities to try skills or concepts learned elsewhere.
- Tutorials are programs in which the computer imitates a human tutor. In tutorials, information or concepts are presented, questions are asked, responses are judged, and feedback is provided.
- Simulations present or model the essential elements of real or imaginary situations. Ideally, simulations should approximate real systems as closely as possible. Simulations can be used for teaching many diverse skills. Students can learn by observing results and relationships or receiving specific diagnostic feedback.
- Educational games are usually decision-making activities that include rules, a goal, conditions or constraints, competition, challenge, strategies, and feedback.
- Intelligent tutoring systems attempt to mimic the "perfect instructor". The basic requirements of intelligent tutoring systems include the ability to model the learner, track misunderstandings, and generate appropriate responses.
- Virtual reality (VR) allows people to be totally immersed in an artificial or simulated environment yet retain the feeling that the environment is real. A distinctive feature of VR is that learners are an integral part of the synthetic VR world. Users can simultaneously interact with computers in complex ways.

Glossary

Copyright. The exclusive privilege allowing authors or assignees the right to copy, sell, and/or transmit their own original work.

Drill and practice. A type of instructional multimedia that provides repeated activity (drill) and opportunities (practice) to try skills or concepts learned elsewhere.

Educational games. Usually decision-making activities that can include rules, a goal, conditions or constraints, competition, challenge, strategies, and feedback.

Feedback. Any message or display given to a learner based on his or her input.

Instructional design. The specific systematic, repetitive process of activities aimed at creating a solution for an instructional problem.

Instructional strategies. Components of a set of instructional materials and the activities that the students must do to achieve the learning outcomes.

Intellectual skills. Skills that require learners to think (rather than simply memorizing and recalling information).

Intelligent tutoring systems. Computer programs that attempt to mimic perfect instructors.

Interactivity. Active learner participation in the learning process.

Learning outcomes. Specific measurable skills.

Learning styles. Characteristic behaviours that indicate how students prefer to learn. Also known as cognitive styles or learning preferences.

Online labs. Web-based labs that simulate and teach what learners must do and learn in traditional settings.

Psychomotor skills. Skills that require learners to carry out muscular actions.

Simulations. Interactive models that mimic the essential elements of real or imaginary situations.

Tutorials. Computer programs that imitate a human tutor.

Virtual reality. A type of computer program that allows people to be totally immersed in an artificial or simulated environment yet retain the feeling that the environment is real.

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23
Computer-Based Games for Learning

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The really basic skill today is the skill of learning, and the best use of games is to leverage their tendency to enhance it. – Papert (1998)

Learning outcomes

After completing this chapter, you should be able to:

- Define *game*, *simulation* and *simulation game* and give examples of each.
- Describe the theoretical arguments for using computer-based games for learning.
- Describe features of computer-based games for learning that contribute to their effectiveness.
- Describe possible approaches to implementing computer-based games for learning in your context.
- Describe possible approaches to creating your own games for learning.

Introduction

Computer-based games are a major entertainment and cultural force (Gamasutra, 2006). Creative ideas using sophisticated graphics and communication technologies are changing the way we spend our leisure time, build friendships and communities, try out new identities, and practise new skills. Whether or not computer-based games are part of your daily life, they offer tremendous opportunities to engage and challenge your students.

You may be a gamer, familiar with the Xbox, Grand Theft Auto, and EverQuest,, and wondering why school isn't as absorbing as your late-night game sessions. You may be a boomer professor, curious but not sure how games could be relevant to your teaching. Or you may be somewhere in between.

This chapter gives you a broad introduction to the use of computer-based games for learning. We start with basic terms and move on to look at why these activities can be powerful learning tools, drawing on current learning theory, game research, and recent experience. After presenting examples to spark your own learning-game ideas, we discuss factors that make learning games effective. The chapter closes with tips for successfully getting started using games in your learning context.

"Square one": what are we talking about?

Because the word "game" can describe many very different activities and varieties of play, we start with a few definitions. Speaking very generally,

> A *game* is a set of activities with goals, rules, and competition (possibly with oneself) that involve one or more players in an artificial situation (Dempsey et al., 1996; Sauvé et al., under review).

Games such as tennis, basketball, Tic Tac Toe, chess, checkers, and Monopoly have been around much longer than computers. Since personal game machines and computers have become widely available, a wide variety of dynamic, interactive electronic games have appeared in many genres. Some familiar titles are the Carmen Sandiego series, Myst, Doom, various sports games, and EverQuest.

Many computer-based games are based on simulations, for example: The Sims, Roller Coaster Tycoon, or MBA management training games.

> A *simulation* is a dynamic, simplified but accurate systems model of aspects of reality (Sauvé et al., under review).

Simulations in which learners have defined roles, with responsibilities, constraints, and feedback in complex data-rich environments, allow them to develop problem-solving skills and experience the effects of their decisions (Gredler, 2004). Simulations are often useful because they let players learn from their mistakes without, for example, crashing planes, killing patients, or sending companies into bankruptcy.

Adding performance goals, scoring, and competition among players or with oneself can turn a simulation into a game (Sauvé et al., under review; Sauvé et al., 2005a). The term *simulation game* refers to these hybrids and includes a wide variety of commercial games that simulate real-world activities. The distinction among games, simulations, and simulation games is important as a foundation for studies relating learning outcome effectiveness to characteristics of the learning activity (Sauvé et al., under review).

Games can use a variety of technologies including boards and tokens, fields and balls, dedicated game machines (PlayStation, Xbox, Nintendo DS), personal computers, and handheld devices (cell phones, personal digital assistants [PDAs]). In this chapter we focus on games for computers and handhelds.

An Internet search will lead you to games for learning in practically any discipline. Some examples, found on the Social Impact Games site (http://www.socialimpactgames.com), include:

- *education games* covering school subjects such as algebra, history, chemistry, computer software, and criminology;
- *public policy games* designed to educate the public on citizenship, democratic participation, and policy issues, such as Cyberbudget France on the French national budget, and several US election-related games;
- *political and social games* designed to stimulate discussion or promote views on world issues (e.g., world agriculture, drug dealing, human rights);
- *health and wellness games* teaching about health issues and management (e.g., for asthma, cancer, heart health, child predators, and self-esteem); and
- *learning applications of commercial games:* job simulations (e.g., emergency room), resource management (SimCity, Railroad Tycoon), history (e.g., Oregon Trail, Rise of Nations).

Similarly, simulation applications are many and varied, including:

- *business:* Computational models that generate business results and provide feedback for practising planning and decision-making for simulated periods (e.g., months, years). Goals are often profit-related. Areas include strategic management, marketing, finance, operations, investments; specific industry simulations, e.g., the Cornell Management Game (http://www.cms-training.com/);
- *public policy*: Simulations of government, educational, or international organizations or scenarios, e.g., Virtual U university management simulation (http://www.virtual-u.org/);
- *military training:* War strategy, equipment, battle, support scenarios, e.g., America's Army, a virtual online army simulation (aimed at recruiting) produced by the US government (http://www.americasarmy.com/);
- *flight***:** Simulations of specific aircraft controls, airports, flight paths, e.g., CAE commercial training simulators (http://www.cae.com); PC-based flight simulators (http://www.pcaviator.com or http://www.microsoft.com/games/flightsimulator/);
- *medicine***:** Physical or computer-based models of medical processes and problems for developing and testing clinical skills, e.g., patient simulators, surgical simulators (http://www.msr.org.il/About_MSR/Medical_Simulation_Equipment/);
- *emergency response***:** Immersive emergency scenarios and environments for testing systems and decisions, e.g., Unreal Triage (http://www.ists.dartmouth.edu/projects/seers/utriage.php); and
- *leadership development:* Simulated scenarios for practising interpersonal and leadership skills, such as Virtual Leader (http://www.simulearn.net/leadershiptraining.html), Change Game (http://www.vanderbilt.edu/lead/simulations.html).

For the rest of this chapter, we will be concerned with games, simulation games and game-like simulated environments that involve play, exploration, and problem-solving but may or may not required explicit scoring and competition. In common with the popular use of the term, we will use "games" to refer to them collectively. Training simulations that are specifically oriented towards technical skills development, e.g., flight simulators and medical patient simulators are beyond the scope of this discussion.

Computer-based games are played by individuals and groups in many configurations. They can be single- or multi-player, played on a single computer, or multiple networked machines, in classrooms, or online. Handheld games can also support individual learning or collaborative learning with teams and groups, and particularly lend themselves to games involving player movement around physical settings. Internet-based massively multiplayer online games (MMOGs) attract thousands of players in complex, evolving interactions and scenarios, including ones created by players themselves. Computers and especially handhelds can also be used to support blended learning situations in which game play happens through face-to-face interactions and activities rather than on screens.

Example

Second Life is a virtual online world built by its "residents" and populated by their avatars (online characters). It includes a dedicated campus area where educators can build and offer virtual classes including simulations. Here learners can "use simulation in a safe environment to enhance experiential learning, allowing individuals to practise skills, try new ideas, and learn from their mistakes. Students and educators can work together in Second Life from anywhere in the world as part of a globally networked virtual classroom environment." (http://secondlife.com/community/education.php)

Why use computer-based games for learning?

Several factors have recently converged to propel learning applications for computer-based games.

POPULARITY AND ACCESS

First, games are widely popular and accessible as entertainment; the Canadian video game market will increase from $732 million in 2005 to $1.3 billion in 2010, while global video game spending is expected to rise from $27.1 billion in 2005 to $46.5 billion in 2010 (Forest, 2006). A 2002 US survey found that 92 percent of children and adolescents ages 2 to 17 played video games, and more than two-thirds of all children ages 2 to 18 lived in a home with a video game system (Kaiser Family Foundation 2002). As well, 61 percent of Canadian households and 75 percent of US households used mobile phones in 2005 (Wright, 2006). Using games for learning builds on their familiarity and relatively easy access.

PLAYER ENGAGEMENT

Computer games are highly engaging. Today's games offer motivating, absorbing, interactive, collaborative experiences that draw in players and keep them playing for many hours, often developing complex social networks in the process.

A growing body of literature analyzes aspects of games that foster player engagement and motivation. Asgari and Kaufman (2004) cite three categories of factors that sustain a game's intrinsic motivation so that a player will play for his/ her own interest and enjoyment, even in the absence of external rewards:

Table 23.1. Intrinsically Motivating Features of Games (Asgari & Kaufman, 2004)

Feature Category	Examples
Psychological: those that meet individual needs	Features that meet needs for competence, self-determination, interest-excitement, enjoyment.
Structural: related to the inner structure of a game	Complexity, novelty, unpredictability, uncertain outcomes, challenge, feedback, fantasy, curiosity, control, interactivity, competition
Implementation: related to the way a game is implemented and presented to the player	Graphics and sound, having multiple players, using well-known characters or settings, high speed, useful interface, "save game" capability

Prensky (2001a) lists twelve elements that make computer games engaging:

Table 23.2. Twelve Elements that make Computer Games Engaging (Prensky (2001a), quoted in Mitchell & Savill-Smith, 2004)

Game Characteristic	Contribution to Players' Engagement
Fun	Enjoyment and pleasure
Play	Intense and passionate involvement
Rules	Structure
Goals	Motivation
Interaction	Doing the activity
Outcomes and feedback	Learning
Adaptive	"Flow" state
Winning	Ego gratification
Conflict/competition/ challenge and opposition	Adrenaline
Problem solving	Sparks creativity
Social interaction	Social groups
Representation and a story	Emotion

Another analysis of games' engaging quality focuses on players' experience of "flow", a state of intense concentration and focus in which they have a balance between ability level and challenge, a sense of personal control over the situation, and a sense of intrinsic reward from the play (Csikszentmihalyi, 1990). Well-designed games do this by, among other things, having multiple skills levels so that players face new but achievable challenges as they develop mastery of lower levels.

Gee (2003) explains player engagement in terms of *semiotic domains* (worlds of symbols, meanings, practices, and experiences). He points out that games can be very challenging and time-consuming, yet young players who might spend little time on schoolwork become absorbed in games and learn complex knowledge, responses, and behaviours in order to win. In his words,

> A game like Pikmin recruits from our six-year-old a complex identity composed of various related traits. The game encourages him to think of himself as an active problem solver, one who persists in trying to solve problems even after making mistakes; one who, in fact, does not see mistakes as errors but as opportunities for reflection and learning. It encourages him to be the sort of problem solver who, rather than ritualizing the solutions to problems, leaves himself open to undoing

former mastery and finding new ways to solve new problems in new situations.

Gee suggests that players take on and master lengthy, complex games because they become involved in new semiotic domains and affinity groups, resulting in new identities (e.g., a game character with abilities, faults, and decisions to be made) and situated learning that can be transferred to other domains. Squire (2005) suggests that this focus on new identities is leading to new computer-based games that build new attitudes and behaviours for players in simulated management and advertising settings.

THEORY-BASED SUPPORT

Computer-based games embody current learning theories. For example,

- *Constructivist learning* (Boethel & Dimock, 1999; Vygotsky, 1978): When requiring exploration, collaboration, and complex problem-solving, games can help players to explore, discover, articulate, and create their own understanding of complex phenomena;
- *Situated cognition, cognitive apprenticeship, and experiential learning* (Kolb, 1984; Schank & Neaman, 2001): When they create simulated authentic contexts and activities that involve social interaction, games can support both understanding and skill development. Also, skill development increases with learning by doing, and feedback in a safe environment;
- *Self-efficacy* (Bandura, 1986; Kaufman et al., 2000): Through learner control and increasing achievement levels, games can provide opportunities for successful experiences to help develop self-efficacy and positive attitudes concurrently with knowledge and skills.
- *Learner-centredness* (McCombs and Whistler, 1997): Games can transform traditional teacher and learner roles so that learners shift from a passive to an active role, and from learner to teacher through active exploration, experimentation, discovery, and collaboration with peers.

EVIDENCE OF LEARNING OUTCOMES

A number of studies have demonstrated the effectiveness of games for cognitive, emotional and psychomotor learning. For examples, see Baranowski et al. (2003), Kirriemuir & McFarlane (2004), Lieberman (2001), Roubidoux (2002), Sauvé et al. (2005b), and Steinman & Blastos (2002). According to these, games motivate learning, offer immediate feedback, consolidate knowledge, support skills development and application, aid learning transfer, and influence changes in behaviour and attitudes, all pointing to greater learning effectiveness with simulations and games.

NEW-GENERATION LEARNING MODEL

Finally, some observers argue that new generations of learners are developing new cognitive processes and a culture that is changing the nature of learning. Learning may be evolving into a much more "unruly," less controlled process than we have been accustomed to in our classrooms (Seely Brown, 2002). Prensky (2001a) and others suggest that the "game generation" has developed a new cognitive style characterized by multitasking, a short attention span, and learning through exploration and discovery; today's games provide their ideal learning environment.

Examples

Case studies of Lineage (Steinkuehler, 2004) and World of Warcraft (Lau, 2005) describes how these MMOGs develop online communities of practice that foster learning as social practice through "situated understandings, effective social practices, powerful identities, shared values, and shared ways of thinking" (quote from Lau, 2005).

Game-based learning examples

To move from theory into practice, some concrete examples show how games are being used for learning from K–12 through university and professional training levels.

- **Educational Games Central:** A pioneer in the use of computer-based games for learning, the *Carrefour virtuel du jeux éducatifs,* operated by the SAVIE research centre at the Université du Québec à Montréal, has recently been translated into English as Educational Games Central (EGC). The site (http://www.savie.qc.ca/carrefourjeux/an/accueil.htm) provides "frame games"—generic frameworks for well-known board games and game-show contests (e.g., Tic Tac Toe, Trivial Pursuit, Concentration, Snakes and Ladders) into which questions, problems, answers, and feedback can be entered to create specific games in any content area. Because each game shell is designed to let a teacher produce a game in an hour or two (once the content is developed), EGC can be used in the classroom or in a training context without extensive

training or infrastructure. Its games are accessed on the Internet by individual players or teams; the newly released ENJEUX multiplayer environment (http://www.savie.ca/enjeux) supports their use for multiple players online at different sites. Performance and research statistics can be collected for each play session.

Although EGC games are based on more traditional question-and-answer exercises, they have proved very successful in using play and competition to engage learners from young children to adults. EGC games have recently been used for several health-related applications as part of the *SAGE for Learning* research project (http://www.sageforlearning.ca) on games and simulations for learning.

- **COTS games in the schools:** Commercial off-the-shelf (referred to as COTS) games have being applied in many learning contexts. In one example, a school in the US reports using Roller Coaster Tycoon projects to teach momentum, speed, mass, and other concepts in junior-high physics classes (Kirremuir, 2006a). In another case, SimCity is being used for a complex Grade 6 to 8 project to create and manage a small city's infrastructure and environmental impact (Kirriemuir, 2006b). In a third example, the Education Arcade project at MIT used Civilization III to teach high school and middle school social studies. The researchers found that students used much more complex concepts than expected. One student commented, "What I learned is that you can't separate economics from politics or geography. What natural resources I have or where I'm located affects how I can negotiate with other civilizations." (Jenkins & Squire, 2003).
- **University, adult and professional learning:** A project at Purdue University is building the Critical Mass video game to teach university chemistry through an adventure mission that requires solving chemistry problems (http://web.ics.purdue.edu/~kmartine/). Virtual-U (http://www.virtual-u.org/) lets players experience the intricacies of university management. Public Health Games (http://www.publichealthgames.com/), a centre at the University of Illinois at Chicago, is creating "state of the art games for public health workers and emergency responders for a multitude of catastrophic scenarios," including an anthrax attack response simulation. The Objection! simulation (http://www.objection.com/), customizable for any state's legal system, is used in US law schools to teach trial skills and is approved for continuing legal education.
- **Mobile games:** Naismith et al. (2004) use case studies to review how a number of mobile games implement current learning theories. One example is Environmental Detectives (http://education.mit.edu/ar/ed.html), an augmented reality game, in which Grade 5 to 8 students use a constructivist approach, playing the role of environmental engineers searching for data to solve problems related to a toxic chemical spill. Simulation events are triggered by real-world locations as players navigate through a physical space.

Tip

Search the Internet to find examples for your discipline. Some sites to start you off are the FutureLab showcase (http://www.futurelab.org.uk/showcase/show.htm), BBC Schools (http://www.bbc.co.uk/schools/games/), FunBrain.com (http://www.funbrain.com/), and the EDUCAUSE Games and Simulations page (http://www.educause.edu/GamesandSimulations/11263).

What makes a learning game effective?

As with other new learning technologies, it is important to separate hype from reality. Not all game-based learning trials are successful, for reasons related to a game's design, fit with learning objectives, role within the larger learning context, technology support, and other factors. However, experience and research are developing a growing body of knowledge about features and practices that contribute to game-based learning success.

GAME DESIGN

Well-designed learning games aim to achieve engagement levels similar to entertainment games, which keep players involved for many hours of increasingly complex exploration and step-by-step achievement.

Gee (2003, pp. 62–63) argues that "learners must be enticed to try even if afraid, must be enticed to put in lots of effort even if initially not motivated to do so, and must achieve some meaningful success when he or she has expended this effort". He suggests that good video games do this by incorporating the following principles (pp. 137–138):

Table 23.3. Selected Learning Principles in Successful Video Games (Gee, 2003)

Learning Principle	Explanation
Subset principle	Learning even at its start takes place in a (simplified) subset of the real domain.
Incremental principle	Learning situations are ordered in the early stages so that earlier cases lead to generalizations that are fruitful for later cases. Choices in later complex cases are constrained by what the player has found earlier.
Concentrated sample principle	The learner sees and can practise and learn (especially early in the game) many instances of fundamental signs (meanings) and actions.
Bottom-up basic skills principle	Basic skills are discovered bottom up by engaging more and more in the game.
Explicit information on-demand and just-in time	The learner is given explicit information what is needed just at the point where it can best be understood and used in practice.
Discovery principle	Most learning happens through experimentation and discovery rather than through telling.
Transfer principle	Learners are given ample opportunity to practise, as well as support for transferring what they have learned earlier to later problems.

The flow concept offers additional game design help. According to Malone (1980), flow happens in activities in which players can increase or decrease the level of challenge to exactly match their skill levels; they can obtain increasingly complex information through a broad range of challenges, some qualitatively different; they have clear performance criteria and feedback so that they can always tell how well or poorly they are doing; and the activity is free from distracting stimuli that might interfere with their involvement. Evaluating games in terms of flow naturally leads us to look for games with:

- multiple challenge levels that adapt as players learn;
- clear goals and easily interpreted, frequent feedback; and
- a variety of game tasks and activities to avoid the boredom we frequently associate with more traditional learning technologies.

Other features that help to make games engaging (Becta, 2001; Dickey, 2005; Fabricatore, 2000; Mitchell & Savill-Smith, 2004; Prensky, 2001a) include:

- dynamic visuals, interaction, rules and goals (although games can be successful without highly complex virtual reality graphics);
- naturally embedded (rather than external) learning content with contextual relevance;
- simple startup and rules to provide early success and minimize frustration;
- game pace and length matched to the target audience;
- opportunities to exercise the arcade game skills of the "gaming generation";
- opportunities to make many decisions and correct and learn from errors;
- use of first-person point of view, i.e., making the player part of the gaming environment;
- use of narrative (story) to provoke curiosity and give opportunities for creativity, choice and control;
- using physical, temporal, environmental, emotional and ethical dimensions to provide players with a sense of immersion; and
- using compelling characters (or let players create their own) with which players empathize and identify.

Beyond analyzing a game's features, Prensky (2001a) suggests that observing players can help us identify an engaging game:

- Is the game fun enough that someone who is not in its target audience would want to play and learn from it?
- Do people using it think of themselves as "players" rather than "students' or trainees"?
- Is the experience addictive? Do users want to play again and again until they win, and possibly after?
- Are the players' skills in the subject matter and learning content of the game improving at a rapid rate, and getting better the longer he or she plays?
- Does the game encourage reflection about what has been learned?

FIT WITH LEARNING OBJECTIVES

Games can be used to support a variety of learning objectives. Garris et al. (2006) provide a useful review of possible game learning outcomes.

Table 23.4. Game Learning Outcomes (Garris et al., 2006)

Outcome Type	Description
Cognitive	
• Declarative	Knowledge of the facts and data required for task performance
• Procedural	Knowledge about how to perform a task
• Strategic	Ability to apply rules and strategies to general or novel cases
Affective	Beliefs or attitudes regarding an object or activity, e.g., feelings of confidence, self-efficacy, attitudes, preferences, and dispositions
Skill-based	Performance of technical or motor skills

Clearly a key question in selecting or designing a game is how well it fits with the objectives you have in mind. Here are some factors to keep in mind when relating a game to your learning objectives:

- **Cognitive objectives:** Factual knowledge can be readily learned through frame games (e.g., question-and-answer-based Jeopardy, or a Concentration-style matching game) or through solving puzzles (possible with external searching for information) as part of quest games. Simulations or adventure games can require factual knowledge to solve problems or make decisions; procedural and strategic knowledge related to system interactions, as well as problem-solving skills, can also be major simulation game outcomes. In these situations it is important to see that simulation models are realistic and match (or do not conflict with) your objectives in using the game.
- **Affective objectives:** Games are often promoted as vehicles for changing attitudes and beliefs, e.g., when used to teach the importance of diet management for diabetes. How appropriate are the attitudes and beliefs embedded in a game? How appropriate are the implied social attitudes and beliefs, e.g., about violence, gender, race? What attitudes, beliefs, and actions are rewarded?
- **Skill-based objectives:** If your objectives include technical or psychomotor skills (e.g., typing, driving, flying, equipment disassembly and repair), it will be important for you to review any evidence available about how well the skills taught in the game transfer to the real world.
- **Role within the larger learning context:** A game is only one activity in the total learning system. How the game activity is assigned, supported, and debriefed is extremely important in making sure that its full learning potential is realized. Two key ways in which you as an educator can improve the success of your games are through collaboration and reflection.

Finding ways to make game play a collaborative rather than an individual activity adds the impetus of collaborative learning to the activity. In our experience, even simple traditional games such as question-based Tic Tac Toe can become lively shouting matches when teams compete to win. Collaborating on designing a city or roller coaster can lead a group to find and share ideas and knowledge far beyond the capabilities of one individual. Playing an MMOG leads a learner to collaborate spontaneously with others in order to progress in the game (Galarneau, 2005).

Many experts note the importance of reflection—encouraging students to think deeply about, and articulate, the learning that they experience in playing a game. Gee (2003) states the importance of incorporating active and critical thinking about how the learning relates to other semiotic domains. Commercial learning games, particularly for the K–12 age group, are beginning to appear with support materials to help teachers position and facilitate their use and to guide learners in reflecting on what they have learned and how it can be applied outside the game. For an example, see http://www.gamesparentteachers.com.

TECHNOLOGY SUPPORT

As with other learning technologies, technical infrastructure and support can make or break a game-based learning exercise. For an effective experience with your learners, you will need:

- computer and network configurations to support your play plan (individual PCs or handhelds for all, for small groups, or at the front of the classroom; if networked, stable online access with good response times;
- readily available technical support staff if something goes wrong;
- knowledge and experience with the game to answer questions and help learners who run into problems;
- clear navigation and help in the game software; and
- good security (e.g., anti-hacker and privacy guards, particularly when games are used with young children online).

Example

Effective learning games do not always need long story lines or sophisticated virtual worlds. *Education Games Central* games (http://www.savie.qc.ca/carrefourjeux/an/accueil.htm) routinely engage teams of young or older players in spirited competition in many content areas.

Getting started

At this time, games for learning (other than management simulations) are being tested in many interesting examples, but it isn't clear how widely they are being used. Often educators and trainers face obstacles to using computer-based games, including:

- lack of experience and long learning curves;
- time and costs required for custom game development and implementation;

- poor technology support for classroom-based game use; and
- institutional constraints (learning objective mismatches, standardized fact-based testing, class time constraints, lack of peer acceptance, etc.).

Prensky (2006) notes that curriculum requirements, especially when mandated through legislation, can pose a major obstacle, although "curricular" games are starting to be produced commercially. To overcome this and other obstacles, he suggests the following approaches to beginning to use games in class that ease games into your learning situation without major course restructuring:

- Bring games played outside class into the classroom through questions, discussions, etc. This can encourage students to reflect on how a game is relevant to a topic and what they are learning from the game. Make game play an assignment for individuals or small groups.
- Use the principles behind good, complex games to make some or all of your teaching more game-like, and therefore more interesting and engaging to students. One of Prensky's suggestions for keeping students engaged is to have them vote each time you ask a question.
- Play a game specifically designed for education in class, such as one of the examples cited above. To do this, you need to become quite familiar with the game in order to handle questions and technical problems.
- Play a commercial, off-the-shelf game not specifically designed for education, in class, either as a whole class (projected in the front) or as individual students playing separately. Have a student present the game, play the game yourself in front of the class as a springboard to discussion, or divide the students into small groups.

Creating your own game

If you decide to go beyond these options to create your own game, here are some possible approaches:

- **Use a frame game:** Frame games, such as the Educational Games Central ones described above, lend themselves to use, even for complex subjects, without a long learning curve if you can structure your learning in a question-and-answer format. To give an example, the EGC Snakes and Ladders frame game has been used to reinforce introductory social psychology concepts.
- **Do a COTS game modification:** Some commercial games, especially first-person shooters, real-time strategy games, and MMOGs, provide toolkits that let you create "mods" including your own graphics, game scenarios and characters. In one example, the MIT Education Arcade project "modded" the game NeverWinterNights, which comes with the Aurora Toolset game-editing tool, to create the Revolution game (http://www.educationarcade.org/revolution) to teach about the American Revolution seen from Colonial Williamsburg. Another mod of NeverWinterNights, Project BTM, was developed at the University of Minnesota to teach information-gathering stages to journalism students (Paul et al., 2005).
- **Get help to custom-build a learning game:** Many universities and technical schools have game studies programs with students who are looking for projects or work designing and building games using current tools and techniques. You may also be able to find funding for research or learning object development. For example, computer science students at Dalhousie University are working with physicians to build handheld and cell phone game prototypes to help local children learn about and manage chronic diseases (Watters et al., 2006).
- **Create a blended game with computer support:** If building a full-scale computer-based game seems too daunting, you can consider a game that uses computers or handhelds to support a game that also involves offline activities. The MobileGame, for instance, uses task instructions and clues delivered by cell phone to run an orientation game introducing new students to a university campus (Schwabe and Göth, 2005).

Tip

Match your first project with your experience, learner characteristics, and available technology, technology support, and development resources. To build institutional support, aim for early successes before embarking on a large, longer-term project.

Summary

"Our students have changed radically. Today's students are not the people our educational system was designed to teach … Our Digital Immigrant instructors … are struggling to teach a population that speaks an entirely new language". – Prensky (2001b)

In the spirit of introducing the new language of games for learning, this chapter has reviewed basic terms, the motivation to use games for learning, examples to fire your own imagination, factors that make learning games effective, and guidelines for getting started successfully. We hope that this brief introduction has sparked your ideas and your desire to learn more about using computer-based games for learning in your context. Our references and the websites listed in this chapter are a good place to start, and your own searches will provide you with more information. We wish you great success as you explore this intriguing and promising area!

Glossary

Avatar. An image (created or selected and often customized as a fantasy figure) that represents a player in a shared virtual environment.

COTS game. Commercial off-the-shelf game.

Flow. An experience of full immersion, active involvement, and success in an activity.

Frame game. A game structure or template into which content is inserted to create a game.

Game. A set of activities with goals, rules, and competition (possibly with oneself) that involve one or more players in an artificial situation.

Massively multiplayer online game (MMOG). A game played on the Internet, typically in a persistent world, that is able to include hundreds of thousands of players.

Semiotic domain (as defined by Gee (2003)**.** A set of artifacts (words, gestures, images, sounds, that can take on meaning in shared contexts and communities.

Simulation. A dynamic, simplified but accurate systems model of aspects of reality.

Simulation game. An activity that involves aspects of games (goals, rules, and competition) within a simulation model.

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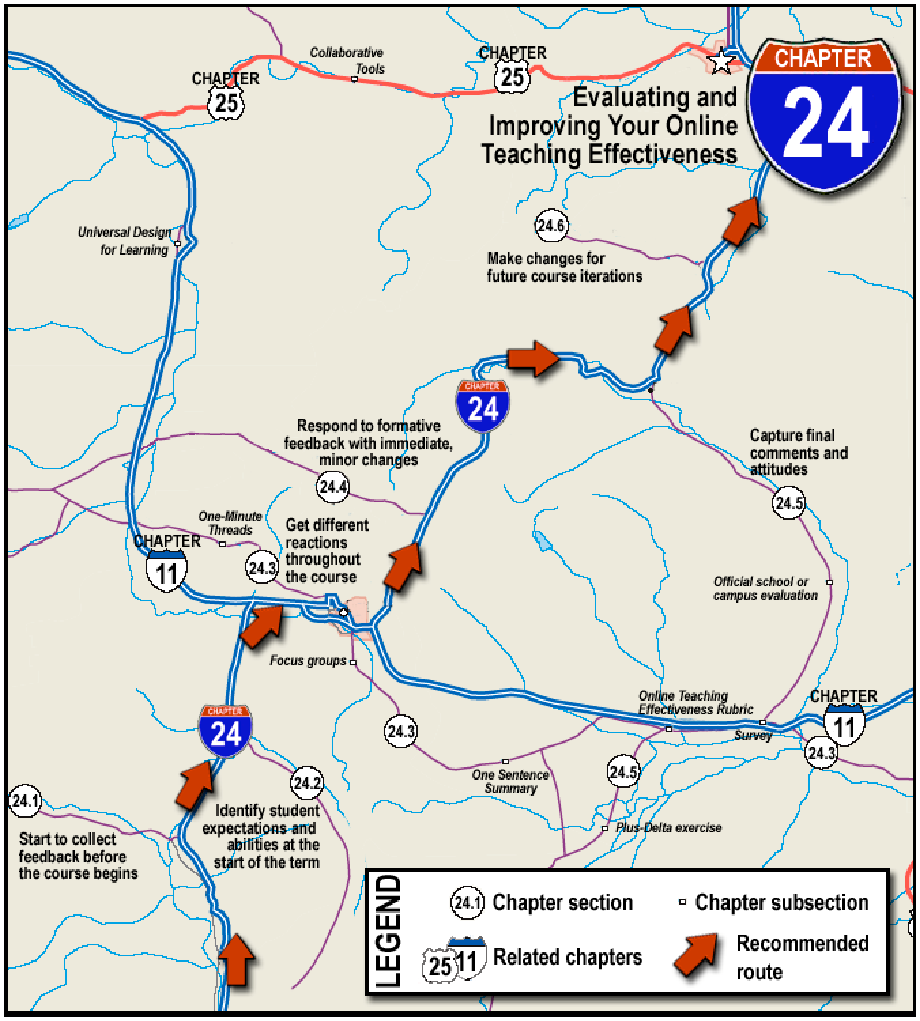
24
Evaluating and Improving Your Online Teaching Effectiveness

Kevin Kelly

Indeed, my argument is that every course is inherently an investigation, an experiment, a journey motivated by purpose and beset by uncertainty. A course, therefore, in its design, enactment, and analysis, is as much an act of inquiry and invention as any other activity more traditionally called "research" or the scholarship of discovery. – Schulman (1998)



Learning outcomes

After completing this chapter, you will be able to:

- Collect direct and indirect feedback from peers and students about online teaching effectiveness before, during, and after the course.
- Use this feedback to make changes to your online course or course environment, both during the course and for future iterations.

Introduction

Teaching effectiveness describes instructors' ability to affect student success. It is usually defined according to several factors, such as how well instructors organize courses, how well they know the course material, how clearly they communicate with students, how frequently they provide timely feedback, and other criteria. In the classroom, effectiveness sometimes depends on the instructor's enthusiasm or disposition. During fully online and blended learning courses, students often need more structure and support to succeed because their course activities usually require them to take greater responsibility for their own learning success. Therefore, many of the criteria take on even more importance when evaluating online teaching effectiveness.

Online teaching is often held to higher standards than classroom teaching, and sometimes these standards have nothing to do with the teacher's ability. For example, a technological breakdown can have a negative impact on students' evaluation of an instructor's work, though the instructor is rarely responsible for the technical failure.

To succeed, you should find some allies to help. If you are new to online teaching and learning, let your students know. They will usually give you a lot of leeway. Some of the students may offer to help you set up or facilitate technology-based activities or at least respond positively to your requests for technological help. Overall, you will find it well worth the effort to evaluate and improve your online teaching effectiveness.

There are many ways to evaluate teaching effectiveness in either the physical or virtual environments. Getting pointers and advice before the term begins can save you from making revisions later. Formative feedback, collected during an ongoing course, improves that specific course. Summative feedback, collected after a course ends, improves the next iterations. Feedback that applies to the instructor's process can also improve other courses.

In this chapter, I discuss seeking feedback from peer instructors, distance education practitioners, students, and even yourself. If you teach fully online, you should be able to convert any face-to-face feedback strategy to the online environment, even if I do not specifically point out how to do it.

Collect feedback before the course begins

Few people are born with an innate ability to teach effectively online. If you have not taught online before, it is a good idea to take a workshop, or to work with someone to plan or create the online environment. If you have just begun the process, you can also explore free online workshops, such as:

- Penn State's "Faculty Development 101," designed for beginning distance education faculty (https://courses.worldcampus.psu.edu/facdev101/student/index.shtml).
- Arizona State University's "Crash Course in Online Teaching: Online Instructors as Online Students," which includes hands-on workshops and self-paced tutorials (http://www.ipfw.edu/as/tohe/2003/papers/VanHorne.htm).

Ask a peer to let you review an online course to see what you like or do not like about how it is constructed, how the instructor(s) provide feedback, how students are assessed, and so on. If you are inheriting an online course from someone else, try to get feedback about what has already been done. Before your course begins, you should ask a peer to tell you about how appropriate the learning objectives are for the topics, as you might do for a face-to-face course.

Depending on your school district or campus, seek additional people who might provide comprehensive feedback in a faculty development centre or an academic technology unit. You might also try to find a fellow teacher who has supplemented face-to-face instruction, taught a hybrid course, or taught a fully online course. Even if this person works in a different department or unit, it is helpful to share your online teaching experiences with someone who has gone through the process.

If this is your first time teaching an online course, or using online components for your face-to-face or hybrid course, you do not have to use every online tool or strategy. Instead, choose one or two strategies based on your learning objectives

Writing personal teaching goals is one more practice you can try as you prepare the online environment and the materials and activities to go in it. Creating an online teaching journal allows you to track your thoughts and actions over time. Including personal teaching goals among the first entries will get you off to a good beginning.

Identifying student expectations and abilities

Involve students in the teaching and learning process from the start. Students who take part in this process often become more engaged in the course itself. Let them know what you will be doing and how you will be doing it throughout the term. Tell them if you are new to online teaching. At the beginning of each term, I ask students to tell me what they expect from the course, beyond the learning objectives in the syllabus. I will revisit these student expectations later, when I get to creating and using **mid-semester evaluation** surveys.

If you want to include students in the entire evaluation process, ask them to help create an effectiveness **rubric** before the course begins. First, tell them the criteria for which you specifically want their feedback. Then ask them how they define online teaching effectiveness. Not only do they have to generate the criteria, they also have to agree on the range that defines how well you meet the criteria. Make sure to provide examples so they can see what typical ranges look like. Let them know up front how many student-defined criteria will go into the rubric. If that number is five, for example, then they can generate as many ideas as they want before voting on the top five. This exercise can be done in small groups or as a whole class, either face-to-face or online.

To prepare for collecting indirect feedback throughout the course, create a benchmark by asking students to perform certain activities at the beginning. For example, ask students to take a small quiz, define common vocabulary, or other minor tasks. In the first week of the course, this activity is not worth any points, though you can assign points to motivate students to complete the activity. Later in the term, you can ask the students to perform the same activity to see how well they are meeting the course objectives or how well they are learning certain material.

Finally, you can improve teaching effectiveness by increasing students' responsibility for their own learning. Ask students to take a **learning preferences** survey, such as the Index of Learning Styles created by Richard Felder and Barbara Soloman (find the survey itself and descriptions of learning styles at http://www.ncsu.edu/felder-public/ILSpage.html). Then direct them to turn in the results to you. This will give you ideas about providing multiple pathways for students to learn the same knowledge, skills or attitudes. By considering the student-centred approach, you will improve your teaching effectiveness in the online environment.

Getting different reactions throughout the course

You can conduct formative feedback for a number of reasons: to check how things are going at a certain point; to evaluate the effectiveness of a specific assignment or resource; or to gauge student attitudes. The frequency with which instructors obtain feedback can range from once per session to once in the middle of the term. Direct methods to collect formative feedback include, but are not limited to, the following:

PEER REVIEW AND SELF-EVALUATION

As important as student engagement can be, student evaluations by themselves are not sufficient. Solicit peer review of specific resources, activities, or assessment strategies, your course structure, your communication strategies, or anything else about which you might have concerns. If you cannot find anyone in your school, department or college who is also teaching online you can ask school or district administrators, academic technology staff members, or faculty development centre staff members to identify prospective peer mentors for this type of feedback. In some cases, the staff members themselves may be able to help you as well.

Another strategy is to create benchmarks for yourself and take time each week to see how you are doing. For example, if you set a goal to answer a certain number of discussion threads in a particular forum, keep track of how many replies you submit, and make adjustments. If you want to return all students' written assignments in a certain amount of time, note how many you were able to complete within your self-imposed deadline. This will help you create more realistic expectations for yourself for future assignments.

ONLINE SUGGESTION BOX

Online suggestion boxes are unstructured activities that capture voluntary comments at irregular intervals throughout an entire term. You can use email or a threaded discussion forum for this activity. If you use a

discussion forum, let students know if their contributions will be graded or non-graded. In some Learning Management System (LMS) solutions, you can allow anonymous comments. Tell students that you will allow anonymous comments as long as they remain constructive. You could make it a portion of a participation grade to enter a certain number of suggestions throughout the term. To focus their comments, give a list of items about which you want feedback, such as amount of respect shown to students and their ideas, variety of avenues to reach learning objectives, amount of feedback provided, relevance of coursework to the world, communication practices, or willingness to make changes based on student feedback. If it is a hybrid or face-to-face course, bring the suggestions back to the classroom and announce them in front of the class, so that students know their ideas have been heard and are being addressed.

ONE-MINUTE THREADS

Normally used as a classroom assessment technique (CAT), **one-minute papers** ask students to write three things in one minute:

- what they felt was clear, helpful, or most meaningful from a course reading, lecture, or classroom meeting;
- what they felt was "muddy," unclear, or least meaningful from a course reading, lecture, or classroom meeting; and
- any additional comments.

With only a minute to write these three things, students provide short, concentrated answers rather than lengthy passages. This makes it easier to see what works and what does not. For example, a biology student might write "clear—basic cell structure," "unclear—4 phases of mitosis / cell division," and "comment—please show more animations and pictures … they help." This process can be anonymous or not, depending on how you plan to use the results. Angelo and Cross (1993) explain the concept of the one-minute paper in their book about CATs, while Chizmar & Ostrosky (1998) cover its benefits in detail.

In the classroom setting, the instructor collects all of the papers and looks for patterns, or areas that are clear or unclear to several students. With this information, they can address problem areas at the beginning of the next class meeting before moving to new material. To respond to less common comments, the instructor may opt to post additional resources, such as journal articles or links to websites that cover a problem area in more depth or from another perspective. Instead of covering the less common problems in class, the instructor has the option of providing more materials related to specific areas, and being open to additional questions.

I began asking students to go through the one-minute paper exercise in an online discussion forum when several international students asked for more time to think about what they did not understand. Writing their thoughts right at the end of the class meeting did not give them a chance to digest what we had done. They wanted to go over their notes from the face-to-face class, to translate any unfamiliar terms and ideas, and sometimes even to discuss the concepts in a small group. By going online, they could have more time to process their thoughts and still give me feedback before the next class meeting.

This new practice turned out to benefit everyone. (See the section on Universal Design for Learning in Chapter 11, Accessibility and Universal Design.) Instead of waiting until the next class period to respond to student needs, I could use the discussion forum to answer each student's question fairly quickly. After only two weeks, something amazing happened. Without prompting, students began answering each other's questions before I had a chance to reply. An online community had formed around a classroom assessment technique that is traditionally not such an open process, being facilitated by the instructor alone. To note the difference, I have started calling this exercise "**one-minute thread**s," encouraging students to help each other from the beginning.

Tip

When creating the settings for a "one-minute threads" discussion forum, do not allow students to post their own original threads or discussion topics. Otherwise, the threads will be hard to sort, since they may not have clear subject lines, and will be added in a fairly random order. Instead, ask them to reply to three specific questions (clearest point, muddiest point, and additional comments). This organizes the responses for you. If your LMS or other discussion forum engine does not allow this, write clear instructions for giving the specific responses you are trying to elicit.

Figure 24.1 shows an example discussion forum, demonstrating how requiring students to reply to the instructor's threads will organize the information for you. For the muddiest point, you can see that the instructor has replied to each student individually. Under "Additional comments," you can see that some students have responded to each other.

Clearest point	Instructor	29 Feb – 23:57
This week's topic—clear	Student A	01 Mar – 06:15
Re: Clearest point	Student H	02 Mar – 14:34
Information that was meaningful to me	Student B	04 Mar – 10:08
…	…	…
Muddiest point	Instructor	29 Feb – 23:59
Re: Muddiest point	Student G	01 Mar – 09:49
Re: Re: Muddiest point	Instructor	03 Mar – 20:10
Unclear on the concept	Student K	02 Mar – 22:01
Re: Unclear on the concept	Instructor	03 Mar – 20:22
This week's topic—unclear	Student A	04 Mar – 06:30
Re: This week's topic—unclear	Instructor	05 Mar – 19:38
…	…	…
Additional comments	Instructor	01 Mar – 00:04
Suggestion about reading	Student D	01 Mar – 07:51
Good suggestion!	Student C	01 Mar – 09:22
Re: Additional comments	Student C	01 Mar – 09:15
Similar idea for reading assignment	Student A	04 Mar – 06:44
Additional comments	Student N	03 Mar – 13:55
This week's topic—comments	Student A	04 Mar – 06:37
…	…	…

Figure 24.1 Example discussion forum

POLLING

There are various online polling tools that allow you to get small amounts of feedback in a short time. Some of these polling tools are built into LMS solutions, such as Moodle's Choice module, allowing instructors to ask single questions related to the material, a course reading, or instructional practice.

FOCUS GROUP

Ask a small group of students to join you once a month, either physically (e.g., office hours) or virtually (e.g., chat, discussion forum). These could be the same students for the entire term or a new group of students each time. During your meeting, ask them specific questions to determine information about learning objectives, resources and how they are organized, online activities, assessment strategies, amount of feedback, or other aspects of your teaching that you want to improve.

Tip

The students are more likely to respond honestly if their comments are anonymous. In this case, you might assign someone from the small group to ask the questions, another to keep track of time, and a third person to take notes that they post as a group or send by email. Most LMS chat tools do not allow students to block the instructor from seeing the archive, so you may have to disable the archive for that chat, if possible. The note taker can copy and paste the entire chat into a word processing document for summarizing, editing, and removing student's names. Other options include telling the students to use a free Instant Messenger (IM) service to hold the chat session outside the online environment for the course.

MID-SEMESTER EVALUATION SURVEY

If you would prefer a larger scale approach than a focus group, try a mid-semester survey. I have used different tools, two of which allowed anonymous student responses, but there are several more. Those that I have used are called the Free Assessment Summary Tool (FAST—http://www.getfast.ca) and survey tools within LMS solutions, such as Blackboard's Survey Manager, WebCT's Quiz and Survey module, and Moodle's Survey module or Questionnaire module.

While it is not perfect, I like FAST for several reasons:

- It is free.
- Anyone can use it to create surveys. It does not require that your campus have a LMS.

- Student responses are anonymous. In addition the survey is conducted in a password- protected environment, so you can be reasonably sure no one who is not enrolled in your course is critiquing your work.
- It provides a question database with more than 350 survey questions related to different aspects of teaching effectiveness. These questions are organized into 34 categories such as Assignments, Enthusiasm, Feedback, Instructor Content Knowledge, Learning Environment, and Student/Student Interaction. You can choose questions from the database, or make your own questions, or both.
- Instructors can download the results as a Microsoft Excel file.

Figure 24.2 contains five items from the anonymous, twenty-question survey I conduct each semester using FAST. The first set of ten questions relate to the student expectations that they define during the first week of the term. The second set of ten questions relate to different elements of teaching effectiveness that I want to improve. Sixteen out of twenty-one graduate students responded.

For my survey, I choose the "Likert Scale & Long Answer" option for each question. That way I can get quantitative data, numbers that quickly tell me what students like or do not like, and qualitative data, written comments that, I hope, will tell me how to improve different parts of my class. Here are some example responses for Question 5, "In this course, I am getting hands-on skills":

- "I agree that I am getting hands on skills, or that theoretically I am. I think that having a client in the immediate area or available to talk to the students on an ongoing basis would be better than allowing a client to communicate solely by email and at their discretion. A contract drafted by the two parties would be desirable when going forward".
- "Kevin brings in great examples. I feel that a day of lecture on starting and finishing a needs assessment may be helpful to anchor the learning a bit. I am really working with clients".
- "Yes, in the sense that I am working on all the steps with my group mates, but I wonder how I would do outside the context of this class …".

ONLINE TEACHING EFFECTIVENESS RUBRIC

If you take the time to create a rubric with your students at the beginning of the semester, then you have to use it some time! This might also be a mid-semester event (in lieu of a survey), or you might ask different teams to complete the rubric at different times. In this way, each student might only complete it once, but you will get feedback once a month or even more frequently. Later I will talk about addressing the students' feedback, both individually and as an entire class. If you choose to use a rubric, make sure to leave time to explain the concept to the students. Going over the results will take longer than an online survey, but the qualitative data provides much more value than survey results alone.

Figure 24.3 contains some example criteria from a rubric that my students and I created together. Notice how the range for evaluating each criterion can be qualitative or quantitative in nature. Also, it is important to provide space for written comments so students can suggest ways to improve.

You do not always have to ask, "How am I doing?" to evaluate online teaching effectiveness. You can also use indirect methods to collect formative feedback. These indirect methods include, but are not limited to, the following.

One-sentence summary

The **one-sentence summary** is another classroom assessment technique that I adapt to the online environment. Designed to elicit higher level thinking, a one-sentence summary demonstrates whether or not students are able to synthesize a process or concept. Students answer seven questions separately: "Who? Does What? To Whom (or What)? When? Where? How? and Why?" Then they put those answers together into one sentence. Angelo and Cross (1993) also describe this exercise in their book about classroom assessment techniques. Examples I have seen include assigning nursing students to write a one-sentence summary of a mock patient's case, as nurses are often required to give a quick synopsis about each patient, and asking engineering students to write a summary about fluid dynamics in a given situation.

It is fairly easy to use this technique online. You can set up a discussion forum to collect the student entries. The online environment also makes it fairly easy to engage students in a peer review process and to provide timely feedback.

When looking at the results of the students' summaries, you can identify areas where large numbers of students did not demonstrate an understanding of the topic or concept. The most common problem area for students revolves around the question "Why?" Figure 19.4 is an example of a one-sentence summary submitted via discussion thread. The instructor's reply gives suggestions for improvement and shows the student how the instructor interpreted the sentence components.

Student-generated test questions

Ask students to create three to five test questions each. Tell them that you will use a certain number of those questions on the actual test. By doing this, you get the benefit of seeing the course content that the students think is important compared to the content that you think they should focus on. You can make revisions to your presentations to address areas that students did not cover in their questions. If there are enough good student questions you can also use some for test review exercises.

Questions	Strongly Disagree	Somewhat Disagree	Not Applicable	Somewhat Agree	Strongly Agree
Q1. In this course, I have had a chance to work on a meaningful needs assessment project.	1	1	1	9	4
Q2. In this course, I am getting good experience with the needs assessment process.	1	1	0	11	3
Q3. In this course, I am getting appropriate practice working with clients.	3	0	1	9	3
Q4. In this course, I have learned to develop an instrument that allows me to determine the client's needs.	0	1	1	10	4
Q5. In this course, I am getting hands-on skills.	0	0	0	12	4

Figure 24.2 Example survey results

Category	4	3	2	1
Organization	Course is very organized, making it easy to find all materials and assignments	Course is fairly well organized, requiring a little effort to find some materials and assignments	Course is somewhat organized, making it a challenge to find most materials and assignments	Course is convoluted, making it very difficult to find any materials or assignments
	Score: Comments:			
Assignments	Course assignments are very appropriate to the topic of study	Course assignments are fairly appropriate to the topic of study	Course assignments are only somewhat appropriate to the topic of study	Course assignments are not appropriate to the topic of study
	Score: Comments:			
Meeting Student Needs	Instructor related all subject matter (all 10 core topics) to student interests and experiences.	Instructor relates most subject matter (6 to 9 core topics) to student interests and experiences	Instructor relates some subject matter (4 to 6 core topics) to student interests and experiences	Instructor relates very little subject matter (0 to 3 core topics) to student interests and experiences
	Score: Comments:			

Figure 24.3 Example rubric criteria with evaluation ranges

My Sentence
by Student B—Friday, 2 September, 12:35 PM

In order to adequately address teaching effectiveness an instructor needs to use an effective tool to measure specific activities or deficiencies in student performance by using techniques including but not limited to: surveys, analysis of performance, and questionnaires.

> Re: My Sentence
> by Instructor—Sunday, 4 September, 08:31 PM
>
> This is a good start. WHEN does it happen? Keep in mind that the process does not end with using a data collection tool. There is analysis of the process before the course begins, and after collecting the data. Also, WHERE does it happen? Is this online, in the classroom, or both?
> ---
> In order to adequately address teaching effectiveness [7 WHY] an instructor [1 WHO] needs to use an effective tool to measure specific activities or deficiencies [2 DOES WHAT] in student performance [3 TO WHOM] by using techniques including but not limited to: surveys, analysis of performance, and questionnaires [6 HOW].

Figure 24.4 Example one-sentence summary student submission with instructor's reply

Evaluate online quiz or test results

If you use a learning management system (LMS), an online workbook environment that comes with publisher materials, or other online space that allows online quizzes or tests, then you can use the results to identify problem areas. LMS solutions like Moodle and ANGEL provide tools to perform an item-by-item analysis to evaluate several factors related to individual questions. These factors include item facility, an indicator of the question difficulty for students; standard deviation of student responses on each question; and item discrimination, an indicator of the difference between performance by high-scoring students and low-scoring students.

Even if you can only get simple statistics, such as how the class answered each question overall (e.g., 10 percent picked "A," 25 percent picked "B," 65 percent picked "C"), you can use this information to make adjustments. One way to do this is to ask your students to take a pretest or baseline quiz at the beginning of the course, and then compare those results to the actual quiz results. In face-to-face or hybrid course situations, you can use the quiz results to address issues through quiz reviews or changes in your lecture. Dr. Karen Grove from San Francisco State University discusses how to use quiz results to address learning gaps via a student preparation module in the Orientation to College Teaching (http://oct.sfsu.edu/implementation/studentprep/index.html). If large numbers of the students get a question wrong, the instructor can cover that topic more fully. The instructor can also dispel misconceptions after seeing how many students choose a particular incorrect answer. Figure 19.5 is a sample of item analysis in the Moodle LMS (version 1.5.4). Figure 19.6 is an example of much simpler item statistics in the Blackboard LMS (version 6.2). The instructor can see how many people select each answer. For essay questions, it provides a complete list of all the essays.

Responding to formative feedback with immediate, minor changes

Collecting the student feedback is just the beginning. However, you do not have to, and should not, wait until the end of the term to start introducing changes as a result of what you learn from the students. For instance, students may use the different instruments to ask you to be more flexible in the teaching approach, to maintain a good attitude towards students and their ideas, to use more appropriate assessment methods, or to add more real-world application to the content.

To continue engaging students in the process, go over the formative feedback results with them and solicit suggestions for changes. I tell my students that, to me, "constructive criticism" means that they must help construct solutions to problems or issues that they find. Together, the students and I look at survey results or rubric scores, and any comments about a specific teaching effectiveness criterion. If no comments address

how I can change to meet their needs, then I ask them to give me suggestions. In one case, the students stated that I sometimes used terms from the field that were not used or defined in the readings. The short-term solution was to create a short vocabulary list for each unit, based on both experiences and readings. I chose to do this myself, but I could have involved the students even further by having the class generate vocabulary lists for each unit, based on words that each student had to look up individually.

Students may ask you to do a number of things related to the course or how it is set up:

- To clarify your expectations, update your course objectives, create more detailed instructions for assignments, or identify how students will be evaluated for each learning objective more clearly.
- To improve the online course structure or organization, consolidate all resources, activities, and assessment strategies related to each learning objective.
- To show more knowledge of the course material, create and upload recorded lectures, upload your presentations, and provide information about any research that you have done related to the course content.
- To increase the variety of avenues for students to reach learning objectives, provide resources in different formats (e.g., video clips, text readings, charts and graphs) and encourage students to demonstrate knowledge or skills in different ways, if possible (also see Chapter 11, Accessibility and Universal Design).
- To provide more opportunities for active learning, create small group discussions around materials or assignments, use collaborative tools such as wikis (see Chapter 25, Tools for Engagement and Collaboration), and assign students to online study groups.
- To show the relevance of coursework to the world, assign students to relate course content to current news, provide examples of current research in the field (e.g., published articles) as optional readings, and invite experts in the field to participate in online activities such as discussion forums.

Question text	Answer's text	partial credit	R. Counts	R.%	% Correct Facility	SD	Disc. Index	Disc. Coeff.
There are many ways to evaluate online teaching effectiveness throughout the course.	True	(1.00)	28/32	88%	88%	0.35	0.83	0.57
	False	(0.00)	4/32	13%				

Figure 24.5 Moodle LMS item analysis

Question 4 Multiple Answer		Average Score X points	
Which of the following are formative feedback techniques for evaluating online teaching effectiveness?			
Correct	**Answers**	**Percent Correct**	**Percent Incorrect**
X	Online teaching effectiveness rubric	94.117645%	5.882353%
X	Mid-semester evaluation survey	88.2353%	11.764706%
	Ouija board	94.117645%	5.882353%
X	Focus group	70.588234%	29.411766%
	One-hour threads	50%	50%

Figure 24.6 Blackboard LMS item statistics

Students may also ask you to change how you facilitate different online course components:

- To improve communication with students, put clear deadlines and policies (e.g., late submissions) in your syllabus, but let students know that you will vary online components to meet their needs,
- To provide timely, appropriate feedback, give yourself grading deadlines and use short rubrics that tell students why their work is good or needs improvement.
- To demonstrate how enthusiastic or approachable you are, hold virtual office hours and encourage students to contact you for help.
- Demonstrate your willingness to make changes based on student feedback, outline your feedback process for students, tell students directly that you will make reasonable changes that will improve student learning, and let them know what changes you make, along with the rationale for each change.
- To show respect to students and their ideas, acknowledge student viewpoints even if they contrast with your own, and bring good ideas to the attention of the other students, even if you do not name students specifically.
- To create and maintain a safe environment for expression, include a "Netiquette" policy in your syllabus, model the types of responses that you want students to employ, enforce your policies when students do not follow them (also see Chapter 26, Techno Expression).

To close student performance gaps identified by indirect feedback methods, you can provide extra resources (e.g., websites, articles, or additional attention during face-to-face lectures or online recorded lectures), extra activities (e.g., self-assessment quizzes, discussion forums, wikis), or both.

Capturing final comments and attitudes

Conduct summative feedback for a number of reasons: to check how things went, to evaluate the effectiveness of a specific assignment or resource, or to gauge student attitudes about the course as a whole. The summative feedback will be a useful set of data for course redesign. While the current students will not benefit from any changes you make, future students will have a better experience.

ONLINE SURVEY

Similar to the formative feedback surveys, you can use a closing survey to find out what students feel about specific aspects of your online teaching or their overall experience. There are numerous survey tools out there. Some are stand-alone, online survey tools and some are integrated into learning management systems.

PLUS/DELTA EXERCISE

This group exercise is used in a variety of settings: corporate meetings, training workshops, closing sessions at conferences, and, of course, K-16 classrooms. The purpose is to identify publicly what people think about a particular shared experience. The name "plus/delta" comes from the two symbols—plus (+), signifying positive aspects of the experience, and delta (Δ), signifying aspects that people would change—that sit atop two blank columns. In a group setting, participants then add items to each column. Some facilitators will give each person a chance to either add an item or pass, while others go with a looser approach, letting people call out items while they write them down in the correct column. Usually this is done with large pieces of paper on an easel or taped to the wall, so everyone in the room can see the growing lists.

After participating in several **plus/delta exercises** during collaborative conference sessions, I decided to facilitate one for my graduate practicum course about needs assessment. In this sixteen-week hybrid course, students conduct needs assessment activities for real-world clients in corporate, higher education, K–12 education and non-profit settings. Since the lists are supposed to be compiled publicly, I used Microsoft Word on a computer hooked up to a projector instead of using a chart board or butcher paper. That way I could post the final product online for reference later. If you are teaching a fully online course, or a hybrid course, you can have students provide the same information using a threaded discussion. Next time, I will conduct it as a discussion forum or wiki, rather than in the classroom.

Figure 24.7 contains the actual plus/delta items from the exercise that I conducted with my students at the last face-to-face meeting of our class on needs assessment. You can see the wide range of things that students liked and would like to change. You can also see that the "Delta," or change request, list is longer. When I teach this course again in the fall, I will make quite a few changes!

Plus (+)	Delta (Δ)
• Having no synchronous activities online was helpful • Structure of discussion assignments worked well • Liked using Moodle • Online discussion with consultant was great • Democratic approach—liked having options such as voting on class meeting time • Real-life experience was helpful • Breadth of projects was helpful, allowed people to get involved in a project that interested them • Teams bring people together from wide-ranging backgrounds with different perspectives for project • Rubrics are really helpful • Good takeaway tools • Parties are good • Balance between face-to-face and online was just right	• Check in points—instructor check in with teams • Set deadline for when you can switch project if client is not responding (panic button) • Would like to have a contract with clients • Have some synchronous activities • Do not be as flexible with submission timelines • Repeatedly returning to Moodle was difficult • Moodle is not standardized throughout department • Would like more examples of needs assessments from different industries • More subject matter experts (more consultants) • Have class build case study library as assignments • Handout/link overload, maybe make a centralized place for links • Embed syllabus in Moodle itself (copy syllabus page into each topic area) • Move teamwork exercise to 3rd or 4th week • Move project management exercise earlier to create some sort of blueprint—rotate roles for each stage of project • Get feedback on individual assignments to students earlier • Give assignments to write brief description about how online meeting went

Figure 24.7 Example plus-delta items generated by students in hybrid course

ONLINE TEACHING EFFECTIVENESS RUBRIC

You may use the same rubric—possibly created along with the students—at the end of the term, as you did at the beginning and/or middle.

OFFICIAL SCHOOL OR CAMPUS EVALUATION

You can use the official evaluation provided by the school or campus. Students are very familiar with this evaluation, so ask them to take it seriously. If you are teaching an online course, check if your campus or school has a way to distribute the evaluation form. If not, copy the questions and conduct it yourself using one of the techniques described above. In some cases, instructors can add questions to gather data about specific teaching practices. Use this opportunity to learn how students feel overall about the experience; how they feel about specific content, activities, or assessment strategies; or how they feel about your teaching. If the official course evaluation is conducted online, then you will be able to code the qualitative comments to find common student likes and dislikes.

Throughout the chapter, I have been telling you how supportive students can be. However, some students turn **summative evaluations** into venting sessions, stating that "the instructor should never be allowed to teach online again … ever" or "this was the worst class I have ever taken." There are any number of reasons why a student might do this: anger at him or herself for not performing up to his or her standards, frustration with frequent or high-impact technology failures, infrequent instructor feedback, or other things. Whether or not the harsh criticism is justified, it is usually not accompanied by constructive comments. Despite our best efforts, it can also be really hard to read. Remember that a vocal minority does not constitute the entire class. Focus on the students who do provide real suggestions for change, and use those as the basis for your next try. Talk to your peers about the negative responses while reviewing your course environment. Your peers might be able to make suggestions that the students did not make. Lastly, use one or two of the formative feedback suggestions above to make sure that students do not go an entire semester without an opportunity to tell you how they feel.

Making changes for the future

Once you have the summative feedback, you can let it sit for a while, or immediately begin revising the online course for the next iteration. Changes might include being more flexible in the teaching approach, having a better attitude towards students and their ideas, using more appropriate assessment methods, adding more real-world applications, and so on. Since the new students most likely did not see the previous version of the course, you are free to do anything, from making minor changes here and there to completely starting over. Usually it is somewhere between the two.

In one personal example, using the Moodle Glossary tool, I will revise the short-term vocabulary list solution, described above, to be a communal glossary assignment. Each week I will ask the students to generate glossary terms that they do not understand from my lectures and from the readings. If multiple people add the same term, then I will know it is a concept that requires more attention. Other LMS solutions, like WebCT, have a Glossary tool as well.

Most importantly, do try again. Regardless of how you feel about your first attempt at online teaching, it will get better each time you try. Online course offerings provide students with more flexibility. Hybrid, or blended learning, courses can combine the best of both worlds. Online environments that supplement fully face-to-face instruction can help students to stay on task, to plan ahead, to access resources at any time of day, and more. In all three types of online learning, the pros outweigh the cons. Most students will appreciate your efforts, which is a good thing to remember if you ever question why you are teaching online in the first place.

Summary

> "The educational value of war stories has been grossly underestimated". – Schank & Cleary (1995)

Maintain your sanity by keeping the short-term solutions on a small scale. Unless it is based on feedback given before the course, or right after it begins, it is a good idea to wait until after the course is over to institute a major revision. If there is a good reason to make a major change, communicate clearly and often with your students about what is going to happen and how it might affect them.

I hope I have given you a wide array of possibilities that will help you evaluate and improve your online teaching effectiveness. Do not feel like you have to do everything listed in this chapter! Treat this chapter like a buffet that is open all day, every day. You can put as many, or as few, items on your plate as you like. You can always come back for more. You should chat with other instructors at the buffet to see what they liked and did not like. When you sit down at the table with your peers, take a look at what they are doing and tell them about how your own choices worked for you.

If I rename the modified classroom assessment techniques as "online assessment techniques," then I say "It's always a good time to sow your OATs!" This is corny, I know, but it leads me to my last bit of advice: Keep your sense of humour. At times, it can be tough to go through the online teaching process, to hear or read student criticism, and to make adjustments to your carefully planned course. If you can laugh at yourself and remember that the students are on your side, then you are on your way to teaching effectively online.

Glossary

Formative evaluation. An ongoing process used to determine the relative success of an activity or course at specific points throughout the activity or course.

Learning preferences. Items used in the metacognitive process—learners learning about their own learning process in order to improve learning success. Learning preferences are often broken into categories (e.g., sensory input, perception, organization, processing, understanding) to enable comparisons and to make it easier for learners to associate with one or more in each category. Some learning preferences are also called "learning styles." Learning preferences can also include attitudinal, social, environmental, and physical preferences, as well as brain hemisphere dominance.

Mid-semester evaluation. An activity designed to give formative feedback to the instructor, with enough time to make minor changes or improvements to the course that will improve the chances of learning success for current students.

One-minute paper. An activity used to collect participants' reactions to a reading, event, or activity.

One-minute thread. An online activity based on the principles of the one-minute paper. Variations include allowing students to give feedback to one another about what some students did not understand. This feedback must be moderated by the instructor, but creates a sense of community.

One-sentence summary. An activity used to determine a learner's ability to synthesize a complex process or a large amount of information. Learners are asked

to answer seven questions—Who? Does What? To What or Whom? When? Where? How? and Why?—before stringing the answers together into a single sentence.

Plus/delta exercise. An activity used to collect participants' feelings about what they liked and what they would change about a particular experience or event. This is often conducted by someone other than the instructor.

Rubric. An instrument used for evaluation. Analytical rubrics are usually constructed as tables of items, called criteria, to evaluate, on one axis and levels of proficiency, usually called the range, on the other axis. Holistic rubrics give one score for the overall product.

Summative evaluation. A process used to determine the overall success of an activity or course after the activity or course has ended. This type of evaluation allows the facilitator or instructor to make changes and improvements before conducting the activity or course again. Current students do not benefit from their own feedback, but future students do, provided the instructor makes some of the suggested changes.

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