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Designing Dynamic Online Lessons with Multimedia Representations

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Abstract

The focus of this paper is on the use of multimedia representations in the online lesson. The information presented here may be of interest to online instructors with varied levels of experience, yet it is geared more toward those who are new to online teaching. A central feature of this paper is the importance of the lesson plan, which can include identification of how multimedia will be used to create instructional messages for the lesson. The potential exists to increase the quality of instruction through the careful use of static and dynamic multimedia representations. Support for the use of multiple representations is documented in the research literature.

Introduction

The development of a fully asynchronous online course involves designing instructional materials that may be accessed by students through computers at various times and locations. Instructional information and communications are sent and received through the support of an electronic conduit of computers and cables. It is somewhat analogous to children playing telephone with two cans connected by a string except that with online instruction there is a much longer string and far more advanced cans. Teaching in the online classroom requires that instructional materials be developed in an electronic form that can be distributed from computer to computer. This opens up possibilities for the integration of dynamic instructional content including multimedia representations such as animation, audio, video, and interactive components, which are easily supported by computers. When developing multimedia supported lessons for online instruction it is beneficial to design them with careful consideration of how the multimedia will support communication of instructional ideas. This may be accomplished through the use of an instructional design process specifically geared toward maximizing the benefits of multimedia for learning.

Designing the Multimedia Supported Lesson

It has been argued that instructional design is important to distance education due to the critical role of good planning (Zheng & Smaldino, 2003). All instructional programs benefit from good planning, but it becomes essential in distance education where students are separated from the instructor. In a face to face classroom an instructor has the immediate opportunity to adjust instruction based on spontaneous feedback by students. This is less likely to occur in online instruction due to the separation of teachers and students. With the asynchronous nature of the online course it is conceivable that hours or days could pass before a student obtains answers to questions submitted by email to an instructor. Course content may be modified after the instructor receives emails describing confusion, but this too occurs after a period of time has passed. In the meantime poorly planned or designed instruction leaves students confused and frustrated as they attempt to interpret the course content and wait for a response to their questions. Careful planning can help to alleviate problems with instructional materials before they occur. The place to begin when designing a multimedia supported lesson is with the lesson plan.

The Lesson Plan

A lesson plan serves as a blueprint for an instructional event. The lesson plan may include elements such as lesson title, description of the lesson, learner characteristics, goals or objectives for the lesson, related standards, timeline, and a list of learning activities. When planning a multimedia supported lesson to be taught in an online course the lesson plan is used to map out connections between text and multimedia elements. For example, the instructor of an online science course may wish to develop a multimedia supported explanation of the concept of surface tension prior to assigning a series of home experiments. The lesson plan would include a section that lays out exactly how the multimedia will be used to communicate the instructional ideas involved in the surface tension lesson. This establishes a roadmap for development of instructional messages, which Mayer (2001) has defined as communications that foster learning. An example of how this might be done for the science lesson on surface tension is shown in Table 1 overleaf.

Table 1

Matching Instructional Messages With Multimedia Representations

Instructional Message Summaries	Corresponding Multimedia Representations
<p><i>Define surface tension:</i> Explain what surface tension is and give the scientific definition.</p>	<p>Text is used for the definition and explanation. An image shows a diagram of a water droplet.</p>
<p><i>Explain how small items can be supported on the surface of water due to surface tension:</i> Describe how a needle or paper clip can be supported on the surface of water.</p>	<p>Text is used for the explanation. An image is used to show a paper clip floating on water.</p>
<p><i>Explain how surface tension works at the molecular level:</i> Describe how water molecules are attracted to each other due to polarity. Explain what happens at the surface of the water.</p>	<p>Text is used to explain the attraction of water molecules and what happens at the surface. An image is used to show a diagram of water molecules and the partial charges that occur on them. An animation is used to show how surface tension works at the molecular level. Note: The animation opens in a new window. It is a small window that opens right above the rest of the information in the text of the instructional message. The animation serves to extend the instructional message and it is self-contained. Having it in a separate window draws attention to the information in the animation so the focus is on the information in it.</p>

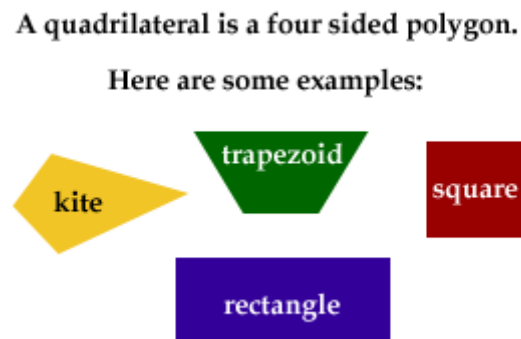
The complete surface tension lesson plan and corresponding multimedia supported lesson are available online at: <http://edtech2.boisestate.edu/snelsonc/examples.htm>

The Role of Representation in the Multimedia Supported Lesson

In Table 1 a column of instructional message summaries is matched to corresponding multimedia representations. The role of representation is vital to consider when developing the lesson plan and instructional messages that will become part of the online lesson. Representations are used to stand for elements of the instructional message developed by a teacher. This creates two worlds related to representation: the *represented world* and the *representing world* (Palmer, 1978). The represented world is the world of ideas and objects that a teacher wishes to communicate to students. The representing world is the world of representations used to stand

for and convey information about those ideas and objects. To get a sense of how this works consider the example of a geometry teacher who wishes to define quadrilaterals for a class of online students. The ideas that constitute a definition for quadrilaterals are part of the represented world. The teacher takes those ideas and creates representations to stand for the ideas involved in the definition. The representations are selected to capture specific elements of the definition. Text may be used to write a verbal description and labels for a set of images showing a family of four-sided shapes. The text and images form the representing world as shown in Figure 1.

Figure 1: Represented World of Quadrilaterals



The User Interface

Instructional content and communications for the online course are displayed on the computer monitor, which serves as the user interface for the course. Instructional messages, created with one or more representations, are displayed on the monitor screen for students to read or interact with. What the student sees displayed on the screen will most likely include text. Text is easy to produce and supports communication of linguistic information well. There are additional choices when representing information in the online course, however. A list of eight categories of representation is shown in Table 2.

Table 2**Eight Categories of Representation**

Representation	Description
Verbal Text	Text used to form words and sentences.
Mathematical Text	Numbers and mathematical symbols.
Tables	An arrangement of columns and rows.
Images	Pictures, diagrams, graphs, drawings, etc.
Animations	Text and/or images in motion.
Audio	Sound files.
Video	Real world video with or without sound.
Interactive Components	User input leads to a modification of the representation or an automatic display of feedback.

The Properties of Static and Dynamic Representations

The representations shown in Table 2 can be divided into two categories: static and dynamic. The static representations are those that may be supported by textbooks or online courseware equally. These include verbal text, mathematical text, tables, and images. The dynamic representations are not supported in traditional textbooks, but may be integrated into an online course due to the availability of an electronic medium. The dynamic representations include animations, audio clips, video, and interactive components. Dynamic representations can be used along with the static representations to create an online lesson that takes full advantage of the inherent properties of each type of representation.

The properties of representations are structural features that support communication. Properties vary from representation to representation. Consider the properties of an image. These properties include the ability to capture spatial information that is specific to a single moment in time. For example, a digital photo can capture the image of a monkey in a zoo one frame at a

time. The motion path of the monkey swinging from one tree to another cannot be captured in a single image. Images do not have the property of motion. They are static representations. Video or animations are required to capture the dynamic motion of the monkey.

Dynamic representations have properties that may be exploited to expand the way instructional concepts and procedures are taught online. For example, animations can be used to draw the eye toward steps in a mathematical procedure, demonstrate the process of tornado formation, or show how the position of a baseball changes while flying through the air. Video can be used to capture elements of the real world such as a rocket launch or a deer feeding in the woods. Audio clips are valuable for sounds such as music, speeches, or bird songs. Interactive components allow a student to drag and drop virtual algebra tiles to solve quadratic equations or receive instant feedback based on their answers to a practice quiz. These dynamic multimedia elements provide the online instructor with a broad spectrum of ways to explain concepts and procedures to students.

Combining Representations

When two or more representations are combined they form systems of representations (Goldin & Shteingold, 2001). Instructional messages may be written using systems of multiple representations to take full advantage of the inherent properties of each one and create an effective presentation of information. Mayer (2001) has suggested that an effective multimedia presentation should include a combination of words and pictures. Support for this idea comes from the results of his own research and dual coding theory (Paivio, 1990), which suggests that the combination of image-like representations and language-like representations may serve to increase learner capacity for working memory. There is some corresponding evidence in support of dual-coding theory that is based on Positron Emission Tomography (PET) scans of the brain conducted during mental imagery tasks (Mazoyer, Tzourio-Mazoyer, Mazard, Denis, & Mellet, 2002). In essence, there are situations when combinations of representations are more effective for instruction than single representations such as text alone.

Pros and Cons of Learning with Multiple Representations

There are three compelling reasons for using multiple representations when creating instructional messages according to De Jong et al. (1998). First, different kinds of information can be conveyed with specific types of representations. Spatial information can be conveyed with images, changes over time with animations or video, and so forth. Second, the achievement of expertise in a field is characterized in part by mastery of the representations associated with the domain. Mathematics and science are both examples of knowledge domains that require fluency in many types of representations including mathematical symbols, diagrams, and graphs. Indeed, considerable attention has been given to the role of representation in these knowledge domains (Ainsworth, Bibby, & Wood, 2002; Cheng, 1999; Friedlander & Tabach, 2001; Yang, Andre, & Greenbowe, 2003; Yerushalmy, 1997). Third, representations can be developed and sequenced to create learning material that benefits students. Information can be structured in a simple to complex sequence or qualitative to quantitative sequence. This strategy enables a progression from familiar concrete representations to more abstract ones that are initially unfamiliar to them.

Other benefits of using multiple representations for learning have been explored in a wide array of research studies. The combination of images and text has been associated with gains in student understanding of instructional content (Ainsworth & Loizou, 2003; Lai, 1998; Mayer & Steinhoff, 1995). The use of images and animations to represent and encode the laws of momentum in physics has been linked to increased conceptual understanding of those concepts (Cheng, 1999). Audio, when combined with images or animations has been connected to increased student performance on measures of comprehension in computer language instruction (Lai, 2000).

While the conclusions of numerous studies exist to support the use of multiple representations in learning there are also studies that report inconclusive or even negative results. One explanation for this is the difficulty learners sometimes have understanding how to obtain information from representations or how to translate between different representations in an instructional message (Ainsworth et al., 2002; Ainsworth, Bibby, & Wood, 1997). Students may need to learn how to read and use information from the representations. They may use one preferred representation

and avoid others thus limiting their own potential for learning the information in a knowledge domain. It is not always enough to simply provide multiple representations.

In an online course it is possible to take advantage of the technology to help overcome the learning demands and difficulties associated with multiple representations. One proposed method is dynamic linking (Kaput, 1989). In dynamic linking one representation is linked to one or more others so that changes occur simultaneously in all of them. For example, the graph of an equation can be linked to the mathematical symbols of the equations. As the equation is modified the graph refreshes to show how it changes in correspondence to the equation. A modified form of dynamic linking has shown promise in helping children understand how the solution to a mathematics problem can be represented in different yet related ways (Ainsworth, Wood, & O'Malley, 1998). Dynamic linking is a strategy that may be incorporated into the multimedia supported online lesson to assist students as they learn the relationship between representations. The value of this approach may vary depending on the instructional content. If the individual representations are concrete and well-known to students then the relationship between them may be apparent. Alternatively, abstract symbolic or graphical representations may seem foreign. In this situation, students may reap substantial benefits from the use of technology to dynamically link those representations.

Multimedia and Online Course Development

The use of multimedia representations in an online course provides a powerful way to make the instructional content dynamic and effective. The spectrum of representations makes it possible to go well beyond the limitations of text when developing instructional content for students who will access that content through the display of a computer screen. The potential exists to create and combine multimedia representations that lead to development of online lessons of superior quality. There are some drawbacks that might interfere with the potential of multimedia learning, however. Teachers who develop multimedia content need to master the software used to create it. Some of the software currently on the market is expensive and complex to use. If the cost factor is overcome teachers are likely to require training prior to effectively using the software. The purpose of this training may need to extend beyond software skill attainment to include pedagogical aspects of teaching with multimedia.

Difficulties aside it is possible to integrate multimedia into an online course without becoming overwhelmed. One strategy described by Allen (2001, p. 18) is called an “onion paradigm.” What this means is that a course can be developed around a core text with multimedia elements added in layers over time. Each time the course is taught a bit more multimedia can be added as time and technological skill allows. It does not all have to be done at one time.

Conclusion

It is an important challenge for online teachers to develop effective lessons. Through the use of multimedia it is possible to improve the quality of instructional messages thus benefiting students. As online pedagogy advances and additional research is conducted, more will likely be revealed about the value of multimedia in online learning. There is potential for multimedia representations to become a central feature of the design of dynamic online lessons.

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