
Health Education and Multimedia Learning: Connecting Theory and Practice (Part 2)

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Part 1 of this article reviewed the contributions of educational psychology to the early development of health behavior theory and the difficulties faced by health education in adopting some of the perspectives that today guide multimedia learning. Whereas Part 1 involved discussion at the theoretical level, the purpose of Part 2 is to connect theory and practice by describing the most relevant multimedia learning theories and by providing recommendations for developing multimedia health education programs. It also provides practitioners with specific examples of the features that may make computer-based interventions more attractive to their particular audiences.

Keywords: *computer technologies; theory and practice; instructional technology theory*

► **MULTIMEDIA LEARNING THEORY**

One of the first issues that educational psychology tried to answer was whether computer technologies enhance learning. Richard Clark (1983), for example, argued that media do not affect learning under any conditions. The author conducted several research studies and rebutted meta-analyses to conclude that media do not influence learning in and by themselves. Despite the fact that this argument can and has been challenged, health educators should take advantage of the practical applicability of Clark's principles. First, Clark differentiated between studies with media (media as a tool) and studies on media (media as the subject of study). Most of the published health literature attributing an enhanced effect to computer-based interventions does not make such a distinction. Second, Clark insisted on the need for distinguishing between media, which deliver the message, and symbolic systems, which involve cognitive processing. Most computer-based health education

programs implement a symbol system, either verbal and/or visual, in a way that does not differ from traditional approaches used by, for example, television or video programs.

Kozma (1991) reviewed various media and described their distinctive characteristics. These include (a) books, whose main characteristic is their stability (allowing learners to go back and forth to review information) as well as the fact that they can be enhanced by pictures; (b) television, which features systems of transient symbols; (c) computers, the prototypical information processors; and (d) multimedia, which bring together in a single instructional environment the symbolic and processing capabilities of many other media. Kozma presented studies on each one of these media to demonstrate their influence on learning. He concluded that in these studies, learning was actually influenced by the methods used, but this was because they took advantage of the particular capabilities of the medium to complement learners' skills and prior knowledge. There is also a lesson to be learned here in health education. The limitations of traditional program planning and evaluation schemes make it difficult to take full advantage of computer and multimedia capabilities and the new instructional strategies they enable.

Another subject of debate is related to the factors that facilitate computer and multimedia learning. Kozma (1991) described the learner as actively collaborating with the medium to construct knowledge. In this process, the learner takes information from the environment and integrates it with information already stored in memory to create new knowledge. Kozma concluded that the described learning process is sensitive to or can be influenced by certain factors, such as the characteristics of the external environment, the way the information is structured, and its accessibility. In summary, the actual effect of a medium on learning depends to a large degree on the characteristics of the learner, how the specific capabilities of a medium correspond to a particular learning situation, and how these capabilities are used in the instructional design.

This concept was also sustained by Salomon (1983), who argued that learning depends on how the person

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perceives the source of information. This perception influences the amount of invested mental effort expended in the learning process. The amount of invested mental effort reflects cognitive as well as motivational attributes. Salomon discussed what he referred to as *perceived demand characteristics* and argued that although the nature, complexity, novelty, and pace of stimuli affect learning performance, the individual's perception of the difficulty of a medium is also a key factor in how the information is treated, as is the effort dedicated to processing that information. Thus, perceived demand characteristics affect learning, and the learning effect of a particular medium depends on how the learner perceives the effort it demands. A second factor discussed by Salomon was Bandura's (1977) self-efficacy, which he directly related to effort investment.

From a practical point of view, these concepts should be taken into account when both planning and evaluating programs. Before deciding on the medium for delivering the educational message, practitioners should assess the participant population. Computers may not be an appropriate educational medium for population groups that are not familiar with new technologies and/or do not perceive them as being educational. The perceived stereotype of the medium could affect willingness to invest time and effort in the learning process as well as expectations. These may affect learning, skill development, and ultimately, behavior change (e.g., television is generally perceived as being noneducational and "easy," whereas print is perceived as educational and "hard").

Another of the most relevant issues in computer and multimedia learning is how humans process information in dual presentation modes. In other words, how do they handle auditory and visual information? Are auditory and visual inputs processed and stored separately, or are they competing for the same cognitive resources? Should the information be presented separately or simultaneously? Baggett (1989) proposed that in a dual-medial presentation, auditory and visual information are handled separately through two different processing units. Because there are two separate processing units and there is no competition for resources, dual information should be more effective in communicating information. Paivio (1990) proposed a dual coding theory that could, in Baggett's terms, be described as a dual processing–single storage model. Dual coding theory postulates the existence of two independent systems for the processing of verbal and nonverbal information. These two systems can process verbal and nonverbal information simultaneously and independently, which can result in an additive learning effect when referential connections between the verbal and the nonverbal information are constructed by the learner. Dual coding theory also grants a key role to environmental factors (perceptual, affective, and behavioral knowledge) and argues that mental representations have their developmental theoretical origin in perceptual, motor, and affective experiences. Without denying the brain's

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innate capability to generate, manipulate, and transform images of objects, the assumption is that these processes depend more on perceptual-motor experiences.

The application of these concepts in the design of health education software and Internet-based programs would be expected to be a subject of study in health education research. Several multimedia studies indicate that recognition accuracy and learning levels are improved when the information is presented combining text and pictures (verbal and nonverbal channels) or audio and pictures (verbal and nonverbal channels) compared with the same content presented via text alone (verbal channel), audio alone (verbal channel), or picture alone (nonverbal channel) (Najjar, 1996). For health education, the question to be answered is whether these particular features not only improve learning but also provide the perceptual, motor, and affective experiences that facilitate behavioral change.

Another question that researchers are trying to clarify is under what conditions multimedia learning is effective. According to Mayer (1997), multimedia learning occurs when learners construct and coordinate multiple representations (verbal and visual) of the same material. He presented research studies to support the idea that coordinated visual (images) and verbal (narrations) explanations increase the learner's ability to produce more creative solutions. Because scientific understanding requires a mapping between words and pictures at the time of encoding, appropriate coordination of verbal and visual explanations is a key factor for enhancing learning (Mayer, 1997; Plass, Chun, Mayer, & Leutner, 1998). Another key factor is what is called the Attribute \times Treatment Interaction, which means that the effect of a treatment depends on the characteristics of the learner (Mayer, 1997; Plass et al., 1998). For example, high-spatial ability learners are expected to learn better when visual information is available to them. Similarly, high-verbal ability learners are expected to learn better when verbal information is available. In multimedia and com-

puter learning, a lack of consistency between personal cognitive style and instructional method can inhibit the learner's transformation of knowledge (Ausburn & Ausburn, 1978).

A final theory that should be mentioned is the cognitive load theory. The limitations of short-term memory have long been recognized as a confining factor in the learning process. Regarding the acquisition of new information, Sweller (1994) distinguished between two main learning mechanisms to reduce the cognitive load: schema acquisition and transfer of learned procedures from controlled to automatic processing. He argued that knowledge acquisition is heavily dependent on schema acquisition. A schema is a cognitive construct that organizes the elements of information according to the manner used and determines how the information is going to be handled. For example, the schema "computer" will organize an individual's different elements of knowledge about computers, which can range from a very complex system of elements in a computer expert to a very simple schema in a novice. This is thought to reduce cognitive load because short-term memory does not have to hold all the elements the person knows about computers. It simply has to hold one: the schema "computer." Automatic processing, Sweller's second learning mechanism, occurs when a skill becomes automatic and requires minimal thought for its operation; that is, it occurs without conscious control. This too will result in reduced cognitive load as the individual does not have to consciously execute procedural knowledge to complete the task. Sweller contended that instructional techniques that are not consistent with the two described learning mechanisms are limited and defective. He differentiated between extraneous cognitive load (imposed by instructional techniques) and intrinsic cognitive load (imposed by the material itself and the degree of element interactivity). Sweller's concepts could constitute vital aspects of the design process of health education computer-based programs. Relevant information that must be understood (rather than merely learned) should consist of materials with a high degree of element interactivity and simplicity. That is, it should be written using coherent language and a simple format that does not require learners to go through complex menus and multiple screens to retrieve unknown concepts from other sources to understand the information. On the other hand, programs aimed at modifying other enabling factors, such as skills, may need a higher degree of sophistication and complexity and take advantage of the full spectrum of multimedia capabilities.

► FROM THEORY TO PRACTICE

Multimedia is the use of text, graphics, animation, pictures, video, and sound to present information. In general, the literature supports well-developed, computer-based multimedia applications for improving learning. The challenge for developers of health educa-

TABLE 1
Assessing Computer-Based or Multimedia Health Education Programs

Ways Programs May Be More Effective

- Take full advantage of computer and multimedia capabilities by providing choices that support different abilities, cognitive styles, and learning preferences
- Distinguish between media, which deliver the message, and symbolic systems, which involve cognitive processing
- Reduce cognitive load by removing redundant information and simplifying instructional tasks
- Allow participants the freedom to choose any combination of media input
- Present visual and verbal concepts in a coordinated manner
- Include evaluation approaches that are consistent with the type of information and the system used for presenting it (information presented verbally should be evaluated using a verbal learning test rather than a pictorial recognition test)
- Combine educational technology and health education theory

tion programs is to incorporate the current body of research into appropriate designs. For practitioners, understanding the basic principles of multimedia learning theory will facilitate the selection of programs with increased probability of success. Table 1 includes a checklist for assessing computer-based programs.

From a practical viewpoint, the key is to present learning environments that facilitate the interaction between the program and the learner in any way that will support the learner, allowing for full use of his or her personal resources. The most important design decision is to provide choices to every learner. For example, the splash page of a youth tobacco education program may include a picture of a nationally recognized female soccer player and a written message reading "Most youth don't smoke." The start screen is simple, and the problematic situation is delivered through a clear social norms message that simultaneously combines both pictorial and verbal information. This should facilitate the engagement of people who prefer to scan first and then select where they want to go next. In addition, several options are presented: video clip, text descriptions, or narratives. Choosing the video icon that appears beside the picture is an option that allows the user to advance to a second screen and watch a movie clip: The clip features the soccer player interacting with other youth in a smoke-free environment as she provides further arguments on the same message. The interface allows the interactive user to play, replay, forward, and rewind the movie, turn the sound on and off, and go back and forth between screens. At any time, the user can request a verbal note or comment on what is being said. On every screen, the user is presented with the option of selecting

a site map or a pull down menu, which will lead him or her to explore other tobacco-related topics. The user can also select options to read and/or hear about smoking statistics, cessation, the tobacco industry, support groups, local resources, and so on. This design supports different cognitive styles: A serialist user might prefer a table of contents or index, whereas a holist might prefer a visual site map. If the user selects cessation, for example, a pop-up window takes him or her to an age-appropriate interactive game that first identifies the stage of change of the user. If this stage happens to be action, for example, the game asks the user to say or type the reasons why he or she wants to quit, to select a quitting day, and so on. If the selection is tobacco industry, a different game helps the user develop media literacy skills by choosing between text description, animation, or still images describing the industry's advertising tactics, and so on. Every screen offers different alternatives and learning approaches for the interactive user. However, if action is not taken within a certain period of time, a pop-up window takes the youth through a programmed screen-by-screen sequence that requires minimum previous experience and interactive skills. This accommodates the preferences of more passive users or of those who are not familiar with multimedia and computer technologies. At the very beginning, users are invited to select a language, which not only allows them to follow the program in the language of their choice but also takes them through a culturally appropriate program. The price tag of developing a program such as the one described may be high, but it is not as costly as developing one by one all of the many programs and options included within it. In addition, a computer- or Web-based program will save on paper, media, reproduction, and distribution.

In general, computer-based multimedia applications can improve learning when they present closely related verbal and pictorial information together and build on tasks that require integration of information just acquired. This can best be achieved when considering the characteristics of the (a) materials to be presented, (b) learner, and (c) learning task (Najjar, 2001). These are summarized in Table 2.

From this perspective, constructivism may offer a more consistent approach to multimedia learning. However, as each individual is responsible for the construction of knowledge, the challenge for designers of computer-based health education programs

TABLE 2
Designing Evidence-Based Multimedia Interfaces

Characteristics

Materials

- Use the symbol system that best communicates the information.
- The auditory system is better for communicating small amounts of verbal information that need to be remembered for short periods of time.
- Text is better than sound when communicating verbal information that must be retained for longer periods of time.
- Pictures are generally better than verbal instructions for communicating spatial information but should not be used to communicate abstract concepts.
- Use multimedia rationally.
- Multimedia should be a supportive not a decorative tool.
- Adding closely related illustrations that support verbal information improves learning performance.
- Adding unrelated illustrations to verbal information does not improve learning and may actually interfere with the learning process.
- Synchronize pictorial and verbal information.
- Pictorial and verbal information should be presented together.
- Make the best use of interactive capabilities.
- Allow learners to control and manipulate materials.
- Avoid text-only screens.
- Periodically challenge the learner to integrate the information.
- Simple "right" and "wrong" feedback does not facilitate learning.

Learner

- Use multimedia particularly with new learners.
- Multimedia may be particularly useful for learners with low prior knowledge and low aptitudes in the domain being presented.
- Present the information in a way that motivates learners.
- External rewards such as extra points or grades may affect what people learn but not how well they learn.
- Rather than providing external rewards, improve learner internal motivation by relating the content and objectives of the instruction to the needs and interests of the learner.
- Using a personal rather than a formal style may stimulate learner interest.
- Consider the age group of the participant population.
- Older children and adults may be more suitable for multimedia learning.
- Younger learners may be distracted by the appearance of the medium, thus missing the meaning of the message.

Learning task

- Use multimedia to focus learners' attention.
- Combining small chunks of textual and graphical information may improve learner attention.
- Encourage learners to actively process the information.
- Simple repetition of information does not encourage active learning.
- Reading a text rather than simply listening to a verbal narration may facilitate active processing.
- Challenging the learner to use the information just learned may encourage active learning.

SOURCE: Adapted from Najjar (2001).

is to determine a common set of outcomes and ensure that they are met. According to current multimedia theory, learning environments should

1. include multiple representations of reality, avoiding oversimplification and representing the natural complexity of the world;
2. contextualize materials by presenting the learner with authentic tasks;
3. provide practical, real-world examples and case-based learning environments rather than predetermined instructional sequences;
4. enable knowledge construction by providing context- and content-dependent instruction;
5. encourage reflective thinking; and
6. support construction of knowledge through collaboration between participants rather than competition between them.

Constructivist approaches can best be designed by taking full advantage of computer and interactive capabilities. Hypertext and hypermedia are two of the most unique and useful tools of constructivist design as they allow for branched and flexible formats rather than linear and closed designs of instruction.

► CONCLUSIONS AND RECOMMENDATIONS

Computer and multimedia programs constitute a valuable tool for health education. To take full advantage of new technologies, health education must be consistent with its traditional multidisciplinary focus and incorporate educational and instructional theory, research, and practice. Only when the existing body of research from these fields is considered in the design of computer-based health education programs will we be able to implement interventions with enhanced probabilities of being effective.

Educational research and multimedia learning have made considerable progress during the past two decades and have contributed to the appropriate use of new technologies for educational purposes. Without compromising its basic principles, health education should allow itself to be informed by multimedia literature and seek ways to adopt models that take advantage of new developments and facilitate a more comprehensive approach to health education. Educational theory and multimedia learning research have much to offer. As with health behavior theory, the basic theoretical concepts behind these disciplines provide a friendly framework for developing programs that are potentially more attractive to learners. Whether the purpose of a program is to increase knowledge, develop skills, or modify behavior, educational and multimedia theories can assist in developing concepts, organizing ideas, and outlining program components.

By incorporating educational and multimedia theory into practice, health education would not be renouncing its theoretical foundations. It should not be difficult to establish a middle ground where theoretical concepts from all these disciplines can be applied. For example, health behavior theory is the appropriate framework for deciding the content and approach of a computer-based

health education program, whereas multimedia learning serves as the guiding principle for its electronic format. Both the implementation and evaluation of the program could easily adopt a combination of models from health behavior, educational theory, and technology learning theory. Only when we consider such combined approaches will we be able to take full advantage of new technologies in health education.

Finally, health education research needs to integrate existing education and technology learning research in a way that facilitates practice and provides answers to the challenges faced by health educators in their day-to-day tasks. This will greatly contribute to the widespread use of effective computer programs in health education. For example, understanding educational psychology theory could assist health education in developing multimedia programs for more diverse populations. Field dependence is a reflection of individuals' cultural values, and groups that emphasize traditional social values are more field dependent. A multimedia program directed toward Mexican Americans with strong traditional social values may be enhanced by incorporating a global perspective that avoids detailed explanations that would make it attractive to the more "analytic mentality" of the Anglo population. Similarly, although hyperlinks allow for learner control and are a key component of constructivist learning, they may be overwhelming to people who are not familiar with computers. Developing programs with a "one size fits all" mentality would be a mistake. The advantage of multimedia, as the memory and speed of personal computers improve, is that all these options can be made available with the click of a mouse.

The use of multimedia for delivering health education to diverse populations constitutes a promising area of study. It is just one example of the potential of computer technologies and multimedia applications for contributing to health education research and practice.

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