

Educational Characteristics of Multimedia: A Literature Review

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The use of multimedia technology has offered an alternative way of delivering instruction. Interactive multimedia learning is a process, rather than a technology, that places new learning potential into the hands of users. Information on the design and use of multimedia characteristics are not available as a coherent body of literature. Educators should have access to appropriate ways to design software packages that will take advantage of multimedia capabilities without losing the focus on the user's needs or the content being presented. The scope of this paper is limited to a review of research on educational multimedia features used for instructional purposes. In this article the effects of (a) screen design (visual elements: color, text, graphics, and animation), (b) learner control and navigation, (c) use of feedback (d) student interactivity, and (e) video and audio elements on the development of educationally effective multimedia modules are examined.

As electronic information technologies are being transformed from expensive, exotic gadgets into standard classroom equipment their extraordinary multimedia capabilities are rapidly becoming a routine part of many learning environments (Slawson, 1993). The old text based approach to learning is being superseded by an approach which combines audio and color video in a much more exciting way (Barker & Tucker, 1990). Interactive multimedia is one of the most promising technologies of the time and has the potential to revolutionize the way we work, learn and communicate (Macromedia, 199; Staub & Wetherbe, 1989). Interactive multimedia programs take the idea of learning and doing, not simply watching. With interactive multimedia programs the learning process becomes active, not passive, and it ensures that users are doing, not simply watching. True interactivity implies that the learning process is, in some degree, modified by the actions of the learners, thus changing the roles of both the learner and the teacher (Barker & Tucker, 1990; Slawson, 1993). Interactive multimedia learning is a process, rather than a technology, that places new learning potential into the hands of users.

Brooks (1993) states that, with all the additional capabilities of the growing number of multimedia applications, the design of these applications has become a nightmare. He listed ugly screens full of multiple fonts, insignificant boxes, irrelevant noises, and confusing webs of possible interactivity among the features of poorly designed multimedia packages. Educators should have access to appropriate ways to design software packages that will take advantage of multimedia capabilities without losing the focus on the user's needs or the content being presented. In the past many articles have limited recommended guidelines to a single multimedia feature requiring an educator to search many references to obtain a complete understanding for the design and development of entire multimedia packages. The scope of this paper is limited to a review of research on numerous educational multimedia features used for instructional purposes. In this article the effects of (a) screen design (visual elements: color,

text, graphics, and animation), (b) learner control and navigation, (c) use of feedback, (d) student interactivity, and (e) video and audio elements on the development of educationally effective multimedia modules are examined.

INSTRUCTIONAL DESIGN

Sponder and Hilgenfeld (1994) reported that most experts advise teachers to make their multimedia software interactive, motivating, and relevant, with plenty of action and novelty. These generalities are insufficient guidelines for educators. Strategies exist that provide better guidelines.

Gagne's (1985) nine events of learning, first applied to teaching concepts to humans, serve well as a framework for the successful development of educational multimedia modules (Hannafin & Rieber, 1989; Reeves, 1986; Sweeters, 1994). The nine events include (a) gaining attention, (b) informing the learner of the lesson objectives(s) and activating motivation, (c) simulating recall of prior learning, (d) presenting the stimulus material, (e) providing learning guidance, (f) eliciting performance, (g) providing feedback, (h) assessing performance, and (i) enhancing retention and learning transfer. Gagne's nine events have been recommended, in one way or another, by a multitude of multimedia researchers (Reeves, 1986; Sponder & Hilgenfeld, 1994; Sweeters, 1994). Many of the multimedia features correspond to Gagne's events and represent the functions performed by instruction that support the internal learning process (Gagne, 1985).

SCREEN DESIGN

Screen design is an issue of great importance for multimedia developers in many different content areas. Mukhedee and Edmonds (1993) broaden the traditional definition of screen design to include the coordination of textual and graphic elements to present sequenced content in order to facilitate learning. While specifics of the content may vary from one situation to the next, each instructional screen in a multimedia package must provide effective instruction, appropriate navigation tools, and visual aesthetics (Milheim, & Lavix, 1992), regardless of content. An environment which adheres to aesthetic principles may do much to enhance the learning experience (Haag & Snetsigner, 1993). In addition, the quality of the design of elements on the screen may lead to improved performance by sustaining the interest of the viewer (Faiola & DeBloois, 1988). Screen design plays the same role as "gaining attention" in Gagne's events of instruction model. It serves as the internal cognitive structure that prepares the stage for learning, orienting the learning to the objectives and stimulating the recall of previously learned information (Taylor, 1992). Screen design has a crucial role in the delivery of information to the learner (Haag & Snetsigner, 1993). Well designed screens should allow for maximum learning from the materials while providing the learner with appropriate control of the learning process (Milheim & Lavix, 1992). Effective screen design causes learners to develop and maintain interest in lesson content, promotes the engagement of the learner with the material, and facilitates deep processing of important information (Faiola & DeBloois, 1988; Hannafin & Hooper, 1989; Milheim & Lavix, 1992; Sponder & Hilgerifeld, 1994). Screen designs should aid the user in the complex process of taking the information out of the program and integrating it into his or her own conceptual knowledge base (Jones, 1995), providing cognitive benefits in the user's ability to perceive, organize, and integrate information (Hannafin & Hooper, 1989).

For effective learning, screen design decisions should reflect balance among learner attributes, content factors, and processing requirements of the learning task (Hannafin & Hooper, 1989). All visible aspects, including the design and location of text, the graphics frame

protocol, and various cosmetic application methods are considered relevant screen design factors (Hannafin & Hooper, 1989). The primary recommendation is to keep the screen as simple and uncluttered as possible because presenting too much information at one time can be confusing and overwhelming (Orr, Golas, & Yao, 1994; Overbaugh, 1994; Rambally & Rambally, 1987).

Ipek (1995) claims that information in some multimedia software is presented in a format that must be read. Reading speed and reading rate are important learner characteristics to consider in the development of multimedia modules. Hannafin and Hooper (1989) reviewed the literature about screen design and found that text is read more slowly and comprehension is lower when it is read from the computer screen rather than from print based media. People read text on a computer screen at a rate 28% slower than reading from a book. It is recommended that developers utilize as many screens as needed and not fill individual screens with text information.

Many researchers have recommended displaying relevant information in chunks using screen buildup or window overlays (Ipek, 1995; McFarland, 1995; Orr et al., 1994) and limiting the quantity of information presented to a few items per screen. Chunking separates a sentence into phrases or idea units. According to Hannafin and Rieber (1989), the use of indentation, leading sentences, and text chunking strategies appear equally valuable for both print and computer display. Strickland and Poe (1989) recommend phrasing text carefully and limiting it to no more than three lines per screen, whereas McFarland (1995) contended the exact amount depends on the age and grade level of the learners.

Well designed screens should visually stimulate, be easy to read, and exhibit no annoying or distracting features (Strickland & Poe, 1989). Generally, it is suggested that no more than two or three types and sizes of fonts be used per screen. However Bailey and Milheim (1991) suggested that only one font per screen be used unless certain material needs to be emphasized. In this case, varying the size and font of text can be used to attract attention (Garner, 1990). Often sans-serif fonts work better on the computer screen than serif fonts (Poncelet & Proctor, 1993). Highlighting of text helps to control selective perception and focus attention on identified information (Hannafin & Hooper, 1989). Flashing is distracting and, because it makes text difficult to read, should never be used for text presentation (Jonassen & Hannum, 1987). Titles and headings should be centered Educational Characteristics of Multimedia: A Literature Review (Orr et al., 1994), while text should be left justified and mixed with upper and lowercase letters for higher legibility and faster reading (Gamer, 1990). The use of graphics instead of text is also recommended when possible (Strickland & Poe, 1989).

Another important aspect of screen design is the location of various components on each screen (Milheim & Lavix, 1992) and the consistency of those locations throughout a program. Certain parts of the screen should be associated with specific tasks such as titles or headlines, operational instructions (navigation buttons), feedback, input/output, and areas for help or a glossary (Faiola, 1990; Rambally & Rambally, 1987). In other words, for various purposes within the program there should be consistent, functional screen areas that vary only slightly from one screen to another as a student goes through the module (Hazen, 1985). Rambally and Rambally (1987) suggest the following guidelines with regard to content of screen information: (a) place questions and important messages in central part of the screen, (b) provide key information at prominent locations, (c) provide critical information at the beginning of a message, and (d) place prompts or navigational buttons at the bottom of the screen.

In summary, screen design seems to be guided by principles derived both from research and commonsense heuristics. Good screen designs are expected to fulfill a number of requirements: (a) focus learners' attention, (b) develop and maintain interest, (c) promote

processing, (d) promote engagement between the learner and lesson content, (e) help learners find and organize information, and (f) facilitate lesson navigation (Grabinger, 1993; Hafinafin & Hooper, 1989; Mukhedee & Edmonds, 1993).

INTERACTION AND FEEDBACK

John Sculley (1993), former chairman and chief executive officer (CEO) of Apple Computer Inc., states that multimedia allows for individualized learning, making students active participants in the instruction learning process. By enabling the individual to interact With and control the flow of information with the computer, interactive multimedia distinguishes itself from older multimedia formats such as books and video. Learners must process information actively in order to comprehend and remember it (Ausubel, 1960; Weller, 1988).

Interaction is the major difference between traditional instruction and instruction delivered by multimedia (Sclwier & NEsanchuk, 1993). Interaction is commonly viewed as stimulus response reinforcement encounters action is an integrated form of between the learner and instruction. Intera two of Gagne's events of instruction, eliciting and assessing performance. Schwier and Misanchuk (1993) cite examples of behavioral orientations to instructional interaction: designer imposed pacing, overt responses, immediate feedback, knowledge of results, controlled sequencing, small step size, promoting, and confirmation. Hannafin (1989) promotes cognitive engagement in interactive multimedia through the use of fault free questions, queries, real time responding, note taking, predicting/hypothesizing, hypertext, and cooperative dialogue.

Interactivity, actualized through intentional selection of information, can positively affect learning (Wittrock, 1974). This means incorporating strategies that cause the learner to code, organize, integrate, elaborate on, or transform information. Weller (1988) states that an instructional software program should be designed with specific learning outcomes in mind. The instructional events of the lesson, with which the learners must interact, should be based on a model of events of instruction that are related to a known organizer for their thinking similar to Gagne's nine events of instruction.

Research has shown that it is important to design as much meaningful interactivity as possible into multimedia software (Hannafin, 1989; Schwier & Misanchuk, 1988). Orr, Golas, and Yao (1994) give the following guidelines for increasing interactivity in multimedia programs:

- 1. Provide opportunities for interaction at least every three or four screens or, alternatively, about one per minute.*
- 2. Chunk the content into small segments and build in questions (with feedback), periodic reviews, and summaries for each segment.*
- 3. Ask as many questions as possible without interrupting the continuity of the instructional flow. Ask a question after, but not immediately following, the related content. Ask students a question that they can answer based on previously learned knowledge. Ask students to apply what they have learned rather than memorize and repeat answers.*
- 4. Use rhetorical questions during instruction to get students to think about the content, to stimulate student's curiosity, and as a natural transition between frames.*
- 5. Consider designs where the learner is not presented with information in a linear format, but rather discovers information through active exploration in the program.*

Feedback is information about the appropriateness of the learner's response that is given to the learner by the courseware (Poncelet & Proctor, 1993). According to Clariana, Ross, and Morrison (1991), feedback is an important variable that is often ignored in multimedia software. Feedback can be defined as output, usually displayed on a screen, to tell students how successful they have been in solving problems or to provide information about the quality of their response to a test like event. Gagne described his seventh event of learning as "providing feedback about performance correctness" to establish reinforcement of appropriate performance and prevent further inappropriate performance (Reigeluth & Curtis, 1987). Several factors can determine the effectiveness of feedback. Examples include the type of feedback given, the frequency of the feedback, and the delay between the feedback and the instruction (Jonassen & Hannum., 1987). Feedback should provide occasional motivational messages, as well as information about the correctness and/or appropriateness of the response. The challenge is to try to anticipate typical mistakes the learner might make and then create a feedback segment which mimics how a good instructor would respond in each case.

Feedback is a method to reinforce, elaborate, and clarify. However, Park and Hannafin (1993) state that feedback can narrow the learner's focus to only the content covered in the question feedback cycle. Feedback needs to emphasize information that is conceptually relevant than explicitly or absolutely "correct." Orr, Golas, and Yao (1994) give the following guidelines for feedback:

- 1. Keep feedback on the same screen with the question and student response.*
- 2. Provide feedback immediately following a student response.*
- 3. Provide feedback to verify the correctness. For incorrect responses, give the student a hint and ask the student to try again.*
- 4. Tailor the feedback to each learner's response.*
- 5. Provide encouraging feedback; however, do not provide the type of feedback that may encourage a student to make an incorrect response on purpose just to see the feedback.*
- 6. If possible, allow students to print out their feedback.*

NAVIGATION

Learners become easily confused and disoriented in complex interactive multimedia modules (Beasley & Lister, 1992; Tripp & Roby, 1990). Search (1993) indicates a need to develop interfaces with orientation cues that help users navigate through large multimedia databases. Navigation and management features serve to enhance learning and make an interactive multimedia module easy to use (Kensworthy, 1993; Schwier & Misanchuk, 1993). Navigational elements give a program structure, perform housekeeping chores in the program, and provide the learner some control over events (Schvier & Misanchuk, 1993).

Clearly defined procedures for navigation should be provided within the system and for accessing on line support (Park & Hannafin, 1993). Navigational item location should be consistent throughout a program so a student does not have to search for the buttons (Hannafin, 1984; Milheim. & Lavix, 1992). A screen design template should be established and used consistently. Kensworthy (1993) stated that keeping the keys in the same locations throughout a program helps to build confidence in the learner.

While specific options can vary significantly from one program to the next, an effective screen design often includes buttons or hot spots to quit the program or to access die next screen, previous screen, help screens, glossary, and main menu (Milheim & Lavix, 1992). A navigational control panel can be a useful device (KensworLhy, 1993). This often appears as a

small control panel positioned at the bottom of a screen display (Garner, 1990; Isaacs, 1987). To give more complete control of the program to the learner, carefully selected words or icons should be used with navigational keys in the program. Universal icons like play, stop, and pause for video or audio clips should be used when possible (McFarland, 1995). Users recognize these icons and associate them with something they already know, rather than having to learn new, abstract concepts. (Gurak, 1992).

Within an interactive multimedia module, one button is often used to access a progress chart or map showing a student's location in the program (Milheirn & Lavix, 1992). This map serves as a table of contents for the entire program and provides an opportunity for students to jump to new sections or revisit information from an earlier screen (Search, 1993). A representation of the map is usually in the form of a tree structure, showing the current location of the learner and its hierarchical association with the rest of the program. A very useful control device for interactive programs is a global escape routine or exit button. The escape routine is designed to allow the learner to exit the program at almost any point.

Help segments offer additional information which embellishes ideas originally presented in the core instruction. They include some background or detail that most learners will not need (Schwier & Misanchuk, 1993). By clicking or touching a target, the learner is given access to elaborative or tangential material, permitting the learner to follow interests and construct his or her own learning experience.

Poncelet and Proctor (1993) stated that good courseware, in addition to the delivery of text and graphics to appropriate areas of the screen, should promote learner interactivity by always providing access to some or all of the options; found in Table 1.

Table 1

Poncelet and Proctor's Guidelines for Interactivity

Content Icons:

- Help key to get procedural information.
- Answer key for answering a question.
- Glossary key for seeing the definition of any term.
- Objective key for reviewing the course objective being worked on.
- Content map key for accessing an overview map of the content in the course or lesson.
- Options key for seeing a list of learner commands or options available to the learner.

Navigational Icons:

- Overview of instruction key for reviewing the introduction to the unit.
- Previous frame or next frame key for moving forward or backward in a lesson.
- Test key for letting the program know when the learner is ready to take a test.
- Next lesson key for accessing the next lesson in a sequence.
- Menu key for exiting the lesson and return to the menu.
- Exit key for exiting the course.

Analysis Icons:

- Summary key for seeing the summary or conclusions of the lesson.
- Review key for reviewing parts of the lesson
- Common key for recording a learner comment about the lesson.

- Example key for seeing examples of an idea.

The appropriate combination of icons will depend upon the needs of the designer and the learner. The navigational bar containing the icons should be placed at the bottom of the screen and the location of the icons should remain constant (Hannafin, 1984) throughout the multimedia module.

LEARNER CONTROL

The topic of learner control is central to the design of interactive in instruction. The term learner control has been defined and used in a number of ways in the literature, including content to learn, context within which to learn, method of presentation, provision of optional content, sequence in which to learn, amount of practice to undertake and or the amount of time devoted to practice items, and the level of difficulty of the instruction and or exercises (Overbaugh, 1994; Schvvier & Misanchuk, 1993). Greater control over the learning event promotes satisfaction. Consequently, students feel more responsible for their own learning process (Miller, 1990). Prior knowledge, learner ability, the use of structural guidance, and procedures for monitoring lessons all influence the effectiveness of learner control environments (Hannafin, 1984).

Overbaugh (1994) indicates research findings are not conclusive that students in control of their instruction will achieve higher results. Although the findings are inconsistent, learner age and ability have been found to affect the extent to which learner control strategies can be effectively applied (Hannafin, 1984). Older students and more able students perform more effectively under *guided learner control*; younger and less capable students perform best under *lesson control* (Hannafin, 1984). Hannafin stated,

"guided learner control is demonstrated in lessons where individuals control the path, pace, and/or contingencies of the instruction, typically by specifying choices among a range of designer embedded options. Lesson learner control is defined as instruction in which all learners follow a predetermined path established by the designer without exercising individual judgements as to the appropriateness of the path." (p. 6)

Low ability students are especially confused when control depends on a wide range of options. They do not have the mental models and schema necessary to investigate a program efficiently and effectively (Litchfield, 1993).

Laurillard (1987) suggests that learners should be given more control over the content, access to the content, and interaction with the multimedia content. One way multimedia can give control to the learner is by providing the ability to navigate through programs at the learner's own pace and ability level (Sponder & Hilgenfeld, 1994). One student may learn all the intended information rapidly and never need to branch for review or remediation (Hannafin, 1984), where others will want to review previously presented material. It is suggested that complex programs should advise students about the sequencing (Hannafin, 1984; Jonassen & Hannwn, 1987; Litchfield, 1993) and provide some form of coaching to assist learners in making informed decisions (Hannafin, 1984). Litchfield (1993) states that students feel more confident with advice about control selections because it helps them make better choices.

Instructional components should be clearly identified and separated to facilitate learners' selection and sequencing according to their needs and interest (Overbaugh, 1994). One way this can be accomplished is by the use of menus. A menu offers several choices for instructional segments, and the viewer is permitted to select topics for presentation or skip over

topics (Schwier & Misanchuk, 1993). Limiting the number of choices on the screen helps direct the learner to the appropriate path, yet still providing the learner with control of the lesson. Pop up windows in conjunction with menus can provide learners with expanded clarifications, enabling the learner to make informed selections. The use of pop up windows with icons can farther explain the use of the icon. While hierarchical menus provide access to various types of information, the use of numerous menus embedded within other menus can create potential problems for users who may lose their place within the overall structure. It has been suggested by Schwier and Wisanchuk (1993) that users may need an icon to access a map that will reveal the path which they have forgotten. Orr, Golas, and Yao (1994) have compiled the following learner control guidelines:

- 1. Provide the learner control of the sequence when (a) lengthy instructional sequences must be completed by the student in no specific order, (b) students are familiar with a topic and are able to make appropriate sequence choices, and (c) the training is for cognitive strategies or higher order problem solving tasks.*
- 2. Do not provide sequence control to students in a situation where the materials have a specific prerequisite order.*
- 3. Provide learner control of content when (a) students have significant previous knowledge of the content; (b) students have higher ability; (c) there is a high probability that students will succeed in learning the content regardless of the chosen content; (d) cognitive strategies and higher order problem solving are being taught; (e) the skills are not critical, the training is optional, and student motivation is high.*
- 4. Do not provide full learner control of content when all topics in the instructional presentation are required for successful completion of the program and there is a hierarchical order to the materials.*

Jones (1995) has intertwined the concepts of screen design and learner control. Jones also recommends a screen design environment where students may browse, allowing for the flexible exploration of the content. Browsing can be done by providing users with a list of the topics covered in the program through the use of a menu, list of navigational and informational choices, and with content search glossaries. The glossaries allow users to browse through the use of terms entered on the keyboard, or clicking on "hot words." Sweeters (1994) refers to hot words as a collection of textual information on a specific topic featuring the highlighted words that can be activated by touch or mouse click. When the word is activated the user can branch to additional information such as definitions, elaboration, or related material. Browsing can also be invoked from clicking on an area in a graphic or from a pop up menu. Jones provides the following guidelines for browsing:

- 1. Provide selectable areas to allow users to access information.*
- 2. Allow users to access information in a user determined order.*
- 3. Provide maps so that users can find where they are and allow provisions to jump to other information of interest from the map.*
- 4. Provide users with feedback to let them know that they must wait when significant time delays are required for the program to access information.*
- 5. Provide users with information that lets them know that they are making progress.*
- 6. Arrange information in a non threatening manner so that users are not overwhelmed by the amount of information contained in a program.*

7. Provide visual effects to give users visual feedback that their choices have been made and registered by the program.

Exploration and discovery learning approaches have demonstrated educational worth in certain circumstances. However, multimedia researchers contend that very little learning occurs when students are left to explore information on their own with no guidance (Merrill, Li, & Jones, 1990).

COLOR

The use of color in multimedia modules can be effective, but also should be considered carefully. Color should be used sparingly, because the more color that is used, the less effective it becomes (Kanner, 1968). Color is most effective when used consistently for cueing and highlighting; it direct student attention to important points or relationships (Merrill, 1983; Merrill & Bunderson, 1979).

A consistent color scheme should be used for the entire presentation. A number of authors (Bailey & Milheim, 1991; Faiola, 1990; Faiola & DeBloois, 1988; McFarland, 1995; Milheim & Lavix, 1992; Orr et al., 1994) have recommended specific guidelines for using color. These recommendations include (a) using a maximum of three to six colors per screen; (b) being consistent in color choices within a program; (c) using it the brightest colors for the most important information; (d) using a neutral gray or pastels as a background, since it recedes optically; (e) using significant contrast between text and a background color to provide a higher degree of text readability; (f) always using dark letters on a light background for text; (g) avoiding the use of complementary colors (e.g., blue/orange, red/green, violet/yellow); and (h) using commonly accepted colors for particular actions (e.g., red for stop or warning, yellow for pause or consider, green for go or proceed). Very hot colors (such as pink and magenta) should be avoided since they may appear to pulsate on the screen.

GRAPHICS

Multimedia software can easily present information in either text mode or graphics mode, but, when possible, both should be used (Overbaugh, 1994). Students who do not understand information delivered by text quite often will understand it if it is presented or augmented by various visuals (Merrill, 1983). In particular, difficult topics sometimes become easier to understand when augmented by graphic displays (Gropper, 1983).

Photos and scanned images can be used to illustrate almost any fact, concept, or procedure (Sponder & Hilgenfeld, 1994). Learning tends to be strongest when pictures supply redundant information, supplement information that is unclear or incomplete, or supply additional coding stimuli (Jones, 1995; Park & Hannafin, 1993). Information presented in text is often better recalled and retained when supplemented with pictures (Hooper & Hannafin, 1988). Graphic icons or still photos can enhance menu screens by illustrating the menu choices. Kensworthy (1993) indicates that text based instructional strategies from books often reappear in the form of pictures or graphics in multimedia training. When freed from the constraints of text, questions often become more simulation oriented and focus on what the learner should be able to do with the information. Caution should be exercised when using graphics for decoration or cute effects; used in this manner, graphics can become tiresome and/or interrupt the flow of the lesson (Hazen, 1985).

Graphics are also used to represent icons and indicate to the user that a choice is available. Left and right arrows indicate that users may go to the "next" and "previous" pages; hooked

arrows indicate that a return to the previous menu is possible; question marks may represent the availability of on line help; and directional arrows may offer users the chance to see a map to help decide where they want to go.

ANIMATION

Most graphics or pictures can be animated to illustrate points, teach facts or concepts, motivate students, and demonstrate procedures (Sponder & Hilgenfeld, 1994). Animation can serve motivational and attention getting functions, but no extra learning effects can be attributed to the use of animation (Hannafin & Rieber, 1989). Animation is use , however, both for the explanation of dynamic processes and for heightening the impact of presentation. While research has shown no significant difference in the use of static graphics versus animation, it is generally recognized that the use of animation can offer many subtle benefits (Rieber, 1994) such as highlighting key information, heightening student interest, and facilitating recall (Orr et. al., 1994). When the animation is congruent to the learning task, it can offer instructional benefits to the learners (Rieber, 1990).

AUDIO

Many multimedia programs rely on text as a critical instructional component which poses difficulties for poor readers. Text based information is easy and inexpensive to develop and has minimal computer memory requirements (Kensworthy, 1993). Nugent (1982) found research that pointed out that audio has obvious advantages for presenting simple material to younger children with undeveloped reading skills. Orr, Golas, and Yao (1994) state that research data indicate that students find it easier to complete lessons which use audio extensively to present information. The combination of visual presentation with audio explanation delivers information in an easily understood format (Wright, 1993). For example, audio can be used to explain icon choices with the choices highlighted as they are explained. Audio could also be used to explain further the findings from x statistics screens that present a range of data in bar charts and pie graphs. Audio should be designed so that the learner can interrupt the audio at any time and continue the program. Whenever audio is used to support text, it is important to provide a way for the learner to pause or repeat the sound. Poor readers may want to go through a text passage more than once, or may want to pause the audio to study an unfamiliar word (Kensworthy, 1993).

Research reviewed by Ipek (1995) found that prerecorded readings of teacher-directed instructions in multimedia modules were effective because (a) they focused only on the most important information necessary for understanding the text, (b) they included direct and explicit instruction, and (c) students were familiar with this type of traditional. Orr, Golas, and Yao (1994) list the following recommendations for audio use in multimedia software:

- 1. Use audio for the primary presentation of the program content when the message is short, simple, and requires immediate student response or if the target audience has poor reading skills.*
- 2. Do not allow audio to interfere with reading from the text and vice versa*
- 3. Do not let audio compete with video presentation.*
- 4. Do not put a lot of text on a single screen. Research data indicates that students find it easier to complete lessons which use audio extensively to present information. Students generally prefer not to have to read long text passages on a screen.*

5. *If audio is used, provide students with headphones.*
6. *Tell the student only what is relevant. If the message is too long, break it into chunks separated by instructional activities.*

Orr, Golas, and Yao (1994) also suggest the following techniques for creating scripting narrations:

1. *Visualize the images that will be presented on the screen during the narration.*
2. *Use style and tone appropriate to students' language ability, subject matter, and knowledge and vocabulary.*
3. *Write the script for the ear and not for the eye.*
4. *Keep the language simple, use the active voice and be direct.*
5. *Watch out for acronyms, technical jargon, and unfamiliar terms.*
6. *Make the transition from one concept to another clear.*
7. *When possible, provide a corresponding visual for every piece of narration.*
8. *When using visuals, avoid long pauses in visuals while waiting for extended narration to finish.*
9. *Alternate male and female voices to provide variety and maintain audience attention.*

VIDEO

Motion video, including commercial tapes, movies, and home videos, is often a major element of interactive multimedia software, but computers need special hardware and/or software to display video. Video presentations are generated from video files that consume a lot more storage space than simple animations.

Taylor (1992) has recognized that video is not an ideal medium for presenting detailed material, but is better used for broader, abstract material, possibly with an emotional appeal. An abstract video segment may serve well as the medium for an advance organizer, and, similarly, for a lesson summarization. Hooper and Hannafin (1988) have found that media that employ both print and video are likely to result in deeper processing than a medium that employs just print. Taylor (1992) also reports that most learning occurs when audio and video are redundant, are synchronized with content, and repeat and reinforce the concepts being presented.

SUMMARY

Multimedia programs can be used to present information in many exciting ways by combining hypermedia techniques with instruction. Good presentations can be created when they are based on cognitive objectives that focus on the learning of topics at different levels of comprehension.

Grabinger (1993) states that there may be no way to ascertain to what degree a single multimedia component, such as graphics, menus, audio, and video, contributes to the amount of learning that occurs. There are three basic events that a designer can try to enhance: (a)

getting the learner's attention, (b) helping the learner find and organize pertinent information, and (c) integrating that information into the learner's knowledge structure. Rather than focus on individual text elements, multimedia producers should instead focus on arranging text, graphical, and audio visual elements in order to create organized, structured, and visually interesting screens.

Figure 1. Screen functional areas

Generally, the most useful way to organize components of multimedia modules is to organize the screen into functional areas as seen in Figure 1 (Grabinger, 1993; Mehlmann, 198 1). Designers should decide where status and progress information, navigational buttons, content display control buttons, and illustrations will be located and use graphic devices such as shading, lines, and boxes to separate one area from another. However, this strategy works best when consistency between screens is also practiced. The functional areas should appear in the same locations, and the devices used to define them should be the same throughout a program. When user expectations match the actions on the screen, the user can most effectively concentrate on the multimedia material rather than trying to figure out how the screen works. Generally, users prefer screens that use headings, provide directive cues, and position paragraphs to indicate the hierarchy of the content and to break the content into manageable chunks of information. This can be achieved by using headings as organizers and directive cues to point out important terms and phrases, by using increased spacing between paragraphs rather than traditional indentation, and by showing comparisons in side by side columnar arrangements.

Multimedia instructional packages become nightmares when designers try to dump anything and everything into a single program simply because the capability is there. Audio and video should be used only when they will enhance learning of the content; overuse of both can be distracting. Simplicity is one of the most important goals of interactive multimedia software design. Establish a background by consistently placing related elements of text, graphics, and navigational controls. Be consistent in the typeface, graphics, and labels. Save special effects for key moments of interaction, so that they will be noticeably different from the user's established expectations.

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