Educational technology. 39:19-26. 1999

Screen Design Guidelines for Motivation in Interactive Multimedia Instruction: A Survey and Framework for Designers

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The purpose of the study reported in this article was to identify the available guidelines for screen design that ,. would improve the motivational appeal of interactive multimedia for instruction, and organize those guidelines into a useful framework for application by designers of interactive multimedia instruction. Available guidelines for creating well-designed motivating screens in multimedia are poorly organized within the literature. Two primary types of guidelines were discovered-those aimed at enhancing motivation and those aimed at preventing loss of motivation. The authors call the first type of guideline "expansive," and the second "restrictive." The authors propose a framework for considering motivation in the process of designing interactive multimedia instruction, and speculate that instructional designers guided primarily by restrictive guidelines may be kept from discovering the strategies used by graphic designers, multimedia designers, and others in related disciplines to enhance the motivational aspects of screen design.

Screen Design and Motivation

The importance of motivational factors in the design of interactive multimedia has been recognized for some time, since software must be appealing to learners if it is to be effective (Jacques, Preece, & Carey, 1995; Keller, 1983; Keller & Kopp, 1987; Misanchuk & Schwier, 1995; Okey & Santiago, 1991; Rieber, 1994). Many learners are attracted to the novelty of interactive multimedia, at least initially, but if the motivational components of the design do not extend beyond the level of novelty, the learners' involvement does not persist long (Keller & Suzuki, 1988). Engaging, relevant interactions that foster confidence and produce satisfaction are the primary vehicles for augmenting learners' intrinsic motivation (Czikszentmihalyi, 1992; Keller, 1983, 1987), and the graphical nature of current interfaces for multimedia makes effective screen design an equally critical factor in producing effective interactive multimedia (Grabowski, 1991; Mukherjee & Edmonds, 1994).

Studies on human memory and message design consistently show that well organized material causes learners to develop and maintain interest in lesson content, promotes learner engagement with the material, and facilitates deep processing of important information better than does unorganized material (Cook & Kazlauskas, 1993; Faiola & DeBloois, 1988; Grabinger & Albers, 1988; Hannafin & Hooper, 19891. Well organized material also improves reading speed and comprehension, and effectiveness and efficiency of learning from multimedia software (Galitz, 1989; Hannafin & Hooper, 1989; Hathaway, 1984; Strickland & Poe, 1989). Skillfully designed screens for interactive multimedia are recognized to draw learners' attention, to motivate learners toward

interaction with the software, and to help learners accomplish learning goals without confusion and fatigue (Faiola, 1989; Galitz, 1989; Jacques, Preece, & Carey, 1995; Shneiderman, 1992), as well as to contribute to the quality and usability of interactive programs (Tufte, 1992).

Although the importance of motivational factors in screen design for interactive multimedia is recognized, many designers think of such factors late in the design process (Keller & Burkman, 1993) and may not have time during the development process to find appropriate guidelines in the literature. The purpose of the Study described here was to identify the available guidelines for screen design that would improve the motivational appeal of interactive multimedia for instruction, and organize those guidelines into a useful framework for application by designers of interactive multimedia instruction.

The Survey

The authors surveyed almost 100 sources (both books and articles) relating to screen design and design of interactive instructional materials, and selected 77 for the survey based on one or more of the following criteria:

- The author of the book or article listed explicit guidelines for screen design of instructional software.
- The author of the book or article listed explicit guidelines for the general design of visual interfaces.
- The book or article was referenced as the genesis for a guideline, or guidelines, by multiple authors (some of these gave guidelines for print materials which subsequent authors adapted to interactive media).
- The book or article gave some reference or rationale for the guidelines presented.

We recorded specific guidelines as they were encountered in these sources, then compared the individual guidelines independent of their original sources by means of a card-sorting activity. The purpose of this comparison was two-fold. First, we grouped and re-grouped the guidelines to discover a manageable number of categories in which we might discuss them, since the categorization of guidelines from one author to another varied considerably. During this phase, we eliminated any guidelines that were originally states! as specific advice regarding development of a single product rather than as general advice to developers of interactive multimedia. Second, we consolidated guidelines which were the same or similar into single statements. This sorting activity was conducted once by the authors, then again by an independent collaborator. Finally, we all met to resolve the few discrepancies between sorts. Sorting the guidelines resulted in creation of five categories based on the type of element to be designed: typography, graphical images, color, animation, and audio. An additional category emerged in which the guidelines are more properly called principles, since they do not imply specific actions with regard to design of individual media elements, but give instead a statement of effect for which the designer must strive using whatever specific means are appropriate. We call these guidelines "integrative."

Subsequent review of the categorized guidelines revealed additional distinctions between the types of guidelines within each of the six categories of guidelines. The first type is aimed at supporting intrinsic motivation or enhancing extrinsic motivation. The

second type is aimed at preventing the loss or degradation t. ~n of either intrinsic or extrinsic motivation. We call the first type of guideline "expansive," and the second type "restrictive." Guidelines for each category are listed based on the expansive and restrictive classifications.

The Guidelines

Typography

Typography, or the visual treatment of text, is the key element in text materials and in almost any well-designed table, chart, map, or diagram (Marcus, 1992). Text on screens has been found to be generally less legible than text on paper, but text display on a computer screen can be easy to read depending upon the font, the screen layout, and the contrast provided (Moose & Dwyer, 1994). Typography includes the selection of typeface, the placement of text in relation to the whole screen and in relation to other text, and the use of signals and cueing.

Signals (e.g., titles, headings, pre- and post-instructional strategies, such as preview, overview and summary, and typographical cues) are writing devices that emphasize aspects of a text's content or structure without adding to the content of the text and help readers identify specific points in a text (Golding & Fowler, 1992; Lorch, 1989). Signaling should serve to clarify content.

Typographical cueing, or the attachment of a specific meaning to a part of a text by displaying it in a way which is different from the rest of the text, is mainly used for accentuating single words, phrases or whole paragraphs (Nes, 1986). Cueing guides the construction and implementation of learner's prose-processing decision criteria (Glynn & Di Vesta, 1979).

Expansive Guidelines

- Use graphical fonts to catch a viewer's. attention because of their size and unusual shape, even if they may be less legible than normal fonts (Nes, 1986).

Restrictive Guidelines

- Be consistent in addressing textual cues and signals to the learner (Faiola, 1989). Consistency in typographic. signals and cueing can establish and convey a very clear visual message to the viewers that they are now reading a certain subject or section of instructional content.
- Use both upper and lower case letters (Apple Computer Inc., 1989; Faiola & DeBloois,1988). The legibility of text with letters in mixed case, i.e., with capitals only used for indicating the first letter of a sentence, a name, etc., is higher than for letters in upper case only (van Nes, 1986). All upper case characters should be used only occasionally, and for the purposes of emphasis (Strauss, 1991).
- Use high contrast between letters and background to improve legibility and readability (Isaacs, 1987; Pastoor, 1990; Reynolds, 1979; Rivlin, Lewis, & Davies-Copper, 1990).
- Left-justify text, but do not right-justify it (Garner, 1990). Limit text to approximately 65 characters per line, or a maximum of 8-10 words per line (Galitz, 1989, Garner, 1990). Increase the spacing between lines for long lines of text (Garner, 1990; Hartley, 199,0). ,

• Use highlighting techniques conservatively and carefully, since they are likely to attract the reader's attention (Apple Computer Inc., 1989; Galitz, 1989; Hartley, 1987; Heines, 1984; Isaacs, 1987; Rivlin, Lewis, & Davies-Copper, 1990). Underlining and blinking should only be used if they do not interfere with the legibility of the text (Heines, 1984; Merrill, 1988; Rivlin, Lewis, & Davies-Copper, 1990; Tullis, 1988). Flashing should be reserved for items that must convey an urgent need for attention. Reverse video can be an effective method in attracting the reader's attention, but it should be used judiciously to avoid "crossword-puzzle effects" (Galitz, 1989, p. 61) when inversed blocks run into each other and make the test look like a filled-in crossword puzzle.
• Select a typeface with a simple, clean style and use a few typefaces in any one screen or multimedia program (Apple Computer Inc., 1989; Hartley, 1994). Most screens look best with no more than two different fonts, using different sizes and weights of each (Strauss, 1991)

Graphical Images

Graphical images include symbols, diagrams, and illustrations. They function to attract and maintain attention, and facilitate learning from text materials (Duchastel, 1978; Levie & Lentz, 1982; Rieber, 1994). Graphical images can also provide functional guidance, aesthetic charm, and corporate or product identity (Marcus, 1992).

Expansive Guidelines

• Consider the overall standard of imagery that meets learner expectations for style (Rivlin, Lewis, & Davies-Copper, 1990).

Restrictive Guidelines

- Use simple, clear images (Levie & Lentz, 1982; Marcus, 1992; Rivlin, Lewis, Davies-Copper, 1990; Thompson, 1994). Simple images are more effective for instruction than complex images. Don't use images with too much detail at a small scale as this can be lost on screen.
- Use graphical images for instructional, motivational, or attention-focusing effects, and not simply for the sake of including them on the screen (Duchastel, 1978, 1983; Levie & Lentz, 1982; Pettersson, 1993; Rieber, 1994; Surber & Leeder, 1988).
- Make sure all the key components of the graphical images are labeled (Rivlin, Lewis, & Davies-Copper, 1990). Use captions or titles for labeling the key elements of graphical images.
- Consider the prior knowledge and cultural conventions of the learner in choosing graphical image components (Apple Computer Inc., 1989; Boling, Johnson, & Kirkley, 1994; Easterby, 1970). Avoid sexist, culturally-insensitive, and other potentially offensive imagery. Designers may or may not wish to recognize cultural stereotypes in enhancing the appeal of a program, as recommended by Jakobsdottir, Krey, and Sales (1994), who suggest that including pictures of people, plants, and animals in software will raise its appeal for girls, while including vehicles and machines in action will appeal to boys.

- Obey any existing conventions, such as the standard symbols in a circuit diagram or the top to bottom or left to right order for a flow chart (Rivlin, Lewis, & Davies-Copper, 1990).

Color

Color is the most sophisticated and complex of the visible language components for screen design, and the misuse of color, or misunderstanding of the use of color, is common, as evidenced by the strong cautionary tone of most guidelines given for its use.

Color may promote deep processing of important information, aid in organizing lesson content, allow reasonable learner-control options, promote interaction between the learner and lesson content, and facilitate lesson navigation (Hannafin & Hooper, 1989). Most researchers seem to agree that colored images are desirable from a motivational point of view, although the research suggests that the motivational effect of graphical images varies greatly with the age, the intelligence, and the education of the reader (Hartley, 1994). While claims are often made for the motivational value of color in instructional materials, the research findings on motivation are by themselves not strong enough arguments for using color (Brockmann, 1991; Misanchuk & Schwier, 1995).

Expansive Guidelines

- Make color coding aesthetically pleasing and logical according to the lesson objectives (Chapman, 1993).

Restrictive Guidelines

- Use color in a conservative way: Limit the number and amount of colors used (Brockmann, 1991; Garner, 1990; Knupfer, 1994; Shneiderman, 1992; Strauss, 1991). Use a maximum of five plus or minus two colors per screen (Faiola, 1989; Marcus, 1992; van Nes, 1986).
- Keep color coding consistent (Faiola, 1989; Galitz, 1989; Marcus, 1992). Carefully select colors for all visual devices, such as touch screens, buttons, menus, and titles, and never change the coding scheme during the presentation (Brockmann, 1991; Chapman, 1993; Davidoff, 1987; Faiola, 1989; Faiola & DeBloois, 1988; Galitz, 1989; Heines, 1984; Marcus, 1992; Rivlin, Lewis, & Davies-Copper, 1990; Shneiderman, 1992; Strauss, 1991).
- Use colors selectively to mahipulate attention: Use a bright color to cue the learner to new information, while presenting the reminder of the information in standard colors consistent with the rest of the screen (Durrett & Trezona, 1982). Color can be used to highlight text or graphics to make them stand out (Garner, 1990; Milheim & Lavix, 1992; Pastoor, 1990).
- Use cool, dark, low-saturation colors (e.g., olive green, gray, blue, brown, dark purple, black, etc.) for backgrounds that recede and do not vie for the user's attention. Foreground colors can be hotter, lighter, and more highly-saturated colors (lemon yellow, pink, orange, red, etc.) that tend to come forward on the screen and

attract the user's eye (Davidoff, 1987; Faiola, 1989; Faiola & DeBloois, 1988; van Nes, 1986; Strauss, 1991; Tufte, 1992).

- Avoid the use of complementary colors (e.g., blue/orange, red/green, violet/yellow) (Boling, Johnson, & Kirkley, 1994).
- Use commonly accepted colors for particular actions, remembering that such color may be appropriate only for a specific culture or social system (Hannafin & Hooper, 1989). Colors should match culturally conventional meaning and symbolic associations (Chapman, 1993; Loosmore, 199=1).
- Use higher levels of brightness for distinguishing colors when designing for younger audiences (Misanchuk & Schwier, 1995).

Animation and Audio

Although animation can offer a very dramatic visual effect, the efficacy of animated presentations on cognition is quite subtle (Rieber, 1990). Animation, like any graphical image, may be expected to help learners to visualize a dynamic process that is difficult or impossible for them to visualize on their own, and thus facilitate learning tasks (Rieber, 1990). The available guidelines refer almost entirely to the instructional use of animation rather than the effective design of animations themselves.

Audio in interactive multimedia is not a new phenomenon; however, relatively little research has been none so far regarding its use. Audio can draw and hold learners' attention to the most important parts of the display, complement the visual information on the screen, support the learner reading the text on the screen (Aarntzen, 1993), and help make sense of temporally-based presentations (Mann, 1995). Audio falls into three general categories: (1) voice or speech, (2) music, and (3) sound or natural effects (Brewer, 1986).

Expansive Guidelines

- Use voices or speech for providing information. When speech is used as the mainstream provider of information, text of the spoken words should appear on the screen. According to redundancy theories (Aarntzen, 1993), this will enhance learning.
- Use animation as a substitute or aid for verbal communication (Park, 1994; Park & Hopkins, 1993).

Restrictive Guidelines

- Use animation sparingly (Rieber, 1990; Venezky & Osin, 1991). Small and simple animation may be more effective than large, complex animation (Rivlin, Lewis, & Davies-Copper, 1990).
- Use animation congruent to the learning task (Rieber, 1990, 1994). Use animation as a visual analogy or cognitive anchor for the instruction of problem solving (Park, 1994; Park & Hopkins, 1993). Use animation to simulate functional behaviors of mechanical or electronic systems and to demonstrate troubleshooting procedures

(Park, 1994; Park & Hopkins, 1993). Use graphical animation to explicitly represent highly abstract and dynamic concepts in science, including time-dependent processes (Park, 1994; Park & Hopkins, 1993; Rieber, 1990, 1994). (We call these guidelines restrictive because they attempt to delineate the precise conditions under which animation will be affective, and to eliminate other conditions as appropriate for the use of animation.)

- Avoid unnecessary or gratuitous animation on the screen so as not to distract (Strauss, 1991).
- Use calm music to create a relaxing atmosphere. Use loud sounds for alarm and warning messages (Aarntzen, 1993).

Integrative Guidelines

Most guidelines offer specific recommendations as to individual elements used in screen design; typography, graphical images, color, animation/audio, and so forth. Although single element research, as a necessary first step in understanding how to combine elements into overall screen, is extremely important in identifying the strengths, weaknesses, and potential problems of using specific attributes on screen, this research does not often address the overall visual effect of the screen (Grabinger, 1989; Haag & Snetsigner, 1994). The effect of multimedia is more than just the sum of its individual elements (McKerlie & Preece, 1993). The combination of these elements to create an overall design, look, or aesthetic is one not typically addressed in the current literature (Haag & Snetsigner, 1994), which may not be surprising since multi-element research, like the study of the "visual gestalt of a screen" (Grabinger, 1989, p. 179), tends to be much more complex than singleelement research. The integrative guidelines tend to be drawn directly from traditional visual design disciplines, and the tradition of those disciplines -is offered as the rationale for such guidelines.

Expansive Guidelines

- Follow aesthetic principles in the design of screen displays. The general rules of visual composition (balance, symmetry, unity, and harmony) should be observed in (Galitz, 1989; Garner, 1990; Hartley, 1990; Lucas, 1991; Schwier & Misanchuk, 1993; Surber & Leeder, 1988). Many authors contend that aesthetically pleasing screens can attract and hold the learner's attention more successfully, and will promote cognitive learning better than screens constructed without regard for aesthetics (Apple Computer Inc., 1992; Haag & Snetsigner, 1994; Lucas, 1991; Misanchuk, 1992; Schwier & Misanchuk, 1993; Shire & Olszak, 1992; Thompson, 1994).

Restrictive Guidelines

- Use the motivational elements of multimedia screen as economically, or parsimoniously, as possible. Get the message across as simply and clearly as possible (Heines, 1984; Galitz, 1989; Garner, 1990; Rivlin, Lewis, & Davies-Copper, 1990; Shire & Olszak, 1992; Shneiderman, 1992) and design screens to "...exhibit no annoying or distracting features" (Strickland & Poe, 1989, p. 89). The implication in these guidelines is that screen elements over and above the minimum required will be experienced as annoying or distracting.

- Be consistent in the appearance, location, and behavior of screen elements and ensure that screen elements with similar functions share similar appearance, location, and behavior (Apple Computer Inc., 1992; Faiola, 1989; Galitz, 1989; Marcus, 1992; Shneiderman, 1992). Consistency is stated to make multimedia programs easy to learn, use, and remember (Reilly & Roach, 1986), and reduce the effort required to learn new programs (Galitz, 1989; Pett, 1989).

Motivation and Framework for Screen Design

Motivated learners focus on developing, understanding, and mastering knowledge, skills, and attitudes; they are enthusiastic and optimistic; they take pleasure in academic tasks and pride in their achievements (Graham & Weiner, 1996; Stipek, 1996). Learners may be motivated through intrinsic or extrinsic motivation. Intrinsic motivation is dependent on factors that are internal in origin, while extrinsic motivation originates in factors outside of the individual. Intrinsic motivation usually derives from feelings of satisfaction and fulfillment, not from external rewards. Extrinsic motivation derives from rewards and/or punishments administered by outside forces.

Keller (1983) has developed a four factor macrolevel theory, called the ARCS model, to explain individual motivation in designing instruction.- The first component of the model is attention (A), meaning to arouse and sustain curiosity and attention. The second component is relevance (R), or connecting instruction to important needs and motives. The third component is confidence (C), which refers to developing generating positive expectations through repeated success. The fourth component is satisfaction (S), or managing reinforcement to provide satisfying consequences. The ARCS model provides a theoretical background to design and develop the motivational aspect of designing interactive multimedia instruction.

In considering motivation as it relates to screen design for multimedia software, it may be useful to note that the learners' motivation in the experience is not only important at the highest level (instructional design, which is concerned with learning). The learner also needs motivation for different types of activities within the interactive experience: to click a "Forward" button, to explore more then one path in a hypertext environment, or to compare two video sequences at the content level in order to draw a conclusion about some subject. Only one of these activities represents what might be called a "learning activity," although the others must be recognized as contributors, and perhaps prerequisites, for learning to occur. Adapting the three design processes of Kristof and Satran (1995), information design, interaction design, and presentation design, we can organize consideration of motivation within the screen design process into discrete, although interrelated levels as shown in Table 1. Column 2 of the table shows examples of the types of activities learners may carry out during the interactive software experience, and it breaks those activities into three groups, according to the relative complexity of carrying them out.

For the sake of this discussion, instructional design is presumed to mean the selection of strategies and tactics for delivering the interactive multimedia experience. Functional design is the description of the capabilities that a multimedia program will have, and the capabilities it will place under control of the program user, or learner. Formal design is the creation or selection of specific representations of function. For example, the

instructional design might specify that content will be delivered in - exploratory environment. The corresponding functional design might specify that "learners will be able to collect items of information and compare them as they move through the environment." These functions would be operationalized as visual forms-perhaps an illustrated knapsack into which the learner might drag items using a cursor in the shape of a tiny hand.

Screen design issues exists at all levels-instructional design, function design, and forms design. For any given element in the overall screen design, Column 3 of Table 1 lists examples of the types of issues for which a screen designer is responsible, and divides them into categories corresponding to the learners' activities.

Once the distinctions we have drawn between levels of screen design issues are clear, it may be possible to characterize the overarching principle guiding each level of design activity according to the three primary goals of engagement laid out by Jacques, Preece, and Carey (1995) in their discussion of engagement as a design concept for multimedia. Although the design of an individual on-screen navigation button might aim to encourage learners by using animation to attract their attention and audio to entice them into choosing the button, it ;s cur opinion that any "encouraging" features of a navigation button (susceptible to expansive guidelines) should be subordinated to the "don't distract" principle (embodied by restrictive guidelines). At the top of the chart, however, a screen designer mad wish to be cautious regarding the possible distractions inherent in a chosen metaphor by following restrictive guidelines, but subordinate those concerns to promote "encouragement" and look to the expansive guidelines to do so.

At Level 2, function design, where the designer's aim is to facilitate, both restrictive and expansive guidelines should prove useful, and the balance between them is likely to be most difficult for designers to achieve.

Conclusion

Available guidelines for creating well-designed, motivating screens in multimedia are poorly organized within the literature. Although the framework we propose for considering motivation in the process of designing interactive multimedia instruction implies that expansive guidelines are needed in two out of the three levels of design, the vast majority of guidelines in the literature are restrictive. We speculate that instructional designers guided primarily by these restrictive guidelines may be kept from discovering the strategies used by graphic designers, multimedia designers, and others in related disciplines to enhance the motivational aspects of screen design.

Acknowledgment: The authors express appreciation to Joanne Beriswill for valuable assistance in the sorting process for this survey.

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