DOCUMENT RESUME

ED 408 991 IR 018 404

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TITLE Visualizing Instructional Design: The Potential of Dynamic Computer Presentations.
PUB DATE Jan 97
NOTE 10p.; In: VisionQuest: Journeys toward Visual Literacy. Selected Readings from the Annual Conference of the International Visual Literacy Association (28th, Cheyenne, Wyoming, October, 1996); see IR 018 353.
PUB TYPE Reports - Descriptive (141) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Computer Assisted Instruction; *Computer Graphics; Graduate Students; Higher Education; *Instructional Design; Introductory Courses; Models; *Student Developed Materials; *Visual Aids; *Visual Learning

ABSTRACT

Graduate students often have difficulty understanding the concepts behind the various models of instructional design (ID). In order to help students in an introductory ID course come to a better understanding of the similarities and differences between various instructional models, the models were developed into dynamic computer graphics to use within a class setting. The projects described in this paper represent a series of steps taken to develop visual learning materials that enhance student understanding of the subject matter within the limited amount of class time available. Each represents a different approach to developing visually rich and interactive computer-based materials. Four projects are described in this paper in terms of topic selection, design features, lessons learned, and suggestions for improvement. The projects focus on: (1) concept clarity; (2) color coding; (3) aesthetics; and (4) shapes and textures. (AEF)

Visualizing Instructional Design: The Potential of Dynamic Computer Presentations

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Abstract

Four development projects are described in this paper. Each represents a different approach to developing visually rich and interactive computer-based materials that are expected to enhance student understanding of the instructional design process. The projects described in this paper represent a series of steps taken to develop visual learning materials that are expected to enhance student understanding of the subject matter within a limited amount of time.

Graduate students often have difficulty understanding the concepts behind the various models of instructional design (ID). As a result, they spend excessive time debating and trying to understand how to interpret the various ID models. Although it is important that students reflect upon and discuss the various similarities and differences in the models, it is more important that they do so within the clear direction that is afforded by a solid framework of understanding. In order to help students in an introductory ID course come to a better understanding of the similarities and differences between various instructional models, the models were developed into dynamic computer graphics to use within a class setting. These graphics can be used by the instructor as a presentation aid or by individual students.

Since many of the students who enroll in the ID course are working professionals from rural areas, the only time they are able to come to campus is during class time, one evening per week. In addition, many students take two evening classes on the same night, so their minds are not free to reflect upon the readings or class material for extended periods immediately before and after class. Because of this situation, it is very important for the students to reach a solid understanding of the basic concepts during a brief time on campus. The projects described in this paper represent a series of steps taken to develop visual learning materials that are expected to enhance student understanding of the subject matter within the limited amount of class time available.

The Development Team

All of the authors involved in this multimedia development project had completed a basic ID course and were enrolled in an interactive systems design course. This project was assigned as part of the course work for the interactive systems design course.

The elusive problem that plagued the class was the lack of proper access to development software. Only one computer was available with either Macromedia Director or Astound, so the students needed to share.

The first three projects were developed using Director and the fourth project was developed using Astound, due to perceived time constraints of learning Director. There is no doubt that Director allowed greater flexibility of development and also utilization.

While designing the presentations, particular attention was given to the impact of visuals on learning. The development team carefully considered the elements of good screen design, concept mapping, cognition, and the paradigm shift from behaviorism to constructivism within the educational technology field.

Focus Questions

Four projects are described in this paper. The paper will discuss each project separately but within the same unifying set of questions as follows:

1. Topic Selection
   - Why did you choose this topic?
   - Why is it important to ID?
   - Why did you think this topic would benefit by adding visual information?
2. Design Features
   - Describe the design features of your project.
   - How is information organized in a visual format to help cognition?
3. Lessons Learned
   - What did you learn from doing this project?

4. Suggestions for Improvement
   - What recommendations would you suggest to improve your project?
   - How would this project best be used?
   - How could you test this project to see if it really works better for learning about ID than reading text from a book?

Project One -- Concept Clarity

The first project was developed strictly as lecture support. It was meant to be used to help students organize information within their minds according to logical chunks of information that students had read about and that were explained by the instructor. The intent was to provide the basic concepts of the ID process. This project could be used by students after the lecture for review, or if they had missed class. The amount of information within the project is skeletal and therefore, it depends upon supplemental information provided by the instructor or by the course readings.

Topic Selection

This topic was selected as the starting place because it gave the foundational underpinnings necessary to learn more about ID. The book explanation seemed to fall short of students' needs; students could not seem to read the information and understand it and remember it well enough to apply it consistently to class projects. Visual information would provide the students with cues to help remember the basic concepts of ID.

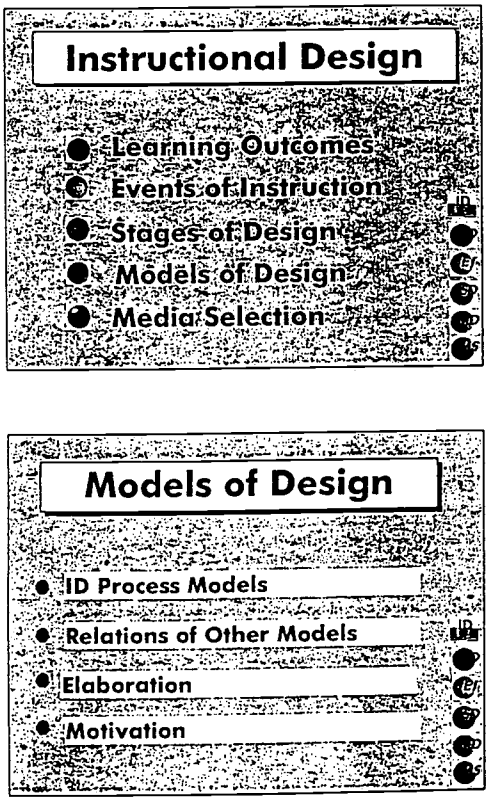
Design Features

The design features used within this project began with basic organization of information into logical chunks that were related and consistent with common ID course content. It was important that the material be designed for the greatest amount of flexibility for lecture support. The instructor wanted to be able to begin and leave off with any of the major concepts as necessary to support the lecture, which could vary depending on students' needs. Also, if students wanted to see part of the material again or the instructor wanted to compare or contrast information, then the material needed to be flexible enough to allow moving forward and backward as well as skipping around.

This project used muted or neutral colors in the background with a soft overall pattern that provided texture without interfering with the text. The text itself was presented in a contrasting colors, using a complementary color scheme. Titles, main information, sub categories, and sectioning of the screen were accomplished with color coding, layout, and font appearance so that the learners could easily keep track of their placement within the program.

Four basic screen designs were used to signify the type of information that was presented, thus learners would know what to expect based upon the visual layout of the screen. For an example of a main and a subordinate screen from Project One, see Figure 1.

Figure 1
Project One Main and Subordinate Screen



Lessons Learned

This project was fun to do and it was a start in the right direction. In addition to lecture support, it could be used by individual students if they missed class. The project taught us that logical visual layout of information can help students to understand complex concepts.

Suggestions for Improvement

Although an instructor could easily maneuver around the software, we believed that students who might use it after missing class could become lost or not see the visual links between some of the more subtle color changes in the fonts. To help clarify the visual relationships within this presentation, additional color coding was added in the form of bullets. This was a good addition in terms of conceptual relationships, but there needs to be further refinement of the size and placement of the bullets, as well as clarification of the accompanying color key.

The color key will need to be made smaller so that it can fit as a template on all screens without crowding the screen or otherwise interfering with existing content. We are also experimenting with button size. Right now, the buttons on the main screens are larger than the buttons on the subordinate screens, but we are not sure if the size is distinctive enough to serve effectively as a cue. It would be a good idea to use the smaller button size for aesthetic purposes and add a texture to the buttons as an addition cue. The existing colors on the buttons are distinctive, however, some people might have special needs related to color vision and large screen projections systems often seem to distort colors beyond recognition.

Project Two -- Color Coding

This project emphasized color coding overlays to enhance the standard ID process model, known as ADDIE. The ADDIE model moves through a process of:

- Analysis
- Design
- Development
- Implementation
- Evaluation

Close inspection of the ADDIE process and its relationship to a variety of ID models, revealed that the implementation process was usually skipped over within the models. This was not apparent at first and as a result, it was a confusing point for students.

Topic Selection

While taking the introductory ID class, several students had difficulty understanding the difference between the functionality of different ID models. The textbook presented a variety of models, and although the models were diagrammed in black and white, they were difficult to understand. The book could be improved by applying one or more of the models being discussed. The first thing to analyze was the presentation of the models themselves in a circular attempt to improve their presentation.

The importance of understanding the similarities and differences among some ID models in an introductory ID class is obvious. With a rock solid understanding of what the different models emphasize, a student should be able to gain confidence in selecting or modifying a model to use in developing good instructional materials.

Multimedia computers offer instructional designers different way of applying certain instructional cues. The use of color, sound, images, and even motion are now much more economically feasible than they are in a printed textbook. Color seems to be an obvious is element of visual design, so we thought about how it could be used in this context. For most people, color is a very strong organizing cue. For example, in highway signs greens and blues can safely be ignored; yellows and reds cannot. Or consider a man who enters a restroom with pink walls; he is likely to stop and make sure that he is in the right place.

In this example, we use color to classify and compare ID models to the basic ADDIE process, but we added a sixth component "R" to represent the need to revise, thus making the acronym, ADDIER. ADDIER is the basic model for all kinds of design processes. By relating ADDIER to other models in a very clear yet unobtrusive way, we believe that future ID students will learn about ID better than they otherwise would.

Design Features

We called this project *Investigating Instructional Design Models* and its goals was to help students understand the basic principles of six major models for designing instruction. Those models are typically addressed in instructional design textbooks as IDI, Air Force, Dick and Carey, Gagne and Briggs, Kemp, and Seels and Glasgow. Although there are many ID models, these were chosen as basic ones. These models were to be presented as variations of the basic applied design process model, ADDIE, which is presented as an introduction to ID principles.

The program is based on a simulation called *Learning Unlimited*, which is a video clip developed by an ID consulting firm. Learners take on the roles of "apprentice designers" who must attend the firm's design orientation program, called *Meet ADDIE*. Following this orientation, the learners work as a member of their selected client's ID team. During the course of the program the apprentice designers could work with the six different models. But, they must choose two design models from which they will create instructional packages.

The presentation of the instructional ID models was done in Macromedia Director, enabling an easy combination of text, graphics and color. The user can select which ID models to look at by clicking on hyperlink objects, similar to the hypertext of web pages.

The ID models under study are depicted with a mixture of graphics and text, similar to a flow chart. One model is presented on each page and compared to the ADDIER model. That is, the page is split vertically, with the more compact ADDIER on the left and the model under study on the right.

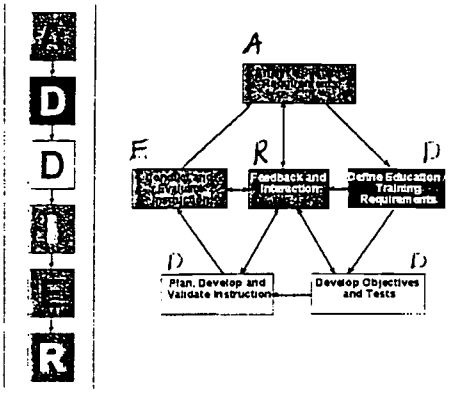
Each step of the ADDIER model was assigned a background color. The primary purpose of the steps in the target model were determined and their backgrounds were filled in with the corresponding color from ADDIER. Since ADDIER is such a cognitively simple applied process, it provides a firm anchor for analyzing, comparing and contrasting, the other models. By providing context, it allows users to construct their own mental models using the more complex ID models.

Figure 2 shows the ADDIER model with its color coding represented in shades of gray. "A" is cyan, the first "D" is royal blue, the second "D" is vivid yellow, the E is hot pink, and the "R" is red. The "I" is missing form the right side of the image and that would be immediately noticeable because of the presence of green on the left side and the absence of green on the right.

Lessons Learned

The immediate reaction was how much clarity such a simple thing as adding background colors could make. The best example was one of the models which did not have any sort of implementation step. In a totally unscientific survey, we asked about a dozen people to look at this page and comment upon it. With little or no prodding, every single person but one pointed out that a color was missing from the model on the right. It is interesting to note that the one exception had a fair amount of ID experience and was probably looking at the model from a different viewpoint than the beginners.

Figure 2
Project Two ADDIER Model



The absence of the color immediately focused people's attention. By starting to build a mental structure before the user has to think about the words being used, we expect that the resulting structure will be more nearly correct than would otherwise be the case.

A second example of what was learned through this project was the process of mapping the flow of how the program worked. By fitting various ID models into a similar flow or process of learning, it required us to look at the similarities and differences of each model in great detail.

Suggestions for Improvement

Starting to improve this project is simple. First, finish it. The result of the class project provided a good beginning to developing a course curriculum on ID models. Currently, it corresponds to a single chapter from one ID textbook. Adding four or five more chapters to create a semester course content would make it viable.

Having this be the introductory text for ID course would be its best use. Its strength lies in its simplicity. This allows the user to start constructing mental models of ID without the complexity associated with most texts. By starting at the beginning, relating ID to the everyday approach of ADDIER, the details of the different ID models are

connected to something already within the students' frame of reference. This association will foster a more thorough understanding of what goes into the ID process.

Instructional design is a cognitive course that should result in thorough development of certain skills. Any knowledge obtained is useless without a demonstration of the skills learned. By reducing the amount of time spent on learning ID models, more time can be devoted to actually creating instructional material. Since this project's goal is a more concise, hence a shorter instructional period, it should result in less time spent learning about the larger range of ID models.

To determine whether or not this approach is better, a comparative study of subjects using it versus those who don't can be conducted. The criteria for deciding if this approach is better is two part and fairly simple. The first criterion is the quality of the students instructional projects. While somewhat subjective, most ID instructors have opinions on what is good and what is not. In this case, their opinions should count. The other criterion is the students assessment of what they did. To a certain degree, how they judge their own projects should demonstrate how well they understand why they did what they did.

Project Three -- Aesthetics

This project concentrated on developing the overall visual aesthetics of the interactive instruction. It employed a dual colored, graduated background, screen partitioning, and several unique design features such as two way sliders for learners to control window views. Metaphors were employed with care so that the imagery fit well within the overall aesthetic appeal.

Topic Selection

We selected an overview of the ID process as an appropriate topic because the generic ID model benchmarks that were elaborated in the project would necessarily guide the project team's decision making. Furthermore, the overview provides a mental map that prompts or aids the user in making connections and predictions. The scope of available resources - time, knowledge base, software, and hardware availability - also informed that decision.

Sophisticated ID models are diverse and complex yet universally insistent upon the following steps which may be acknowledged specifically or as integrated components: analysis, design, development, implementation and evaluation. These benchmarks provide direction for thought and action toward specific, measurable, instructional outcomes be they cognitive, behavioral or psychomotor.

Textbooks used and referenced in the ID class are wanting of clear organization and portrayal of the general ID process. Visuals, infrequently placed in close proximity to associated text in traditional textbook formats, were often confounding rather than helpful. Furthermore, because the visuals are static, too much information is revealed too early in the instructional sequence.

An alternative approach to information sequencing is evident in texts attempting to emulate the unfolding of a hypermedia document. Nevertheless, these were judged a poor approximation in that the visual maps indicating location within the model occurred only at the beginning of sections necessitating page skipping in order to place the textual information within the overall model. Text-based maps may be helpful but could be omitted in favor of the simplicity offered by concise thumbnail maps repeated at the upper left corner of every other page. In either case, the texts were poor models of ID process in general.

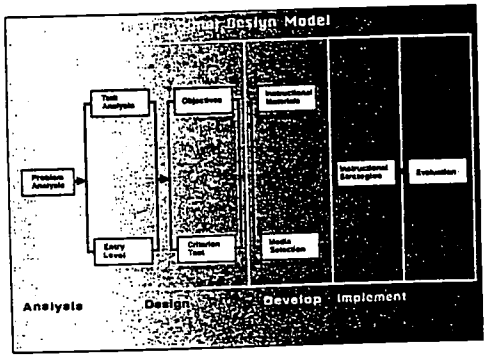
Design Features

This project provides a map for thought and action relevant to the Problem Analysis phase of ID. The design permits the learner to tailor, within predetermined limits, the sequence, linear or non-linear, according to prior experience with ID and individual preferences. For instance, the *Tour* option presents information in a step-by-step sequence, with the option to *Quit* at any point. Students already familiar with problem analysis as a component of ID may opt for the non-linear approach by using the overview screen's ID model which serves as a main menu (see Figure 3). Throughout, students have the option to quit or return to the main menu.

Evaluation is integrated into the sequence by way of check point question screens. Questions are intended to invite reflection and review. An Answer field is readily available upon a *Click* request from within the bounds of a question's text field.

More formal evaluation in also integrated into the project. An *Exercise* folder contains various formative and summative evaluation activities. Formative evaluation includes items which invite the learner to select correct responses from a list. Incorrect responses are flagged. A click on a flagged response provides a rationale for correct response and a prescription for correcting the faulty application of the concept. Queries may be submitted by personal call or submitted to the *Activities* folder are electronically transported to external tutorial agents at the host institution. Dialogues between student and tutor can thus occur by way of the electronic medium or verbally.

Figure 3
Project Three Main Menu



Completed summative evaluation activities are transported electronically to the host institution directly from the *Evaluation* folder. The graded work, replete with prescriptions for corrective action will be transported back to the student. The student is encouraged to take action on the prescriptive feedback and to then resubmit the document for final evaluation. The student is free to accept the preliminary evaluation score or to resubmit the corrected document.

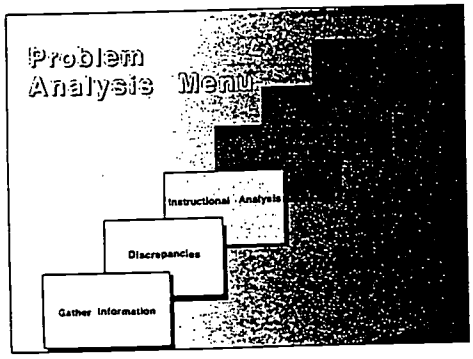
The *Main Menu* layout presents a concise representation of an ID process. Each component of the generalized model quickly reveals the components and flow of activity within the context of a hybrid model. Furthermore, the visual potentially reinforces these general steps each time the learner visits this page. The Problem Analysis screen, as do other sections of the model, also conveys an intentional flow of thought and action that would be reinforced similarly.

Students receive further assistance in locating a referent for their activities within the context of the entire ID process by quick reference to the ID icon in the lower left-hand corner of a screen. The location within the ID process, itself a thumbnail replica, is indicated by a difference in component color and texture by comparison.

Color scheme also conveys continuity and segregation of content. The coloration of the lower right portion of the screen from which the burst emanates changes according to the content of the segment while the overall screen scheme is dominated by a static complement of cooler hues.

The problem of text and visual proximity found in the various textbooks is resolved using selective disclosure. Visuals are placed either in juxtaposition, opaque overlays or as transparent overlays dependent upon the relationship between page components and consequent cognitive load potential. Figure 4 shows a sample of a screen layout.

Figure 4
Project Three Sample Screen Layout



Lessons Learned

Our foundations in ID are broader and deeper as a result of developing this project. We now have experience that includes a better understanding of the importance of interpersonal communication and relationships, group dynamics and power structures, and visual literacy. Since this was an opportunity to undertake an authentic project reinforcing the various concepts and models of ID we added substantially to our understanding of the ID process especially pertaining to user

attributes and needs. Additionally, those inclined to do so, added facility with Director as a sophisticated and powerful authoring alternative, as well as with image capture and subsequent editing.

Suggestions for Improvement

First, and foremost, a problem analysis replete with a strong assessment of learner characteristics must be completed. Our group was content to operate from a combined perspective of user attributes and needs. A simple report of the number correct is hardly an adequate assessment and needs much more information to be useful. Thus we would expect refinement in that area.

There are expectations that the screen design and user interface demands would be different on the basis of adequate understanding of intended users. Furthermore, an adequate knowledge base in visual components and design would surely influence the look and feel of our project.

This project would serve as a useful adjunct to regular classroom instruction. With substantial planning and revision it could become an effective alternative to regular classroom instruction. We envisioned its eventual application for a course offered by a distance learning provider that accommodates the differential needs of students for learner support and immediate person-to-person interaction. The project could also certainly have utility as one source of content for an internet-based course.

The potential influence of the project on learning outcomes would draw upon quantitative and qualitative designs. An experimental design would necessarily include a control group of non-users and an experimental group of users. Evaluation of test scores, project scores, and task efficiency and satisfaction may be useful indicators of the project's effectiveness. Analysis of within group differences may also be illuminating.

Project Four -- Shapes and Textures

This project focused on comparing Gagne's Nine Events of Instruction to the nine Instructional Training Events as described in Smith and Ragan (1993). Although each had nine steps, they included different content, and where steps seemed to represent similar content, they were in different order. The question that this project solved was how those two sets of nine items were interrelated, and thus students could engage in an in-depth analysis of how to apply the two processes in a practical way to the ID process.

Topic Selection

This interactive project was developed in order to help students gain a better understanding of the similarities, differences, and interrelationships among Gagne's Nine Events of Instruction and the nine steps of the Training Events. The textbook contained a clear explanation of each, but most students did not take the time to thoroughly analyze the two hierarchies due to perceived complexity. Students involved with this project at first wanted to address simply Gagne's nine events, but the instructor suggested that we address the project in a more extended way and use a visual representation to address the relationship between the two hierarchies. Thus an interactive lesson was developed to visualize the foundational concepts and interrelationships of Gagne's Nine Events and the Nine Training Events.

We believed that the processes could be modeled in an interactive and highly visual presentation with the messages carried by various forms of visual cueing. The visual representation of this lesson takes advantage of dynamic computer graphics, enabling it to be used as an instructor's presentation aid in a classroom setting or by individual students as a supplement to or review of class instruction.

The lesson itself, was not created to substitute or replace college-level courses in ID, but rather, to enhance them. The users can have a broad range of knowledge of ID philosophies, from novice to expert. But, the primary users of this lesson will be the students with a basic understanding of ID.

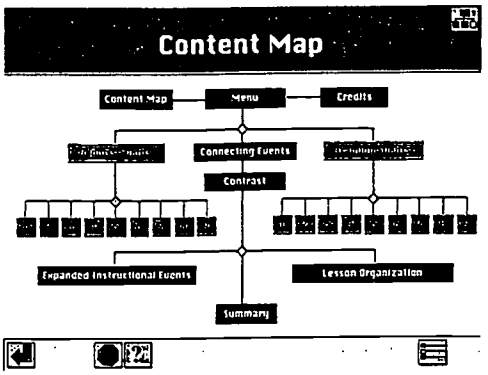
Design Features

The most important aspect of this project was the emphasis on visual cueing. Several discussions and debates yielded an outline of the lesson's framework of information and presentation format. From that outline, the basic information was translated into a visual format.

The key to blending the content and visual design was the evolution of the *Content Map* (see Figure 5). The map's purpose was to be a visual navigation tool -- allowing the user non-linear access to information. The content map, as it

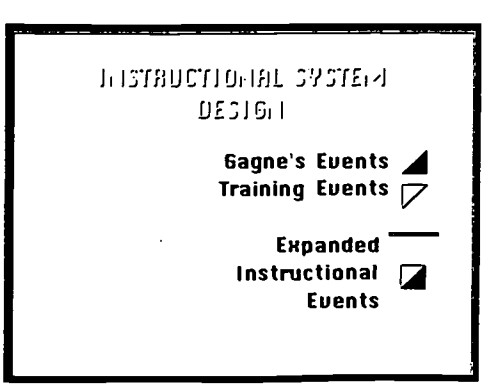
evolved, resulted in an amplification of content information and the interconnection of the elements in Gagne's Events and the Training Events.

Figure 5
Project Four Content Map



In addition to the content map, visual cues were employed as color coding, texture, shapes, and numerical labels. The events as a whole were depicted as a square that was divided into two triangles. Gagne's Events were symbolized by the lower right triangle shape of that square and were in a green color. The Training Events were depicted as the opposite part of that square, the upper left triangle, and were yellow in color. Each triangle also contained the number of the step in question. Thus if standing as separate element, a color-coded triangle with a number was displayed, and if representing an area of matching content, two triangles of green and yellow color were displayed. The numbers in the triangles informed learners about which steps were coinciding. These symbols, minus the numbers, are displayed in Figure 6. The expanded instructional events extended the examples for the learners.

Figure 6
Project Four Color and Shape Symbols



In addition to the color, shape, and numerical cueing, the project employed texture in the content map and throughout so that the learners would have one more visual cue. This cue could be particularly important to people who see colors differently.

Lessons Learned

Team members learned two major concepts during the process of developing this project. First, we learned about the relationship between the visual elements and ID. Second, we learned about going beyond the linear format to employ nonlinear design in a logical way that could aid the learning process.

The relationship between the visual elements and the ID process presented the connection between the use of visuals to communicate ideas and the design process, including the human factors, screen design and information structure that are involved in the interactive instructional system. The ability of the team to look beyond the linear design of instruction for the links to more information grew out of the formative evaluation process. Each team member had and used the opportunity to evaluate, comment, and change the project individually or as part of a group during the formative evaluation process.

The team also found that it was not easy to work together. Different ideas, talents, skills, personalities, working styles, and communications styles all impacted this project.

Suggestions for Improvement

This project should be tested with students in the beginning ID class and adjusted if necessary. It will be important to see if the visual cueing works as we think it will.

The project could be transferred to a compact disc or HTML for presentation on the World Wide Web. This project would lend itself to a research study to compare understanding and retention between classes that use and do not use the software. Part of such a study should evaluate icon styles and other isolated visual elements employed, not just the text-based material.

The crucial constraint was the limitation of equipment and resources needed for the development and presentation of the lesson. We used Astound to develop this presentation because we thought it would be faster than learning to use Director. That

limited us in some unexpected ways. One person knew the most about Astound and it created friction among the group in terms of responsibilities. The knowledgeable person preferred to work in Astound, knowing the program limitations, but did not want to do all of the production work, nor spend the time teaching the others to help out. We found that using Astound seemed to be a good choice initially, but it limited what we could do, and it now limits the ability to actually use the product. The program requires a large amount of computer memory to run in Astound and that severely limits the ability to use it in class as result of hardware limitations.

Summary

These four projects represent a sampling of the ideas employed in first attempts to clarify the ID concepts through the use of visual aids. Each is unique and offers original ideas toward that goal. Each has obvious flaws and so there is room for growth on all the projects presented. Perhaps a logical next step will be to get the students who developed these projects to work with others in developing in even better interactive software than what is represented here. As the students work through the process of teaching others, it will offer an opportunity for them to extend some of their original thinking and work in applying visualization to instruction about ID.

References

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