Gender Balanced & User Informed

Online Instructional Design

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Presented at Michigan Association of Computer Users in Learning MACUL

March 7, 2008

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Abstract:

Men and women learn differently. Computer training typically increases a worker's wages (12%) and increases the chances for a pay raise (82%). The audience for distance learning is overwhelmingly women. Are you speaking to them? Can they use your courses? This presentation looks at lessons learned from implementing a national online college curriculum.

We review research on gender learning differences and show how the Comma Method of instructional design (observation, orientation, and notation) focuses on the needs of women. We demonstrate the benefits of an iterative process of design, user interface testing, and revision within the constraints of Moodle, an LMS.

Cognitive Load Theory

> *"…we have seen that if an e-learning system interface is not usable, learners spend more time learning how to use the software rather than learning the content, which is their main goal." (Lanzilotti, et. Al. 2006).*

Cognitive overload is a danger in non teacher-mediated learning systems such as self-paced distance education courses (Grunwald). The student must not only attend to the instructional material, she has to navigate the course without the benefit of a teacher's direction. The need to keep navigational instructions in working memory in particular can lead to reduced performance.

Modern e-learning applications are delivered on–and have much in common with–the World Wide Web. The Web is a form of hypertext, the use of links to connect disparate pieces of information. Hypertext has been around for quite some time, and some of the perils of using it are well known.

"The problems with hypertext are *disorientation: the tendency to lose one's sense of location and direction in a nonlinear document; and *cognitive overhead: the additional effort and concentration necessary to maintain several tasks or trails at one time." (Conklin 1987).

The student wants to know where she is, and needs to see both what destinations are available and how to navigate to them. While these problems are always possible in any Web site, their consequences are more dire in a e-learning environment, as they may prevent students from learning the material or even cause them to quit the course.

Working memory is the part of the human brain that holds the information we are currently perceiving or thinking about. "Working memory can be equated with consciousness." (Sweller, van Merrienboer, and Paas 1998). It is the only place where information processing occurs.

If we were talking about a computer instead of a person it would be the Random Access Memory (RAM), the chips that hold information for a short time while it is being worked on. When the power goes off, the contents of RAM disappear, which is why we save documents to a hard drive, a device that can retain information in-between working sessions.

Long-term memory is the human equivalent to a hard drive. We have a seemingly infinite capacity to remember things, to hold them in long-term memory, but can only hold 7 items in working memory at any time (Miller 1956). If we are processing the item, that too takes working memory, so we can actually only think about 2 or 3 things at a time.

Baddelly (1992) theorized that working memory actually consists of 3 parts, a visual channel that holds and processes images, an audio channel for processing sound and language, and a managing entity Mayer (2001) depicts the audio and visual channels as parallel processes of selecting and organizing information so that it is available for integrating or other processing.

The total of everything held in working memory is called cognitive load. The more elements a student must keep in mind about how to navigate a system the fewer spaces are available to hold and process the actual educational material that we want them to absorb and ideally integrate into their long-term memory. (Grunwald) If I need to remember how to navigate to the next bit of text or how to get back to where I started, I lose one of my precious working memory slots and I may forget something that was much more important than where to go next.

> *"Any instructional design that flouts or merely ignores working memory limitations inevitably is deficient."*
>
> *(Sweller, van Merrienboer, and Paas 1998)*

So how do we get anywhere with such a limited capacity to hold information in our minds? Long-term memory has great capacity, and it is by integrating individual pieces of information into cognitive structures called schema that we can get around the working memory structure. According to Sweller, van Merrienboer, and Paas (1998) we assemble bodies of knowledge into discreet units they call schema. One schema can hold many bits of information about a subject, and yet be held in working memory as one item.

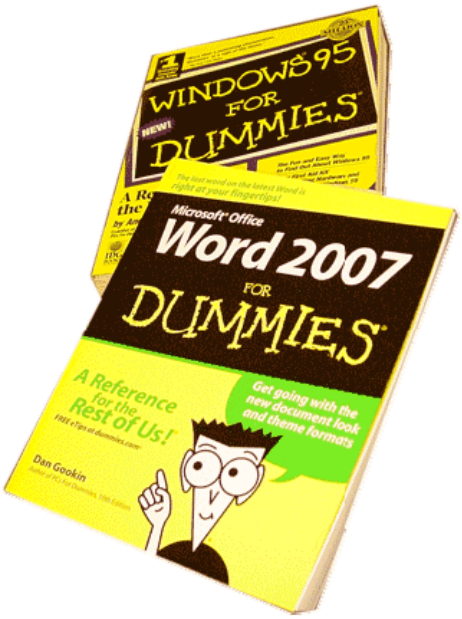
Schema are processes that have been automated by our minds–we can use them without attending to them consciously.

For example, when we drive a car we don't think about the fact that we need to make sure there is gas in the tank, which pedal to press down on, etc. We just drive. Often we have even automaticised the route we follow, arriving at our destination with scarcely a thought about how we got there.

It is this coalescing of small facts into coherent constellations–the creation of schema–that is the goal of education. When we teach Microsoft Word we want our students to be able to go through a series of steps (say, how to cut and paste) without having to re-create each operation from scratch.

Gender and Computer Self-Efficacy

There is no statistically significant difference between men and woman's ability to "locate content online effectively and efficiently." (Hargittai and Shafer 2006) [i] Given equal access and time on task with computers, women may even outperform men, and women generally do better in online learning situations (Price 2006). However, there is a very significant difference in the genders' self-perception of skill:



In fact, not one woman thought of herself as an "expert" user, and not one man thought of himself as a complete novice, or "not at all skilled."

Women also tend to have a lower sense of computer self-efficacy. (Colly et al. 1995) This means they don't believe they are capable of performing various computing tasks, and have higher discomfort or anxiety surrounding those tasks. Parker (1999) found that students' belief in their ability to control the technology (as determined by their score on the Locus of Control test) was the variable that most correlated with dropout from distance education courses.

Other studies have shown that girls tend to select academic and career choices based upon their (perhaps faulty) self-assessment of their technological skills. A person's belief in her own computer ability can become a self-fulfilling prophecy. Increasing our student's computer self-efficacy must be one of our top priorities as learning environment creators.

Gender Differences in Navigation

The Web is a form of hypertext, the use of links to connect disparate pieces of information. The problems with hypertext are *disorientation: the tendency to lose one's sense of location and direction in a nonlinear document; and *cognitive overhead: the additional effort and concentration necessary to maintain several tasks or trails at one time."

While these problems are possible in any Web site, their consequences are larger in an e-learning environment, as they may prevent students from learning the material or even cause them to dropout of the course.

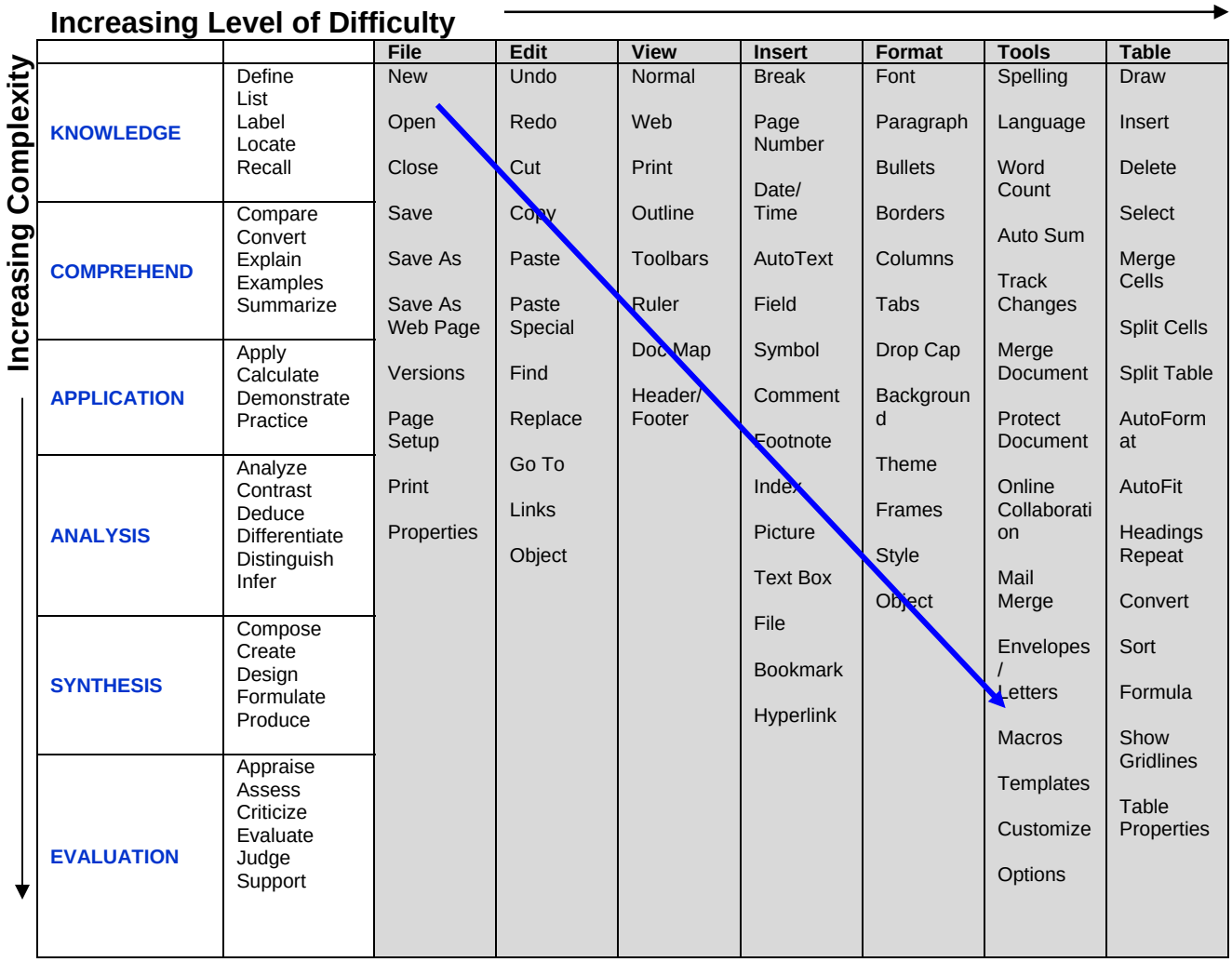
Since orienting yourself on a computer is quite similar to navigating through terrain, designers use visual clues to aid users in locating features they use often (Conklin 1987). The "X" in the corner is a familiar feature; we know we can always click on it to get out of whatever space we are in. In hypertext environments such as the Web we refer to "going places" in the same way we talk about the real world.

Landmarks

When asked how they find their way to new locations, women and men report different strategies. Women are more likely to say they rely on knowledge of whether to turn right or left at specified **landmarks** along the route; men are more likely to report orienting to global reference points, such as the cardinal directions (North, South, East, and West) or the position of the sun in the sky."[ii] (Lawton, 1994, 1996) (emphasis added)

For Microsoft Office 1995-2003, the landmarks were specifically mapped to Bloom's Taxonomy. The menu structure was based on a navigational strategy that read from left to right, beginning through expert skills.

Graphic 1: The Common Microsoft Office Menu Map



The Common Microsoft Office Menu Map

Here is an illustration that overlays Bloom's Taxonomy on the Microsoft Word menus. Notice that the Levels of Mastery correspond with Blooms. The Beginning tools are located in the upper left corner. These are the tools required for Knowledge and Comprehension. The Advanced tools are found in the lower right map for all Microsoft Office software. These tools allow me to analyze data, create or compose sophisticated layouts and designs, as well as evaluate the data or the process.

Breadth-first versus Depth-first

Mapping the menu bars improves learning for students who see the whole structure first and examines the relations between several commands at once (Breadth -first). Navigating the menus and child lists favors the individuals whose learning strategy is more localized, examining one thing at a time (Depth-first). [Ford & Chen, 2001]iii Men score better than women on practical applications of knowledge "when that knowledge was learned Breadth-first."

Men typically see the map first. Men are more likely to be immediately aware that the Standard tool bar reads "File, Edit View, Insert, Format, Tools" in all Microsoft software. This method of acquiring knowledge is called Breadth-first. (Need citation)

Women tend to work with the details first. They learn several commands, such as copy, cut, and paste, then they put those concepts under the label, "edit." This method of learning is called Depth-first.

Spatial Ability

> *"The constant interface across various Microsoft programs, including Word, PowerPoint, and Excel, serves as a common example of a stable environment. Although the programs deal with very different content, they share a common environment… tools are grouped similarly (e.g., File, Edit, Format) to decrease germane load, the process of becoming familiar with a new program."*

Spatial ability has been equated with the ease with which people learn to use the graphically controlled computer interface. Although there is some biological component to gender differences in spatial ability (men having the edge), it may be compounded by the disparity in the number and types of experiences that children have growing up. Boys are more likely to be involved with activities that train spatial abilities such as determining relative motion, etc.

Research has shown that training can improve performance in tasks that demand a similar form of spatial awareness. Sometimes even just pointing out the benefit of paying attention to the spatial aspects of a task can make a large difference.

For instance, naive subjects who are "rotated" through a windowless building make very large average errors when asked to point at another non-visible building. Simply informing subjects that they will be expected to do the pointing task reduces their error by 60 degrees (Elenteny & Baenninger 1994.)

Similarly, asking subjects to attend to cardinal directions in processing a map in order to give verbal directions greatly increases subjects' accurate use of direction terms (Ward, Newcombe, & Overton 1986). These studies suggest that existing spatial competence is simply not engaged in many people's daily lives, but can easily be activated." (Baenninger & Newcombe 1995)

Since women especially may not be aware of patterns in the layout of menus and commands, making them explicit can help them learn new software commands quickly and effectively. Pointing them out may only be reinforcing knowledge that men acquire spontaneously, but it probably does not slow the men's learning.

Motion versus Layout

No doubt you may have seen men frequently glancing up at the television whenever something moves across the screen, or looking over their companion's shoulder when someone walks across their visual field. Perhaps this behavior is routed in evolution, as men may have been more attuned to the motion of possible predators or prey in their roles as hunters.

Research with children has shown that girls respond more to the static visual layout of a screen, while boys react to motion. (Passig)

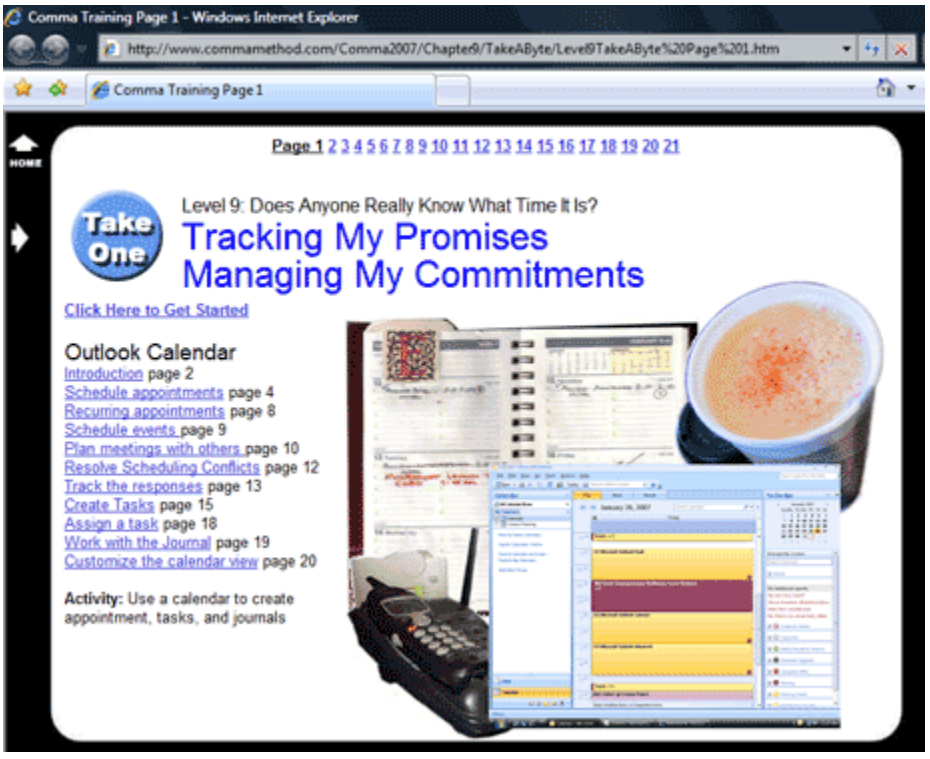
Design Guidelines for the Core Content: The Comma Method

Significant work has been done evaluating the use of navigational tools, and organization of the educational content. (Evans & Edwards) The Internet is an effective tool for delivering educational content. (Miller, Schweingruber, & Brandenburg, 2001) However, the **educational content must be considered separate from the navigational tools**. (Rothenberg, 1997, as cited by Van Dusen] We have found that some of the same issues confront us in both the design of the instruction and the navigational interface.

Observation: What Am I Supposed to Do?

People have a set construct in mind when they use a computer. A user model is the knowledge that someone brings to a new task from a similar software program they used before: word processing, saving data, or searching for information.

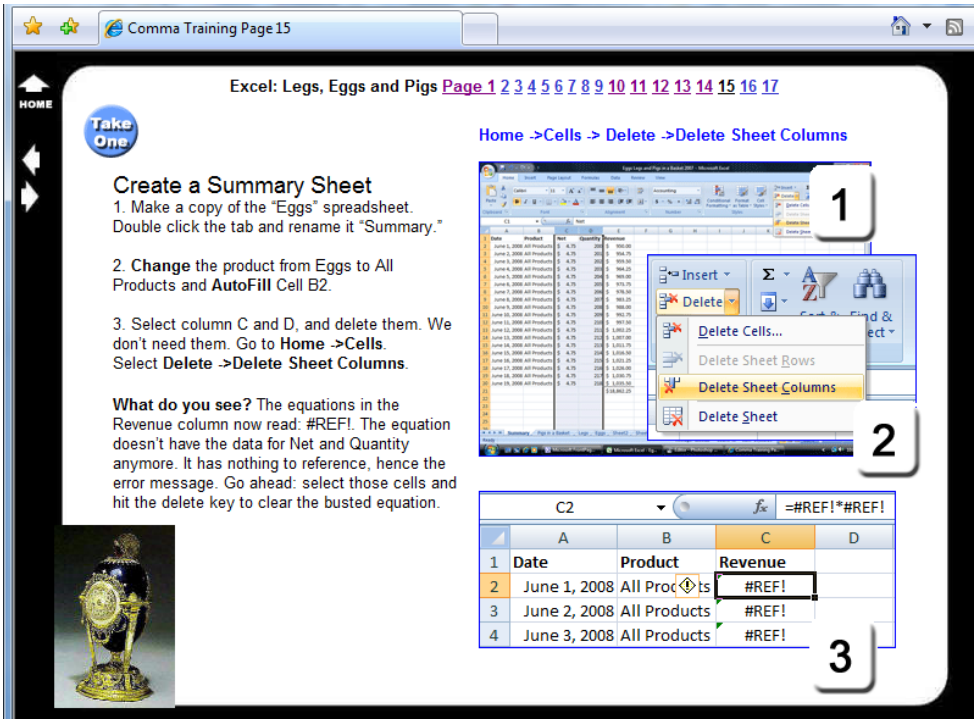
User models aren't very complex. According to Joel Spolsky, "When people have to guess how a program is going to work, they tend to guess simple things, rather than complicated things."



Orientation: Where Will I Find the Tools and Commands?

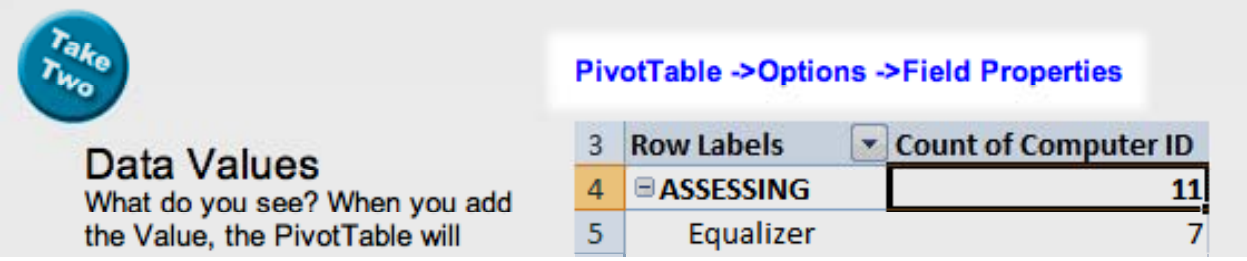
The screen should be formatted into different components that include text, images and utilities. Dividing the content screens into a standard template reduces cognitive load.
Research has shown that users prefer reading text to hearing it read. Adding the complementary learning elements (movies, broadcasts, and downloads) as links makes these utilities available to all users. (Grunwald, Corsbie-Massay, 2006) [iv]

Van der Meij (2000) found that the best arrangement for text and images in software training was placing text on the left with screen capture images on the right of the same page. The Comma Method altered this design to keep the text on the left side. When different browsers use history, search and favorites, the page content may be too wide for the monitor. Hence, the instructions may be off screen and not visible to the user



Notation: How Can I Document the Process?

The Comma Method uses a simple notation formula in addition to the textual descriptions of the software.



Teaching with technology should be efficient and effective.[v] The purpose of online instructional design is to tightly integrate the teaching of: (1) **commands** that are specific to an application, and (2) **strategies** that are general across applications. [vi] This approach offers robust retention (which enables users to execute tasks in specific applications), and robust transfer (which enables users to perform tasks despite changes in interfaces and when using new applications.) (Bhavnani, 2001)

> **"*A user interface is well-designed when the program behaves exactly how the user thought it would.*"**
>
> *"If the UI is wrong and the user feels like they can't control your software, they **literally** won't be happy and they'll blame it on your software. If the UI is smart and things work the way the user expected them to work, they will be cheerful as they manage to accomplish small goals." (Spolsky 2000)*

The authors believe that many people faced with difficulty navigating a user interface will not feel anger at the system's designer and will instead blame themselves for their difficulty.

For example, during user testing, even after explicitly following all instructions completely and accurately one test subject apologized for her performance. She exclaimed that she must be stupid after a dubiously -labeled link took her to an unexpected page. This despite the fact that she knew she had done nothing wrong. The outcome was incorrect and she blamed herself rather than the interface that was the real culprit.

Reducing Cognitive Load

Navigational Control is defined as the "ability to control a computer program, to jump between topics, or to skip sections. The goal is to "maximize freedom while minimizing complexity."(Grunwald, 2006) However, high navigational control only benefits advanced users.

The first view the user should see is the entire task from start to finish. The Course Outline allows a novice to become familiar with the complete task. [vii] This outline also guides the student on a "preprogrammed path." More advanced users can use the hyperlinks to "jump around within the topics and tests."

User Testing

The only way to find out whether the on screen navigation is adequate is to perform user testing. The term comes from the business world (Nielsen 2003), we use it even though we are actually testing students). You can find some flaws with (cheaper) heuristic evaluation, and you should always conduct that first, but ultimately only user testing shows the truth. Please see Nielsen's Usability 101: Introduction to Usability for a quick description of the process and why it is vital for creating any sort of interface.
User Instructions

Participants in the Beta Tests were asked to perform the following sequence of steps:

1. Log into the certification training website
2. Select a Course: Word Level 1:Beginning Guide to Microsoft Word 2007
3. Select a Topic: Go Blue
4. Page through to the last page of the Go Blue lesson
5. Close the Internet window
6. Find the Beginning Word Quiz
7. Take the Quiz and Save without submitting the page
8. Return to the Word Level 1 Topic Outline

In addition to following the instructions for beginning a course, the beta testers were asked to shuffle small screen-shots of the sequence into the right order and label the functions.

Upon completing the learning task the users must re-create the navigation from existing clues on the screen. Incomplete navigational information can lead to errors that take time and are distracting. Ultimately they add to the student's frustration with the process, likely reducing her chance of success.

Beta Test Protocol

At the beta test, the researcher interviewed the participants to collect background information about computer experience and to establish a rapport with the participants. The researcher instructed the participants to say what they saw on the screen. Participants were also encouraged to verbalize their rational for choosing one link and not another. If a participant became confused about the next step, or expressed concern that they may be, "lost," they were prompted to look for the link until they found it. Participants were given unlimited time to complete any or all of the tasks.

Success was determined by two assessments: programming and navigation. The first objective was to confirm that the Learning Management System was programmed correctly: all of the links and resources opened the corresponding course content. The second goal was to evaluate the participant's ability to master the skills required to successfully locate content online effectively and efficiently." (Hargittai, Eszter, and Steven Shafer, 2006)

Hardware and Documentation

The beta test machine was a commercial Windows Vista ™ business computer. The beta testing was performed with the default desktop, display, and Internet Explorer settings that are available without upgrades or add-ons. The beta test was recorded on video. A microphone was placed on the desk. The participant's computer activity was recorded with Adobe Captivate.

Research and Approach

The Comma Project deployed an Action research method of inquiry, a systematic way to improve the teaching and learning environment. This is an iterative development process for continuous improvement. At each stage of the design the user interface was tested. Beta test responses were reviewed and used to refine the navigation and course content.

Action research may be defined as: "use of a variety of research methodologies that organizations use to create change while simultaneously providing understanding." Two stages are involved; the first is a cyclical process that includes action and critical reflection, the second involves using this information for continual improvement. "Collaborative action research:

- is collaborative
- is action oriented
- targets the teaching/learning processes
- targets issues within the team's scope of influence
- is inductive rather than deductive
- uses qualitative or naturalistic methods (Feun, Harrison, Wolf-Branigin, 2001)" [viii]

First Attempt: The Black Moodle

In the early days of computers and online training, Craig Mundie, Senior Vice President of Consumer Products at Microsoft, explained why more people have televisions than computers: ease of use.

> *"If they are afraid of the product, if it's just too complicated for most people to use then, [more people will buy TVs than computers] because* ***television is just dirt simple****."*[ix] [Mundie]

The design goal was to specifically eliminate all of the frames, scrollbars or new windows. The motto was: erase all of the lines and simplify the screen. The Moodle[x] Learning Management System was programmed as a Course with 17 Topics. Each Topic had a frame that displayed links to the external web pages containing the course content. The online assessments were programmed in Moodle with true/false and multiple response questions. The questions provided content feedback as well as a link to the location of the information within the course.

Unexpected Consequences

The first beta test participant was a woman with solid computer skills. The researcher intervened when the participant became frustrated and confused. In the Black Moodle tests, the user was confused by the design.

Where is Home?

Each content link opened a new browser window. To return to the Moodle page that served as the launch pad for the course (what most people would call the "home page") the user had to close the second window. A link on each page of the second window labeled "Home" took the user to an html course table of contents that also opened in the second window. This page was designed for when the course was used by itself as a series of web pages with no Moodle or other learning management system. Although it looked like a course home page, it wasn't what the current system used as a point of departure, and in fact one could not navigate to the quizzes or the rest of the course administration from it.

There were written instructions on the Moodle page telling students to close the second window to return to the Moodle page. This created a working memory issue. The instruction had to be retained in working memory for the duration of the student's work in the topic. Naturally the instruction was forgotten by the time it was required.

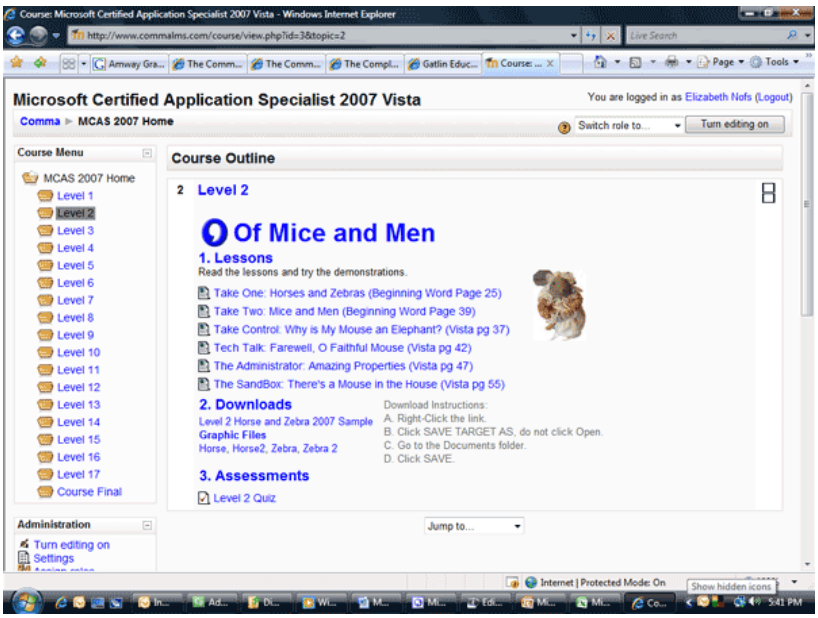
Outside the Box

The black and white TV screen image was too strong: it trumped the users' expectations. At one point, the tester was instructed to take the Quiz. There was a link just below the bottom of the TV screen image labeled "3. Quiz." The student never clicked on it however, circling her mouse within the bounded "screen" image and ignoring the link mere centimeters below her area of attention. When asked later why she didn't use the "Quiz" link she commented that she didn't think she was allowed to go outside the box.

Second Attempt: The White Moodle

Taking the user testing data into consideration, we developed a new design strategy. The Moodle LMS retained the links for the Levels, Quizzes and Assignments.

The Content links were now a separate web page, which was displayed in a frame. The result of this programming was a beautiful, easy to navigate Course Topic. However, the frame page did not track any student activity. The instructor could not determine the student's progress!



The issue was resolved by adding Moodle resource links that launch the course content. Now when a student selects a link to read a lesson or take a quiz, the event is automatically recorded in the Moodle database, making it easy to see who has completed each topic and activity.

Conclusion

e-Learning environments, like any web interface, risk becoming confusing. Navigational information can add to the cognitive load of the student, reducing working memory available for processing the more important instructional content. Women are at a particular disadvantage because most programmers do not take gender differences into account when designing user interfaces.

The Comma Method tries to incorporate the navigational preferences of women into the instructional design. A series of user tests completed on a college-level e-Learning course revealed flaws in early designs that were corrected through successive iterations of design and testing. Two main conclusions were reached.

- Give students an overall map of interface objects or application options. This gives them the advantage of a breadth-first orientation that may be less natural for them than a depth-first approach.

- Giving students permission to perform actions in situations where a decision is required.

While these design considerations were formulated and intended to help women students, it is reasonable to assume that they will not hinder men's use of the system. They may even help.

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