## ABSTRACT

WHITMAN, LISA. The Effectiveness of Interactivity in Multimedia Software Tutorials. (Under the direction of Dr. Eric Wiebe and Dr. Chris Mayhorn).

Many people face the challenge of finding effective computer-based software instruction, including employees who must learn how to use software applications for their job and students of distance education classes. Therefore, it is important to conduct research on how computer-based multimedia software tutorials should be designed so they are as effective as possible for instructing users on a software application and preparing them to use it for the tasks they will need to perform. This study investigated if comprehension of a software program and performance of accomplishing tasks using the software is aided by incorporating animation and user interactivity in a multimedia software tutorial. Effects of multimedia on user engagement and workload were also explored. The study compared common multimedia types of software tutorials – static, animated, and interactive. Results indicated that interactivity in multimedia software tutorials is effective in improving user engagement, the user's perception of the learning experience, declarative knowledge of the software program being taught, and ability to use the software program to perform tasks quickly and accurately.

# The Effectiveness of Interactivity in Multimedia Software Tutorials

by
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## BIOGRAPHY

Lisa Whitman specializes in human factors research and applying it to the design of usable computer systems, especially instructional technology. Lisa finds it rewarding to help people utilize e-learning to accomplish their educational goals. She strives to research and communicate best practices for distance education and apply her knowledge to designing and developing effective and engaging e-learning programs. Lisa has worked in the field of human factors since 2001, analyzing user experiences and designing user interfaces for websites, software, mobile applications, and instructional technology. She has worked for SAS Institute, Inc. since 2005, currently in the role of Senior Sales Training and Development Specialist designing and developing e-learning programs for sales employees, and previously as a Usability Analyst designing SAS Business Intelligence web-based applications and mobile applications. Lisa has also previously done usability research and design work for Lenovo, Distance Learning Systems Group, and Dunlap and Associates. She has presented her research at conferences including Human-Computer Interaction International and the Annual Meeting of the Human Factors and Ergonomics Society. Prior to studying Human Factors and Ergonomics at North Carolina State University, Lisa earned her Bachelor of Science degree in Neuroscience at Fairfield University and earned a Masters of Arts degree in Human Factors Psychology from California State University, Northridge.

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# INTRODUCTION

Computer users often have to learn new software programs in order to accomplish personal or professional tasks. People may find themselves having to learn software that comes with a new electronic device in order to use it, or become accustomed to a newer version of a familiar software application in order to take advantage of recently added features. Students may need to learn new software applications when they are taking classes. Many students find that they have to learn how to use software on their own if they are taking college courses through distance learning or if a college does not provide time for students in a class to learn the software in a computer lab together. A company may decide to use a new software application as a standard for accomplishing a task, and employees need to learn the software application quickly before productivity starts to decrease, but thoroughly enough to do their job well. New employees may find it daunting to be hired on to a new position if they are faced with the challenge of learning software applications that they will be required to use. The employer or the employee needs to find an effective way of learning the necessary software applications, so that the new employee can start doing his or her job as quickly as possible.



There is a diverse multitude of ways to learn about software applications and how to use them to accomplish tasks for personal use, school, or work. Technological advancements in instructional delivery methods and the increasing need for software training for jobs and distance education college students have moved instruction from manuals and classroom instruction to electronic formats including Web-based instruction, and software tutorials

(Atlas, Cornett, Lane, & Napier, 1997; Sims, Burke, Metcalf, & Salas, 2008). Help features are built into many software programs, providing the software user with tutorials or step-by-step instructions on how to accomplish common tasks and provide answers to frequently asked questions. Many software applications refer users to on-line help by providing links to the software company's website. Computer-based tutorials are becoming an increasingly popular means of training (Gist, Schwoerer, & Rosen, 1989). Tutorials on many software applications can be purchased, and an increasing number of software applications include tutorials as a help feature or provide them on the support section of their website. Software tutorials are a type of computer-based instruction that usually contains illustrated examples, instruction, structured exercises, and feedback based on the user's performance (Gist et al., 1989).

There are many advantages to providing software instruction in an electronic format (Atlas et al., 1997; Carpenter, Watson, Raffety, & Chabal, 2003; Reclam & Sexton, 1994; Steele-Johnson & Hyde, 1997). One advantage of computer-based instruction is convenience. Software tutorials included with software or available online are always available to a learner, unlike classroom instruction. Since they are located on the computer, they are also less bulky than manuals or books. Software tutorials are also easier to distribute and update, giving users easy access to the most current instructional materials. Also, computer-based instruction has capabilities that printed instruction lacks, such as providing students with instant performance-based feedback, and the opportunity to practice skills with the software.

If computer-based software tutorials are usable and designed well, then they can effectively teach the user about a software application and how to use it, which will not only improve efficiency and satisfaction with using the software, but financially benefit the software company in reduced product support and marketing costs as well (Atlas et al., 1997). It is in the interest of a software company to provide effective instruction to its users so that users will be able to take advantage of the software application's capabilities, be satisfied enough with the software to recommend it to others and purchase newer versions, and not have to call for technical support. Since the need is evident for computer-based software tutorials, research should be conducted on how tutorials should be designed so they are as effective as possible for instructing users on a software application and preparing them to use it for the tasks they will need to perform. With the potential that computer-based software tutorials have, their design should be optimized to provide software users with highly effective instruction.



Computers have the potential to provide multimedia training environments that are engaging (Atlas et al., 1997; Carpenter et al., 2003; Hegarty, 2004) and effective (Mayer & Moreno, 2002a; Stemler, 1997). Computer-based training may be a more effective and lower-cost training method over classroom training for some computer users (Atlas et al., 1997). Therefore, further research is needed on how to make computer-based software training as effective as possible. In order for a software tutorial to be considered effective, it must: 1) help the user comprehend the purpose of the program, 2) introduce the user to the software user interface layout and tools available to perform tasks, 3) help users understand

the program's capabilities, and 4) help the user learn the procedures and skills for performing tasks. An effective tutorial will teach the user how to eventually use the software to perform tasks and help the user acquire the skills necessary to perform the tasks without the tutorial's assistance. Part of the key to the success of the software tutorial will be effectively engaging the user in the cognitive tasks needed to master the software tool.

Tutorials can be described as being designed in one of three different forms of multimedia presentation: static, animated, and interactive. Static tutorials contain written instruction, and sometimes include graphic illustrations and audio instruction. The user can move from one section to the other as they view the tutorial and learn about the features of the software program that they are interested in. An animated tutorial includes movement of objects on the display with the intent to better demonstrate how one would perform an action using the software. For example, the tutorial could include a video showing a screen shot of the software application with the mouse cursor moving toward a menu, then selecting a feature, the consequent dialogue box appearing, the mouse selecting the appropriate response, and the result of that action. Animated tutorials allow the user to watch while the tutorial demonstrates what the display should look like when the user is performing the action on their own using the software. Interactive tutorials are also used to teach software. After viewing animated or static instruction, an interactive tutorial allows the user to interact with the software application in order to practice what they are being taught. For example, an interactive tutorial, like Ribbon Hero for Microsoft Office (Microsoft Office Labs, 2011), will instruct a user on the step-by-step process of performing various tasks involved in

editing a Microsoft Office document. Ribbon Hero will provide the user with a work file to open in an Office program so the user can use the program's tools to practice editing the document based on what they learned. If the desired result is not obtained, the user can refer back to the tutorial and click on links to view images that guide them to the tools that they need to use to perform the task. An interactive tutorial like this provides instruction, gives the user an opportunity to practice, and provides additional help if it is needed.

While software tutorials hold the potential to be effective learning tools, if they are not designed well, then they can pose disadvantages to the user's learning experience (Hegarty, 2004). For example, a poorly designed tutorial could increase a student's cognitive workload. If the material being taught involves understanding how certain objects being changed can affect a system, it may be hard to understand these changes and effects if the material is taught in a static format. The student would have an increased cognitive workload as they try to visualize changes over time and corresponding effects in their head, and this increased workload could lead to cognitive overload as they try to comprehend the new material. Animation can help relieve the cognitive workload of visualizing changes to a system over time, but if the user is trying to follow along with an animation that is going too fast for them, then it can lead to increased cognitive workload that could interfere with learning. It is not enough for a tutorial to take advantage of the capabilities of computers and multimedia. Its design must be carefully considered and based on human factors research in order for the tutorial to be effective at instructing the user.

In order for a software tutorial to be designed well, the designer must know the goals of an effective software tutorial and apply psychology research to understand what makes a tutorial effective. An effective software tutorial will help a user understand how a software application works and give them the ability to perform required tasks on their own. In order to do this, tutorials must first be able to draw and maintain the user's attention enough that they are motivated to use the tutorial and learn about the software. Secondly, effective tutorials should also be designed in a way that promotes learning, based on cognitive psychology research models, in order to promote efficient storage of information in long-term memory through schema construction and automation, and decrease extraneous cognitive workload. Finally, effective tutorials should be designed to optimize the capabilities of multimedia in order to help the user be able to learn, remember, and apply the concepts and skills taught in the tutorial. Since all of these factors must be considered in the design of a software tutorial for it to be effective, the application of research on how people learn, and specifically how people learn with multimedia instruction, is needed to design effective software tutorials (Hannafin & Kim, 2003; Hung, 2001; Langhorne & Swierenga, 2004; Winn, 2002; Yan, Hao, Hobbs, & Wen, 2003).



**Introduction Summary**

Discovering ways to improve training effectiveness is an important area of research. Traditional instructional delivery methods for teaching computer users about how to use software applications, such as manuals and classroom instruction, are still popular choices for instruction, but they may not be the best methods for teaching users how to understand an

application enough to be able to use it on their own to accomplish necessary tasks. Computer-based learning tools have the potential to instruct users in ways that other materials cannot. Computers can provide multimedia instruction, engaging different senses with audio instruction, visual displays, and physical interaction. Research has shown that the use of multimedia in computer-based instruction has the potential to capture a user's attention and increase their learning performance (Zolna & Catrambone, 2008). Computers also allow for animation so that students can see an analogous representation of the software being used exactly how they will use it. For example, a tutorial can show a video of what it would look like when the mouse moves across the screen and selects tools in the software's user interface. In contrast to other forms of study aids, such as manuals or guides, computers have the potential to offer unique capabilities and opportunities for the creation of interactive elements between the student and the subject matter, giving students the ability to manipulate objects on the display and see the subsequent outcomes. For example, students can be instructed on how to accomplish a task using a software application's tools and then be given the opportunity to practice the task using the software application. In addition, the computer can provide feedback on the student's accuracy and level of understanding of the material through responses to the student's interactions with the computer program. The effects of multimedia, tutorial design, and the capabilities of computers on computer-based instruction and software tutorials have yet to be fully explored. Knowing more about how the capabilities of computer tutorials affect learning will allow the computer to be utilized to its greatest potential as a learning and training environment. The purpose of this study was to

determine if comprehension of a software program and performance of accomplishing tasks using the software is aided by incorporating animation and user interactivity in a computer-based software tutorial. Also of interest is whether animation and interactivity raise perceived user engagement in the tutorial and whether this enhanced engagement leads to more effective training.

## LITERATURE REVIEW

A review of psychology research will support that, in order to be effective, a software tutorial should: 1) engage the user enough so they maintain their attention on the instructional material and are motivated to use the tutorial and learn about the software, 2) provide effective instruction that minimizes extraneous cognitive workload and promotes efficient information processing for storage of information in long-term memory, and 3) teach the user the procedures and tools involved in performing tasks using the software program. Of particular interest is design strategies that can be used to present demonstrations of software use and whether animated and/or interactive elements in a software tutorial provide a mechanism for improved learning. In order to produce an effective software tutorial that will maximize user comprehension of a software program and promote good performance in accomplishing tasks using the software after using the tutorial, literature research must be conducted in areas including human factors and multimedia learning, and then applied to tutorial design.



By exploring research in these areas, software tutorial designers can address the unique challenges of designing effective multimedia instruction in a way that will promote learning and performance for the tutorial user. A software tutorial designer needs to make sure that the tutorial is meeting the needs of the user, and not just including the latest technologies without thought on how the technology affects the learning experience. Referring to research in human factors and multimedia learning, a tutorial designer can check that the tutorial meets the requirements to satisfy the cognitive needs of the user so that

comprehension and performance are enhanced. Research can also reveal to tutorial designers ways in which they can improve their design to be more effective.

Effective software tutorial production is not only dependent on tutorial designers reviewing research, but it also relies on researchers. Empirical research should be driving the design of software tutorials. In order for that to be accomplished, researchers must address the questions necessary to understand and meet the needs of software users. Researchers need to understand what the users are using the software for, how often they will be using the software, and by what means they are able to gain instruction on how the software works. Sometimes people do not use a software program frequently, so software tutorials need to be effective in order to maximize retention of information related to important aspects of the software. Computers are becoming a common way for many software users to obtain instruction (Atlas et al., 1997; Gist et al., 1989; Sims et al., 2008), therefore researchers need to investigate the optimal ways of utilizing a computer environment for providing instruction to software users. This requires research in psychology and education, specifically research in multimedia learning, in order to understand how learning is influenced by different multimedia modalities, and how it can be enhanced by multimedia instead of negatively affected by it. Researchers need to apply supported theories in psychology, education, and human factors in order to design experiments to test relevant hypotheses and develop guidelines for tutorials design. Researchers also need to notice what types of new technologies are being used to produce software and explore if there are any limitations to their use in instructional environments and determine how their potential can be optimized

for providing effective instruction. Improving multimedia software instruction demands an iterative process between research and design to support the wide, and persistently growing, population of people who need to learn software in a computer-based environment.

As tutorial design and development have evolved along with technology to include different kinds of multimedia, human factors research can be conducted to provide design guidelines for producing more effective multimedia tutorials (Mayer & Moreno, 2002a). Design improvements based on research are likely to lead to more effective software tutorials (Stemler, 1997). An effective tutorial will help the learner understand how the software works and promote accurate performance of skills learned by providing the ability to perform required tasks using the software without the help of the tutorial. A software tutorial can be designed effectively by using multimedia to attract and maintain the user's attention to important information, applying theories of information processing to promote effective use of cognitive resources for processing and long-term storage of information and minimize extraneous cognitive workload, promoting the development of an accurate mental model of the software program, and helping the user develop procedural knowledge while practicing skills. Research in these areas can provide guidelines on which multimedia modalities to use - static, animated, or interactive - and encourage methods for engaging users and maintaining their attention, and supporting optimal information processing for storage in long-term memory and retrieval for good performance when the information needs to be used.

Researchers have provided a foundation of psychological theories that can be applied to the effective design of multimedia software tutorials. Regardless of which emerging

technologies are involved in developing a multimedia software tutorial, the design of the tutorial should adhere to the principles established in empirical research in order to be effective in promoting optimal learning and performance, and utilize the multimedia modality that best promotes learner engagement, effective use of cognitive resources for information processing and long-term storage, mental model development, and development of procedural knowledge while rehearsing skills using the software.

## Learning with Multimedia

Multimedia technology provides instructional designers with a variety of options for delivering computer-based software tutorials. It is important for designers to understand potential benefits and limitations of different technologies and modalities in order to choose the best delivery method for a software tutorial. Psychologists have conducted research comparing different multimedia modalities and various applications of emerging computer technologies in the context of computer-based tutorials in order to develop learning theories and provide guidelines for using technology to promote effective instruction.



### *Attracting and maintaining attention and engagement with e-learning*

An instructional designer can manipulate the various ways that multimedia can be utilized to attract and maintain a learner's attention in a computer-based tutorial. Therefore, it is important that a tutorial is designed based on research on how engagement with multimedia can lead to deeper learning and improved performance. Otherwise, multimedia may accidentally be implemented in a way that distracts the user's attention rather than focus it on the information that must be learned and keep the user engaged in activities that

promote further comprehension of the subject matter. Useful multimedia draws the user's attention to important information, maintains their attention on the instructional materials, and motivates them to interact with it. While designing a multimedia tutorial, the instructional designer must think about how to get learners to engage and focus on the instructionally important elements of the tutorial and how the multimedia instruction can be designed so that it is not only engaging, but also effective for instruction. Designing enjoyable and engaging training is important since it is difficult to motivate people to learn more than a minimal amount to get the job done. A training program that no one will use or refer to is useless. Increasing the learner's motivation to interact with a training program is important, but the training program must also effectively teach the material if it is to be a good use of the learner's time. (Atlas et al., 1997)

One modality for presenting computer-based instruction is through static words and images on a computer display. Research has shown that the time users will typically spend with static instructions and images, which do not contain animation, is not sufficient to learn how to use the software efficiently (Atlas et al., 1997). Studies have shown that using multimedia and animation in an instructional system increases learners' motivation to interact with the system. Learners stated that they preferred animated instructions to text-based instructions. Research has also shown that learners pay attention to multimedia examples and refer back to them when solving problems. The examples are beneficial for learning because learners explain the examples to themselves, and effective self-explanation leads to improved learning (Atlas et al., 1997). Czarkowski (1996) found that learners prefer

audio and animation to static graphics and instructional materials without audio. Research has shown that multimedia can keep learners engaged more than passively reading a sequence of screens that contain instructional text and static images by incorporating multimedia and interactivity similar to that of video games, in a method known as serious gaming (e.g., Neill, 2009). The learner is engaged with this type of multimedia learning environment because the animated graphics and sound add a level of realism to the materials that static images and text do not portray, and with realism, the learner feels that the learning environment is relevant to the work environment that they will be executing real tasks in after the training. The learner feels more immersed in the environment when it is realistic and relevant and when interactivity is incorporated to maintain their engagement. Interactivity added should challenge the learner to perform tasks in the simulated environment that are similar to what they would do in their work environment, with hints and tips that can appear to guide the learner. If the learner is advanced, then tips should not appear to distract and frustrate the learner. The multimedia should support the learner's level of expertise, with animated tips and feedback appearing as they are needed (Neill, 2009). Static graphics and instructional text cannot support the user in this way, so they may get frustrated if they come across sections that they don't understand or may get bored and start skimming if they are not challenged enough. Multimedia has the potential to keep a user engaged through a learning environment that is realistic, relevant, and provides customized coaching.

Research has shown positive effects of animated displays on learner motivation (Hegarty, 2004). A theory presented by Kennedy (2004), the cognitive interaction model, also

predicted that effective interactive design of instructional content will improve learning by engaging students in deep-level cognitive processing through behavioral processes. Kennedy proposed that by using cognitive strategies to participate in activities and interactions with the instructional materials, students will have greater motivation to learn due to maintenance of interest in the materials through sustained meaningful cognitive processing. Kennedy also stated that students would have increased performance in recall and comprehension of information learned from interactive instructional materials due to interactivity actively promoting students to engage in learning strategies that promote both surface-level processing (such as rehearsal and memorization) and deeper level processing (including elaboration, organization, and critical thinking).

Research shows that active interaction with instructional materials is important to learning, and a valuable method for keeping students cognitively engaged in the instruction. As Kozielska (2000) states, "Learning can be defined as becoming aware of various relationships: the world with the object, the object with its features, a specific action with its results. This happens, primarily, as the result of carrying out specific educational tasks or assignments" (p. 162). Kozielska compared and analyzed the contribution to cognitive activeness of computer assistance in a physics laboratory at a technical university, and demonstrated that students who used educational computer programs showed more activeness in their cognitive behavior on three levels. Three groups of students were compared, a control group that did not use computer assistance, a group that used a demonstrative educational computer program which presented examples upon the students'