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ABSTRACT OF DISSERTATION

James P. Gleason

The Graduate School

University of Kentucky

2009

THE IMPACT OF INTERACTIVE FUNCTIONALITY ON LEARNING OUTCOMES: AN APPLICATION OF OUTCOME INTERACTIVITY THEORY

ABSTRACT OF DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy in the
College of Communications and Information Studies
at the University of Kentucky

By
James P. Gleason

Lexington, Kentucky

Director: Dr. Derek R. Lane, Associated Professor of Communication

Lexington, Kentucky

2009

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ABSTRACT OF DISSERTATION

THE IMPACT OF INTERACTIVE FUNCTIONALITY ON LEARNING OUTCOMES: AN APPLICATION OF OUTCOME INTERACTIVITY THEORY

Scholars have examined a variety of dimensions and models of interactivity in an attempt to articulate a comprehensive definition. Outcome Interactivity Theory (OIT) considers interactivity to be the result of a communication event involving the successful integration of three *predictive dimensions*: the presence of actual interactive technological features, the presence of similarly reactive content elements, and relevant user experiences that empower the user to employ these interactive elements within the communication event toward a desirable outcome.

This dissertation accomplishes three major objectives: clarify the literature relating to the interactivity construct; introduce Outcome Interactivity Theory as a new theory-based conceptualization of the interactivity construct; and test Outcome Interactivity Theory using a pre-test post-test control group full experimental design. The study tests the impact of interactivity on knowledge acquisition and satisfaction student learning outcomes. In addition, the OIT model itself is tested to measure the effect of interactivity on knowledge acquisition and satisfaction. Finally, this study presents a new set of highly reliable interactivity measurement scales to quantify the influence of specific individual dimensions and elements on interactivity as defined by the OIT model.

Results are described, and limitations and practical implications are discussed.

Keywords: Outcome Interactivity Theory, new media, interactivity, computer-mediated communication, instructional design

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Student's Signature

_12/16/2009_________________________
Date

THE IMPACT OF INTERACTIVE FUNCTIONALITY ON LEARNING OUTCOMES:
AN APPLICATION OF OUTCOME INTERACTIVITY THEORY

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DEDICATION

To Missy and Courtney.
To Mom and Dad.

ACKNOWLEDGMENTS

Few accomplishments are truly solitary, and this journey would have not been possible without the encouragement, support, guidance and insights of many others.

First, Dr. Derek Lane was my mentor, teacher and friend, and it was my good fortune to have him serve as my Chair. From the start, his encouragement and advice have been priceless, and I owe him a great debt. I also thank the complete Dissertation Committee, and outside reader, respectively: Dr. Jim Hertog, Dr. Deborah Chung, Dr. Gary Anglin and Dr. Joanne Melish. All provided valuable insights and critiques that helped refine and strengthen all aspects of this work.

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All deserve my humble appreciation and heartfelt thanks.

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Chapter 1

Introduction

A simple shift in perspective can radically reshape an individual's perception. Such is the case when examining the concept of interactivity and the role it plays in the communication process.

Over the past several decades, scholars have examined a variety of related dimensions in an attempt to articulate a comprehensive definition of interactivity. These models fail to capture the full range and complexity associated with the construct. To date, researchers have failed to produce a broad theory-driven model whose dimensions and influence can be measured reliably in an experimental setting. Efforts have borne little fruit in theorizing how interactivity affects the process and impact of communication (Sundar, 2004; Bucy, 2004). A more balanced and theory-driven model of interactivity is needed, one that incorporates a variety of contributing elements within a wider unifying construct that ultimately predicts the influence of interactivity on user behaviors.

The continued focus on interactivity scholarship is especially relevant as the impact of digital media grows, as evidenced by the rapid migration of published content to online availability and, most, recently by the explosive growth of social networking applications. As new media and technologies surface, the need increases for an overarching theory of interactivity that embraces and incorporates new or emerging elements within the mediated communication process.

In the past, interactivity has typically been conceptualized as relating directly to the presence of particular technological features, a user's perception of the communication process, or a combination of both. In each case, interactivity is generally framed as something embodied within or an antecedent of the communication process. Much ambiguity falls away when interactivity is viewed instead as something that occurs *as a result* of a communication event that embodies the mutual influence of a number of contributing dimensions, including both technology and user perception.

This manuscript seeks to clarify the existing literature relating to the interactivity construct, and presents Outcome Interactivity Theory[1] (OIT) as a comprehensive theory of interactivity as a step toward that goal. According to OIT, an individual's recognition of interactivity as an outcome *requires* the integration and mutual influence of three separate and distinct dimensions—actual features and functions of the technology employed, the content being communicated, and the individual experience of and specific context under which a user encounters this technology and content.

It is important to note that, from the OIT perspective, neither technology nor content inherently foster or constitute interactivity by nature. In fact, either can exhibit considerable interactive functionality without actually eliciting the recognition of interactivity by a given participant.

Content can directly influence an individual's recognition of interactivity and resulting communication outcomes in a manner independent of the particular technology or medium used to communicate these messages. The central role of content within this process has not previously been examined in communication literature.

The study described below examines interactivity's role in contributing to specific (typically positive) outcomes for participants in a communication event. The study describes this outcome as a positive learning outcome (operationalized in this study as knowledge acquisition), and tests several hypotheses regarding interactivity's contribution under experimental conditions. Also of particular value, a set of highly reliable measurement scales are presented for the first time, and quantify the influence of specific individual dimensions and elements on interactivity as defined by the OIT model.

Ultimately, Outcome Interactivity Theory should not be considered an abstract or academic framing of the interactivity construct. Its real value lies in the degree to which it can inform the development and incorporation of interactive functionality in all its forms—technology, user experience and content—in a manner that improves communication outcomes.

Thus, this dissertation serves to accomplish three major objectives: 1) clarify the literature relating to the interactivity construct; 2) introduce Outcome Interactivity Theory as a new theory-based conceptualization of the interactivity construct; and 3) test Outcome Interactivity Theory using a full experimental design.

Further, it offers a predictive model of the interactivity construct that can be applied in a variety of contexts, and in instructional ones in particular, to enhance desired outcomes for communication events. It is hoped that the OIT model can provide a roadmap for communicators in disciplines as diverse as instructional design, online marketing and advertising, and digital entertainment to more effectively apply interactive functionality as a constructive element within the development process as a means toward enhancing desired outcomes for a wide range of audiences.

The next section presents a review of relevant interactivity literature and examines a variety of theoretical perspectives that have contributed to the development of Outcome Interactivity Theory as a new theory-based conceptualization of the interactivity construct.

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Chapter 2

Literature Review

The continued study of interactivity is important because the construct can play a central role in influencing the *success* of a communication exchange. However, while its pan-contextual nature enables interactivity to find application across a range of communication contexts, its breadth has made the construct difficult to corral.

Scholars have tried to fit interactivity into a variety of conceptual frameworks as a means of clarifying its application. A longstanding problem in defining the interactivity construct is that these definitions frequently force it to fit a variety of condition states and conflicting models. Some early models (Rafaeli, 1988; Heeter, 1989; Neumann, 1991; Steuer, 1995; others) emphasize its roots in technology and the various features and functions at play. Other more user-centered models (Laurel, 1986; Ha & James, 1998) describe a piece of a communication process rather than something resulting from it.

In an effort to apply some structure to the range of interactivity scholarship, Yoo (2007) summarizes prior conceptualization efforts into three principal areas: feature-, process-, and perception-oriented interactivity (Kiousis, 2002; McMillan & Hwang, 2002).

From the perspective of feature-oriented interactivity, Steuer (1995) defines interactivity as the extent to which the medium allows the participant to modify the content or form of a mediated environment in real time. Similar conceptualizations of interactivity (Heeter, 1989; Ha & James, 1998) often relied heavily on lists of individual technology functions or features viewed to facilitate two-way communication in a manner emulating face-to-face exchanges.

In a process-oriented perspective, scholars focus on exchanges and message responsiveness in a communication setting, and define interactivity as “the extent to which messages in a sequence relate to each other and especially the extent to which later messages recount the relatedness of earlier messages” (Rafaeli & Sudweeks, 1997). This perspective is similar to the feature-oriented view in that both consider interactivity to reside in the medium or technology, and thus are confined or limited by the degree of available interactive functionality at play.

Perception-oriented interactivity refers to users’ ability “to perceive the experience as a simulation of interpersonal communication and increase their awareness of telepresence” (Kiousis, 2002). In this case perception, as well as those relevant experiences that shape it, enables the participant to *recognize* the potential for interactivity embodied in the technology and communicated content (Wu, 2005; Laurel, 1986).

This conceptualization of interactivity “components” is interesting and useful, but it and similar conceptualizations illustrate three limitations in interactivity literature. First, it should be understood that these categories are broad groupings and, in fact, some scholars combine elements of two or even all three in their models. For example, Bucy (2004) describes interactivity as being operationally composed of three principal elements: properties of technology, attributes of communication contexts and user perceptions. Similarly, Jensen (1998) describes interactivity as “a measure of a media’s potential ability to let the user exert an influence on the content and/or form of the mediated communication,” and goes on to describe four separate applications of the construct: transmissional interactivity, consultational interactivity, conversational interactivity and registrational interactivity. Such a range does not suggest a parsimonious conceptualization.

Second, previous models and topologies overlook the impact of content as it relates to interactivity. A previously underrecognized contributor to the mediated communication experience (at least as reflected in the interactivity literature), some communicated content can provide an *opportunity* for interaction in a fashion similar to that of interactive technological features. Importantly, it does so in a unique manner independent of the technology or medium used to communicate it, and the recognition of interactivity is *directly* related to the receiver's involvement with this content.

Third, interactivity has generally been framed as something embodied within or an antecedent of the communication process. These previous conceptualizations fail to fully examine the manner in which interactivity influences a given communication event. This influence is more completely realized (and more easily operationalized) when interactivity is viewed not as an element within the communication event, but rather as a *result* of the mutual influence of a number of other contributing elements within the event. This distinction has substantial implications and forms the foundation of Outcome Interactivity Theory, as discussed in detail later.

An overview of relevant scholarship reveals how definitions of the interactivity construct have advanced and evolved over the past two decades (See Appendix 1).

Two overarching dimensions are often used to describe the interactivity construct in the literature: *medium* and *human interactivity* (Gerpott & Wanke, 2004; Stromer-Galley, 2000). The term *medium interactivity* is used to describe interactive communication enabled by the nature of the medium or technology itself, and how users apply this technology to make choices and exert control over the communication process. (As such, it finds parallels in Yoo's feature- and process-oriented perspectives described earlier.) The term *human interactivity* describes two-way communication—interpersonal interaction and reciprocal communication between two or more individuals through a communication channel. (Similarly, this parallels Yoo's perception-oriented perspective.) This typology is also known as user-to-medium (or system, content or machine) interactivity versus user-to-user (or interpersonal) interactivity (Massey & Levy, 1999). Others similarly distinguish between media-centered and user-centered interactivity conceptualizations (Goertz, 1995; Kenney et al., 2000; Stromer-Galley, 2000).

Yoo suggests these two dimensions can serve as commonalities for various definitions and dimensions found in prior interactivity studies. Therefore, he argues, multiple dimensions of interactivity can be examined along a continuum from medium to human interactivity (Ha & James, 1998; Heeter, 1989; Schultz, 1999). Yoo incorporates both human and medium interactivity dimensions in his overarching conceptualization of *audience interactivity* as an attempt to "embrace the full spectrum of process-oriented interactivity from two-way communications to fully interactive communications." He broadly describes audience interactivity as "the degree to which audiences engage in the Internet-mediated communication process with the medium and/or other people." He continues more explicitly, at a lower level of interactivity online users can just click hyperlinks to get more detailed news (i.e., medium interactivity) or e-mail their opinions about the news coverage to journalists without immediate responses (i.e., low human interactivity). At a higher level of interactivity, online users can discuss their views based on the postings by journalists or other readers on bulletin boards or blogs (i.e., high human interactivity).

While appealingly parsimonious, such a medium/human model can lead to undesirable ambiguity by oversimplifying the nature of online or interactive communication to a mere categorization based largely on technology use. For example, if a person is ordering concert tickets online, it doesn't matter whether it is another human or a computer processing the transaction as long as the participant still receives his or her tickets. In this case, the outcome is far more important than some details of the process that led to it.

Greater clarity might be realized by a categorization based on technology-based vs. socialization-driven or experiential models of interactivity. In other words, it seems more meaningful to examine the application of interactive functionality according to specific gratifications sought rather than the particular process applied or used. This conceptualization and categorization can be applied to existing literature with equal ease, and is employed in an examination of earlier interactivity scholarship later in this manuscript.

Historically, the variety of incomplete (and sometimes conflicting) conceptualizations has tended to yield inexact or unsatisfying operationalizations of the interactivity construct (Bucy, 2004). A more balanced definition is needed, one that incorporates a variety of elements within a wider unifying construct that ultimately predicts the influence of interactivity on user behaviors. The next section offers just such a definition.

Interactivity Redefined

Although rarely discussed, there exists a clear distinction between the terms *interactive* and *interactivity*, one that illuminates the importance of distinguishing process from outcome in any discussion of interactivity. This distinction is central to the development of a comprehensive theory-driven model of the contributing conditions that explain the construct. It is worth pausing to clearly articulate the condition or action states relating to the concept of interactivity.

Both *interactive* and *interactivity* derive from *interaction*, a noun referring to the communication process characterized by mutual or reciprocal action, influence or message exchange. Interaction is the act or process of interacting—the *process* of communicating itself. However, though obviously related, the words interactive and interactivity each describe something quite distinct from one another. It's true the terms are often applied interchangeably in casual usage, but the roles and elements these terms describe within the communication process differ in important ways.

The term *interactive* describes technological channel features or content elements that *facilitate* an active communication transaction in which these elements enable a participant to initiate a desired action (such as obtaining data, establishing a contact or exchanging information) and, in response, obtain desired immediate results or updated information. Such interactive technology or content might be said to possess some level of "interactive functionality" (as determined by the sender) and thus embody the *potential* for interactivity (as recognized by the receiver).

Interactivity, on the other hand, describes a condition *resulting* from the integration of a number of distinct contributing dimensions during mutual and reciprocal message exchanges. This outcome-based conceptualization of interactivity is ultimately central to its contribution to each user's satisfaction with the results of the communication event itself. (In this sense, interactivity is *generally* considered to be a good and desirable thing.) Each participant individually recognizes the extent of the resulting interactivity at play, and this level varies from user to user. It is rarely a case of whether the potential for interactivity is or is not recognized. Rather, the question is one of degree–-the extent to which individual interactive elements or dimensions are present and relevant to the communication event, the degree to which they are apparent to the user in the mediated communication, the degree to which these interactive elements influence each other, and the resulting level of interactivity recognized by the participant.

By articulating this distinction between interactive and interactivity, a more meaningful definition of the interactivity construct emerges.

> *Interactivity is an observable feature of a communication event that reflects the degree to which interactive technology and content elements are influenced by relevant experiences to empower a participant to achieve a desired communication goal or outcome.*

Thus, it is *the user's* recognition and application of interactive functionality in the technology or communicated content (embodying the potential for interactivity) as intended *by the sender*. It is the realization of *interactivity potential* (a sender-based perspective) as *interactivity recognized* (a user-based perspective).

In order to fully appreciate its range of applications, interactivity must be looked upon as a multi-dimensional and pan-contextual construct. This manuscript makes an important distinction between the roles performed by sender and receiver in the communication exchange. The sometimes frustrating reality for Web developers is that browsers such as Internet Explorer, Firefox and Safari are essentially *client-side* applications, meaning the user or receiver exerts considerable control over the communicated content, or at least how it is displayed. (The opposite would be a *server-side* application in which the developer maintains complete control over the presentation, as in the case of creating an Adobe® Acrobat® pdf document whose appearance typically cannot be altered by the recipient.)

While the sender often defines the potential or opportunity for interactivity, it is the receiver who determines the nature of the interaction and thus its ultimate quality. That is not to say that the intentions of the sender don't matter. Certainly, they do. However, it is the user who ultimately perceives and processes the message and how it is communicated, including the presence and degree of interactivity involved.

This new definition of interactivity provided above differs from previous research in three main ways.

First, the recognition of interactivity *requires* the integration and mutual influence of three separate and distinct dimensions—interactive features and functions of the technology employed, similarly interactive or reactive elements in the content being communicated, and the individual experiences and specific context through which a user encounters the technology and content.

From this perspective, neither technology nor content inherently foster or constitute interactivity by nature. Either can exhibit considerable interactive functionality (or *potential* for interactivity) without actually eliciting the recognition of interactivity by a given participant. This view is in sharp contrast to earlier models that consider interactivity to be akin to a technological attribute, as though interactivity can simply be "added" to a product or process.

Second, interactivity is conceptualized as an *outcome* of a communication event, not embodied as part of the event nor contained somehow within the technology or content. Thus, it is not something one “adds” to a communication transaction, but rather is something that is recognized by the participant as a *result* of one. (For example, this conceptualization has implications for instructional design, in that one cannot “add” interactivity into a design plan beyond encouraging its potential. Rather, one would design specific interactive elements into the plan such that the potential for interactivity is present, and therefore interactivity would be among the planned outcomes contributing to an increase in knowledge acquisition or other desired training outcomes.)

Third, the participant must *recognize* the interactive functionality embodied in the technology and content that would contribute to interactivity for it to play a part in the communication event. This represents the interpretive influence provided by user experience within this definition.

Ultimately, it is the mutual influence among technology, content and user experience that elicits the recognition of interactivity by the user. This new conceptualization of the interactivity construct forms the foundation of Outcome Interactivity Theory, which is described in the next section.

Outcome Interactivity Theory

Bucy (2004) correctly suggests that shortcomings and ambiguities in the overall discussion of interactivity are often indicative of a lack of theoretical framework underlying most existing definitions. “Interactivity researchers have been fixated on continually reformulating the operational definition of the concept with little or no empirical testing to justify new and competing formulations (p. 374).”

Initial research involving the interactivity construct centered on the (then) emerging influence of the Internet and, not surprisingly, much early scholarship was devoted to the role that technology plays in influencing the recognition of interactivity (Williams, Rice and Rogers, 1988). Indeed, several researchers found the ease of measuring interactivity within a technology-based model to offer an appealing concreteness to the construct (Sundar, 2004). Yet while it is true that technology plays a central role in influencing the outcome of a computer-mediated communication event, it is among several dimensions that jointly and concurrently influence interactivity rather than acting as the sole determinant.

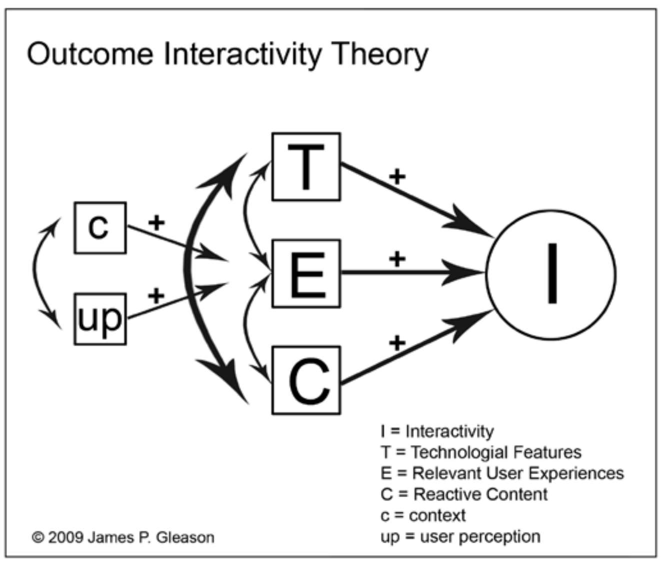
The research study described below breaks new ground by testing a new theory-based conceptualization of the interactivity construct—Outcome Interactivity Theory. It defines dimensions embodied in the OIT model in a fashion that encourages empirical testing and generalization, and examines these dimensions and elements under experimental conditions.

According to OIT, the recognition of interactivity *requires* the integration and mutual influence of three separate and distinct dimensions—the technology being employed, the content being communicated, and the individual experience and specific context under which a user encounters the technology and content during the communication event. Outcome Interactivity Theory differs from earlier scholarship and prior models of interactivity in that it considers the construct to be an outcome of the communication event.

Outcome Interactivity Theory considers interactivity to be the result of a communication event involving the successful integration of three *predictive dimensions*:

the actual presence of interactive technological features, the presence of similarly reactive content elements, and relevant user experiences that empower the user to recognize and employ these interactive elements within the communication event toward a desirable outcome. The user experiences dimension, in turn, is made up of two *contributing sub-dimensions* – context and user perception. Interactivity describes the degree individual user experiences are enabled by the interactive functionality in the technology and content that, together, contribute to a desirable outcome in a communication event (see Figure 2.1).

Figure 2.1: Outcome Interactivity Theory Model



Interactivity is defined within OIT as an observable feature of a communication event that reflects the degree to which interactive technology and content elements are influenced by relevant experiences to empower a participant to achieve a desired communication goal or outcome. Therefore, in circumstances of limited interactive features present in the technology, little interactive functionality available in the content, or a user who is untrained, distracted or unmotivated, each would be sufficient to cause a low or nonexistent level of interactivity to result. Conversely, a skilled and motivated user with advanced technology and highly interactive content (as with an iPhone) would be expected to recognize and experience a much higher level of interactivity. Again, it is *the user's* recognition and application of potential interactivity (as defined by the sender) that leads to interactivity.

As the previous sections make clear, interactivity is a multi-faceted construct too complex to be defined by a single dimension such as the technology employed. Heeter (1988) was among the first researchers to suggest a multi- dimensional model to define interactivity. Ha & James (1998), Downes & McMillan (2000) and many others have advanced this line of research.

Particularly as regards both technology and user perception, considerable earlier scholarship has contributed to the specific elements included in the Outcome Interactivity Theory model. The next section examines how previous research has contributed to the development of OIT as a new conceptualization of the interactivity construct.

Technology-Based Models of Interactivity

Even before the Internet drastically increased the applicability of such discussions, early conceptualizations of interactivity centered around user contact with technology. (In fact, rapid technological advances and this focus on the user experience spawned a unique discipline among product and software developers known as Interaction Design (Moggridge, 2007).) Certainly, many of the concepts that emerged continue to inform interactivity research, including the degree of user control (Williams, Rice, and Rogers, 1988; Neuman, 1991), degree of responsiveness (Rafaeli, 1988; Miles, 1992) and the ability to modify content in real-time (Steuer, 1995).

Early interactivity literature often described conceptualizations (Heeter, 1989; Ha & James, 1998) that emulated face-to-face exchanges, and employed lists of individual technology functions or features viewed to facilitate two-way communication toward that end. Logically, much of this discussion centered around aspects of multimedia or navigation, and tended to rely on a taxonomy of relevant features, often in the form of a simple checklist. In these cases, interactivity often was treated as a merely descriptive element rather than one centrally affecting the communication process.

Obviously, technology plays a central role in influencing the outcome of a computer-mediated communication event. While not every feature- or process-related element influences the communication process, scholars have pointed to several that seem particularly relevant.

A particularly important, and frequently misunderstood, technological attribute is *user control* of the technology, which enables the user to direct the nature of his or her communication experience online. It describes the capacity of a technology or medium to enable a participant to proactively affect the communication event in some tangible, measurable and desirable way, such as by implementing desired navigational choices or modifying (adding, deleting or changing) medium or message content. Most technology-centered models of interactivity incorporate some aspect of user control.

Some researchers specifically describe control as the ability to modify medium content (Heeter, 1988; Steuer, 1995). Others (Jensen, 1998; Wu, 2005) include elements such as the presence of navigational hotlinks. (The *ability* to include hotlinks is technology-related in that the technology or medium must offer the opportunity. However, as discussed later, the specific hotlink itself is a content element.) For example, elements that improve functionality or response time (as in the case of making a purchase online) would reflect higher levels of technological control. In comparison, the ability to change the background color on a monitor, while offering an incidental level of control, doesn't substantively influence the outcome of a communication event, and such a mere manipulation of the technology should not be viewed as synonymous with or contributing to high levels of interactivity. Similarly, a Web site with numerous hotlinks does not automatically indicate a high level of potential interactivity, since the number of hotlinks is relevant *only if* they all have the potential to contribute to a more successful and desirable outcome.

Downes & McMillan (2000) recognize the variable nature of user control as a contributor to interactivity. A higher degree of user control would be indicated by a greater number of relevant options or higher degree of flexibility available in the opportunities in which the content could be modified or an interaction with another participant could be facilitated.

Similarly, *directionality* describes the capacity of the technology or medium to enable two or more participants to interact in a desirable way during a communication event. Multi-source directionality offers an opportunity for a desirable responsiveness or the capacity for a participant to engage with one or more other participants within the event (Heeter, 1988; Ha & James, 1998; Downes & McMillan, 2000).

The potential for interactivity provided by this element is typically determined by the technological capabilities of the medium being used. For example, a typical cell phone would offer a greater degree of directionality than a pager that can only receive messages. Similarly, a chatroom would offer greater directionality than would a simple email exchange. A positive value would be indicated by the opportunity for a participant to initiate a response or to elicit meaningful feedback from another (or multiple) participant(s), whether human or computer.

Communication speed describes the *actual* communication or interaction speed of the technology or medium used in the communication event. The communication speed is affected directly by technology-related limitations such as system resources, network bandwidth or workstation workload. However, only the *actual* speed should be considered a technology element. The actual communication speed is distinct from speed as *perceived* by the user (Kiousis, 2002). (How fast participants *think* the system allows them to react to one another's transmissions—perceived responsiveness—falls within the user perception sub-dimension of the OIT model and is discussed separately later.) Higher levels of communication speed would be expected to encourage higher levels of interactivity. A higher value for communication speed would be exhibited as a faster rate of data transfer compared to a comparison group, as in the case of a broadband connection vs. a dial-up connection.

Sensory complexity describes the extent to which the technology or medium is designed to involve the senses of the user in a richer manner that contributes to the desired outcome of a communication event (Kiousis, 2002). For example, text and graphics employ the visual sense while the use of sound employs the auditory. Similarly, animations engage the visual sense to a greater degree than static illustrations. The greater the degree to which the senses can be employed in a meaningful way by a technology or medium, the greater the potential that higher levels of interactivity will be recognized by a given participant. For example, a higher value for sensory complexity would be exhibited with the capacity of the technology to deliver animated graphics or streaming audio or video.

Regarding the technological features found on such checklists, the sender or developer determines their *potential* for interactivity (or interactivity *intended*), but each element needs to be contextually substantive in order to be relevant to the ultimate quality or success of the communication experience. In this manner, while certainly not the sole determinant of interactivity, these technological features do serve as a kind of "gatekeeper" by shaping or limiting the level of interactivity potentially acknowledged by a user (or *interactivity recognized*).

Ultimately, technology-centered definitions are conceptually limiting because they don't take into account how a given medium or message might be applied in practice. When technology-based features or processes are the sole focus, these models are limited by their failure to recognize the importance of user influence within the communication event because they overlook or discount the manner in which the users *experience* this technology. This focus on the *what* at the expense of the *why* or *how* oversimplifies the complex nature of the intersecting human influences at play, and fails to take into account the variable nature of the interactivity construct (Massey & Levy, 1999; Lee, 2000; McMillan, 2000; Stromer-Galley, 2004; Wu, 2005).

A strictly objective, technology-driven approach undervalues the concrete importance of user experience and context. Unless a particular medium's technological (or interactive) potential is recognized and understood by users, those less sophisticated or experienced are unable to take full advantage of advanced technology, and these features remain unutilized. They may offer considerable interactive functionality, yet all users do not uniformly nor automatically recognize this potential for interactivity. The centrality of the user within the construct is clearly evident when comparing the level of proficiency between two users of the same piece of technology (such as a new cell phone). Indeed, the ubiquitous flashing time on many users' VCRs would serve as a common illustration of this "expertise gap."

The fact that a single technology can elicit a range of reactions makes clear the need to include the human factor in any model of interactivity. The next section explores how scholars have conceptualized these more experiential models of interactivity.

Experiential Models of Interactivity

Far from being the concrete absolute sometimes found in communication literature, interactivity is actually a highly complex and, to some degree, subjective construct—one that ultimately is a *variable*. Lee (2000) suggests "what is important is not the objectively measurable interactivity but the relationship among the variables (p. 23)." Other authors (McMillan, 2000; Stromer-Galley, 2000) similarly recognize the variable nature of interactivity.

As more user-focused models of interactivity emerged, user experience and perception were increasingly embraced as vital components in technology-based mediated communication. The user must *recognize* the potential for interactivity, which Wu (2005) defines as a "psychological state experienced by [the] site-visitor." Laurel (1986) describes the *feeling* of interactivity, or the user's sense of "participating in the ongoing action of the representation," among her defining dimensions of interactivity. In other words, interactivity just doesn't happen or exist in some static state. It is initiated by the user's (receiver's) actions, and the degree to which it is recognized is shaped by each individual's experiences.

Any recognition of interactivity depends first on the ability and capacity of each user to embrace its potential. How an individual responds to one or more interactive elements, and the opportunity for the potential increases in interactivity they present, ultimately determines the degree to which interactivity is recognized. The literature describes two elements through which user experience contributes to this outcome: *context* and *user perception*.

Both the physical and virtual contexts in which the communication occurs help shape a user's readiness and receptivity to respond to the available interactive functionality and potential interactivity present within the communication event (Kiousis, 2002). The manner in which a user comes into contact with technology and its computer-mediated content will have either a positive or negative impact on how it is received, and this influence will be present regardless of whether the contact involves a technology, medium, application, message or other form of communication content. Early communication models (Shannon, 1948; Schramm, 1954) recognize the impact of noise within the communication process. The level of noise within a given communication exchange is mediated by the context within which communication occurs.

The literature suggests a number of ways in which *context* contributes to the outcome of a communication event. Depending on contextual or environmental factors, different users (or even the same user at different times) may perceive a range of options or levels of interactivity that are possible for the same medium, technology, application or content. Context is shaped by three interrelated elements: *setting*, *cultural congruence* and *ability*.

Setting describes the environment of the encounter, including physical elements such as lighting, ambient temperature and sound level, and other similar "creature comforts." A setting that minimizes substantial physical distractions (such as noise or discomfort) would be expected to offer less interference to an individual's recognition of interactivity, and would therefore yield a higher value than one in which environmental influences detract from the desired outcome of the communication event. Thus, a high level of discomfort and a high value for setting are inversely correlated. Setting would be measured as self-reported values of personal physical comfort and freedom from distractions or frustration using a Likert-type scale.

Cultural congruence embodies the influence of the individual psychological or social needs, thresholds or ranges within which participants experience the communication event. Culture shapes the "lens" through which an individual user views and applies this influence. Cross-cultural studies by Hofstede (1991) suggest five dimensions of culture, several of which are particularly relevant as they relate to interactivity. *Individualism* or *collectivism* determines whether people are inwardly motivated or seek in-groups who look after them in exchange for loyalty. *Uncertainty avoidance* considers the extent to which people feel threatened by uncertainty and ambiguity and try to avoid these situations. A *long-term orientation* encourages flexibility, acceptance of change, perseverance and the pursuit of peace of mind.

Cultural influences such as uncertainty avoidance or individualism can shape the way in which a participant interprets other subjective elements, such as perceived responsiveness, connectedness or attitude. A cultural influence inconsistent with a desired high level for a particular element may cause a negative moderating effect on that element. For example, a typical college-age consumer might feel less comfortable with the graphic presentation of a snowboard company's Web site if it used a somber approach typical of a bank rather than one employing a more aggressive graphic style. Similarly, a high school student would be dissatisfied with a lesson if presented in a manner more suitable for a middle school student. It is the cultural gap between the content and its presentation that contributes to its dissonance. Thus, a high level of congruence between a cultural influence and an associated dimension element would be expected to elicit little dissonance, impatience or moderating influence, and therefore would be more conducive to the recognition of interactivity by the participant. Similarly, familiarity with a specific topic or subject matter might influence a user's comfort level and willingness to engage in a difficult or challenging task. Recent advertising studies (Cho, 2003; Yoo, 2007) suggest voluntary and involuntary exposure to content (that which is deliberately sought out or incidentally viewed, respectively) can influence both personal relevance and level of involvement. Cultural congruence would be measured as self-reported values using a Likert-type scale.

Ability describes the level of a participant's individual capacity to successfully engage with available technology or content in pursuit of a particular goal or outcome. A participant's *demonstrated* skill level influences his or her readiness to apply technology features, functions or related content in a meaningful and desirable way within the communication event. It may be moderated by familiarity, experience, specific training or even by a reaction to intuitive design features of the technology itself. For example, someone with a great deal of experience with cell phones and text messaging would be more likely to constructively apply a wider range of the phone's features, functions or communicated content.

A participant's actual level of ability is distinct from his or her *perception* of personal readiness, which may differ either positively or negatively, sometimes to a considerable degree. (Thus, this element is separate from and does not reflect desire, commitment, passion or wish fulfillment. No matter how much you want to be the quarterback, there is no possibility unless you actually possess the ability, George Plimpton notwithstanding.) A positive value for ability might be demonstrated by a participant's performance on a quantitative skills assessment test.

In addition to context, considerable scholarship has made a strong case for the influence of *user perception* as it relates to interactivity and the communication process (Laurel, 1986, 1991; Massey & Levy, 1999; Heeter, 1989; Stromer-Galley, 2000; Downes and McMillan, 2000; others). As discussed earlier, new media technologies may not be *perceived* by participants as affording opportunities to interact or participate (to be *interactive*), though they may actually possess features associated with interactivity by researchers. (It is presumed that these technological elements are real and not imagined. Participants must recognize and engage these technology features, but one assumes the features to be present in the first place. While users may sometimes fail to fully appreciate the potential for interactivity that is available, one cannot recognize interactivity where none is possible.)

Again, the literature suggests a number of ways in which perception can have an influence in terms of a user's receptivity toward interactivity, including *connectedness*, *presence, perceived responsiveness*, *autonomy* and *attitude*.

Connectedness describes the feeling of being able to link to the outside world and to interact with other participants or content as if physically present in a natural environment (Steuer, 1992; Ha & James, 1998). It is one way in which a participant recognizes and interprets objective elements such as technology directionality and communication speed. A high level of connectedness is indicated by the perception of increased opportunity for participant interaction, such as the capacity for real-time two-way voice communication as found in some online game environments, and would encourage a higher degree of interactivity. Perceived connectedness would be measured as self-reported values using a Likert-type scale.

Presence describes the degree to which the communication event is perceived to emulate direct or face-to-face communication or an immersive communication environment (Kiousis, 2002; Heeter, 1988; Murray, 1997). It is sometimes described as a sense of being "in the zone." For example, the popular 3D virtual world *Second Life* is characterized by high interactive functionality and graphic richness that create an immersive environment embodying high levels of presence.

An interesting analysis of this topic can be found in *Hamlet on the Holodeck*, in which Murray describes four essential properties of digital domains and makes a distinction between simply interactive and richer immersive environments.

Interactive environments are procedural and participatory. In a sense, they are closer to the computers that embody them. They follow strict rules that govern how we participate in using them. They are powerful, but rigid and unforgiving, as is obvious to anyone who has ever mistyped a Web site URL or program command.

An important trait of an interactive environment is its nonlinearity. By its nature the Web links everything to everywhere (hence the name), and frees participants from the constraints of sequence. This is reflected in nearly every site on the Web, but it's even more pronounced in digital stories or gaming environments. (Even the Graduate Record Exam is nonlinear today, having dispensed with paper copies some time ago.)

Gaming is not strictly authorship as such, since one is simply reordering a finite number of parts into a new, not quite unique order. But it is a "creative role in an authored environment," as Murray describes it, and the emotional impact is still satisfying. For example, players in *Guitar Hero* aren't actually playing the guitar, but for many the process of using the controller and interacting with the game software feels close enough and it's a lot easier. The effects are undeniably powerful, but the underlying processes are not so apparent.

Immersive environments are all this and more, engaging us at a deeper cognitive and emotional level. At their most evocative, they engage our thoughts, emotions and behaviors in a way that resembles real life. Murray describes them as spacial and encyclopedic, meaning at their best they possess a level of dimensionality, richness and depth that fosters the illusion.

Murray's book, published in 1997 and considered cutting edge at the time, describes an online environment in the earliest days of graphical online interfaces and Web browsers, and well before the advent of Adobe Flash®, let alone streaming video and 3D graphics. She enthusiastically describes text-based MUDs (multi-user dungeons) and the dimensional richness and immersive qualities they offered (for their time). Yet, if text-based MUDs were great then and seem stunningly primitive now, it's a clear illustration of the variable nature of user perception, not just individually but from a cultural perspective as well.

Like connectedness, presence involves a participant's recognition of and reaction to technology directionality, communication speed and sensory complexity. A higher level of presence would be positively correlated with a high level of interactivity. Presence would be measured as self-reported values using a Likert-type scale.

Perceived responsiveness describes a participant's *perception* of the actual communication speed exhibited by a particular technology or medium during a communication event. It is how fast users *think* the system allows them to react to one another's transmissions. As described above, a user's perception of communication or interaction speed (responsiveness) is distinct from the actual communication speed (Kiousis, 2002), although the technology would influence the range within which the perceived value exists. A higher value of perceived responsiveness would be expected to encourage higher levels of interactivity. Responsiveness would be measured as self-reported values using a Likert-type scale.

Autonomy describes a participant's *perception* of the degree of selection and the range of content and navigational options available during the communication event, *as well as* his or her ability to take advantage of those options. Both Laurel (1991) and Steuer (1992) describe the amount of variability possible within each attribute of a mediated environment as an attribute of interactivity. The availability of content options and unrestrained navigation in cyberspace embodies the rejection of strict linearity and is a central characteristic of new media (Heeter, 1998; Ha & James, 1998). Autonomy would be measured as self-reported values using a Likert-type scale.

In general, a perception of greater autonomy should positively influence the recognition of interactivity, although research by Bucy (2004) suggests that too many options may have a curvilinear effect of interfering with a more desirable outcome. He argues interactivity is desirable *up to a point*, after which it has increasingly negative consequences, and that a *moderate* degree of interactivity is optimal. Unfortunately, this interesting line of research is beyond the scope of the current manuscript.

Finally, *attitude* describes a participant's perceptual relationship with the communication event, including personal experience and the relevance of the event to an expected outcome. Attitude is influenced by *mood*, the psychological and emotional disposition of the participant toward both the communication event and the dimensions contributing to his or her interaction with it (Mishne, 2005). A number of researchers (MacKenzie et al, 1986; Holbrook & Batra, 1987; Petty et all, 1991; Batra & Stayman, 1990) have observed that mood affects both the cognitive processing of message content, and the attitude toward it.

Attitude can influence an individual's enthusiasm or receptiveness to participate in a communication event, which in turn may affect the quality and success of that participation. For example, a person who witnesses a car wreck on the way to work or is actively involved in an emotional process like a divorce may be more distracted or exhibit a more contrary attitude than usual, thus potentially affecting the outcome of a concurrent communication event negatively.

A consideration of attitude is relevant because of its impact on behavior. Ajzen & Fishbein (1980) found that the more favorable a person's attitude toward a given product or brand, the more likely the person is to buy or use that product or brand. Ajzen's (1991) Theory of Planned Behavior directly links a person's attitude regarding a given behavior to both intention and the actual behavior itself. Other variables that have been found to influence attitude include personal moral obligation (Schwartz & Tesser, 1972), self-identity (Biddle, Bank & Slavings, 1987), and past behavior or habits (Bentler & Speckart, 1979).

Attitude is also positively influenced by the participant's *level of involvement*—the perceived congruity between the purpose of the communication event and the *opportunity* to accomplish its desired goal (Greenwald & Leavitt, 1984; MacKenzie, Lutz & Belch,1986; McMillan, 2000; Cho, 2003). Regarding the question of whether the participant *cares* about the communication event and its outcome, Houston & Rothschild (1977) explore types of *personal involvement* including three types a consumer might have with a product. Their S-O-R Paradigm describes *situational involvement* (S), which includes social-psychological environmental and cultural influences; *enduring involvement* (O), which includes individual experience and personal values; and *response involvement* (R), which relates directly to the consumer decision process itself and determines both attitude and behavior. Their findings relate to the context within which a communication event takes place. Each of Houston & Rothschild's types of personal involvement reflects aspects of user perception.

Attitude can be measured as a self-reported level of enthusiasm for participation in the communication event using a Likert-type scale.

Jensen (1998) calls interactivity "a measure of a medium's *potential ability* to let the user exert an influence on the content and/or form of the mediated communication" (p. 201). The experience of using an interactive product or technology does not necessarily constitute interactivity unless the user realizes this potential and perceives it to be so (Lee, 2000; Kiousis, 2002; Bucy, 2004).

However, although many scholars have found strictly perception-focused models to be attractive, it is equally true that such models are limited in overlooking the *very real impact* of technology and the manner in which technological features and functions can determine the *opportunity* for increased interactivity as a result of the communication event.

It's plain that a comprehensive conceptualization of interactivity has been elusive, a fact largely due to its considerable complexity and ambiguity (Kiousis; Bucy; others). The emergence of just such a comprehensive view has been further hampered by the surprising absence of content as a predictive dimension in the interactivity literature. The important contribution made by content as it relates to interactivity is described in the next section.

Content's Contribution Within the Interactivity Construct

Interactivity is too complex a construct to be limited to a single key dimension, or to suggest that whether something does or does not convey "interactivity" can be determined by the mere presence of one or more separate elements. The answer lies in recognizing the multi-dimensional nature of interactivity in a more integrated model.

From early conceptualizations (Rafaeli, 1988; Steuer, 1995; others) to more recent ones (McMillan & Hwang, 2002; Kiousis, 2002; Bucy 2004; others), descriptions and models regarding the nature of interactivity have evolved considerably. Unfortunately, definitions have typically been limited or incomplete, and often take an insufficiently comprehensive or holistic view of the construct, resulting in operationalizations that only partially work.

The pan-contextual nature of most new media technology and the emergence of the World Wide Web as a mass communication medium highlight important distinctions in the manner in which senders and receivers use technology and the content it communicates. Massey & Levy (1999) make a useful distinction between *interpersonal interactivity* and *content interactivity*, the degree to which senders (in their case, journalists) technologically empower consumers over content.

The impact of content, a previously underrecognized contributor to the mediated communication experience as it relates to interactivity, is determined by the *opportunity* the specific communicated content provides for interaction. Importantly, it does so in a unique manner independent of the technology or medium used to communicate it, and the recognition of interactivity is directly influenced by the receiver's interaction with this content. Typically, a user's actions with regard to the available interactive functionality of the technology help determine how online content is selected and presented for and by a given individual, whether this content is in the form of text, graphics or multimedia elements (McMillan, 2002). When, where or how a user comes into contact with a message will directly influence the context within which the event takes place, and therefore helps determine the recognized level of interactivity.

As described earlier, the degree to which a technology enables the recognition of interactivity is determined by the degree to which a particular user takes advantage of its available interactive functionality (Bucy, 2004). Thus, the level of interactivity recognized through the use of a particular product or technology can and will vary from user to user.

As an example, take a modern cell phone. This technology can communicate via voice or text message, send and receive email messages, take and transmit photos or video, offer alternative ring tones and much more. Because it has many interactive features and thus high potential for interactivity, many users view it as delivering a high level of interactivity when they use these features. However, for the user who only makes phone calls, this modern communication marvel elicits no more interactivity than an antique dial phone that only makes calls. Yet it is the same phone—the same technology. Each user determines whether and to what degree its potential for interactivity is realized.

Similarly, content possesses interactivity functionality that contributes to the *potential* for interactivity in a manner independent of the technology or medium used to communicate it. In much the same way as technology, communicated content possesses interactive features that may contribute to differing levels of interactivity as recognized by individual users.

Consider an Adobe Acrobat document as an example. Acrobat is a widely used software product designed to enable users to view, create, manipulate and manage content files in Adobe's PDF format, making it easy and secure to share documents online. The PDF format allows documents to be shared in final printed form, including all colors, graphics and fonts.

In and of itself, these cross-platform and portability capabilities make Acrobat an excellent communication tool. However, it has many additional communication capabilities, including the ability to insert hotlinks within the document, thereby creating a Web-ready document that acts similarly to a standard Web page. Thus, a PDF document with hotlinks would possess a greater potential for high interactivity than a PDF document with no opportunities for interaction.

Again, these *content* elements contribute to the potential for increased interactivity. A critique of this view might point out the technology delivers these messages. However, while the technology does provide the capability, it is generally the content itself, and *not* the technology, that solicits the response or action from the user. Healthcare Web sites designed to provide information on specific diseases might use interactive techniques to both inform and share with individuals who have questions about those diseases (McMillan, 1999). By contrast, sites that provide information about industry services are more typically designed primarily as a supplement for the sales function and are likely to resemble an online brochure more than a potentially interactive experience. “Logic… suggests that some types of content may be more conducive to an interactive presentation than others” (p. 379). She found significant differences in levels of interactivity based on content type.

Thus, as they relate to the purpose of an online communication exchange, both content and technology shape the user’s recognition of interactivity. Web sites designed to facilitate dialogue are, almost by definition, likely to possess greater potential for interactivity. Indeed, virtually every byline on online newspaper sites (as well as printed editions) displays the reporter’s email address as a means of fostering just such dialogue.

By contrast, sites designed for publicity or sales are likely to focus on one-way, persuasive communication, consistent with a more traditional broadcast model (McMillan, p.379). How each user approaches the purpose of the communication event influences the perception of interactivity, and both content and context play a role in shaping that perception.

Message-related conceptualizations of interactivity tend to be experimentally desirable because of their precise measurement and ease of data capture. While their characteristics are easy to observe and measure, they still offer an incomplete view because they fail to take into account the content within which the message is delivered and by whom it is received.

The literature describes a number of content-related elements that contribute to the recognition of interactivity, including *accessibility*, *relevance*, *clarity* and *vividness*.

Accessibility describes the manner in which communicated online content is structured, delivered and presented, including how it is written, designed or organized. This presentation enables each user to select and display this content in its most (personally) desirable form and sequence (McMillan, 2002).

New media technology frequently delivers content (text, sounds and images) that enables (or even encourages) the user to interact with it (Lee, 2000). To a large degree, this communicated content itself provides the capability for a user to proactively affect the path or outcome of a communication event in some meaningful and measurable way, such as by implementing navigational choices or modifying medium content. For example, a participant selects a navigational hotlink or a product listing on a catalog Web site because of the specific content each reflects and because each enables a specific desired response. Though related, this is distinct from the mere capacity of the technology to display or enable the selection of a hotlink, which is addressed in the technological features dimension of the OIT model.

But how can content be interactive or foster interactivity? It does so in a manner similar to that of the technology that delivers it. As described earlier, a technology or medium encourages the recognition of interactivity to the degree that a particular participant takes advantage of its available interactive functionality (Bucy, 2004). A typical modern cell phone can communicate via voice or text message, send and receive email messages, surf the Web, take and transmit photos or video, offer alternative ring tones, and much more. Not surprisingly, many users recognize a high degree of interactivity when they use these features. However, for the user who only makes phone calls, this same cell phone is no more interactive than a simple dial phone—despite having access to the same technology. Thus, the level of interactivity resulting from using a particular product or technology can and will vary from user to user.

Content possesses a similar *potential* in the form of interactive functionality that may contribute to differing levels of interactivity for individual users. In this regard, Web page hotlinks might reasonably be considered as content elements, since it is *the content itself*, and not the technology, that directly elicits the response or action from the user. Much as imaginative graphic design or writing skill can influence a reader's interest in or satisfaction with a book or magazine story, it is similar creative influence and tactical intent that determine which, how many and where specific hotlinks are integrated into a Web page's content. These subjective decisions directly affect audience judgment of the site's effectiveness and, in turn, each participant's satisfaction with the communication event. To be clear, while the technology provides the opportunity to include hotlinks, the specific links themselves are *content* elements that contribute to increased interactivity.

High levels of accessibility would be expected to positively influence the recognition of interactivity. A higher value would be indicated by a greater number of desirable options or a higher degree of flexibility in the ways in which the content could be modified or an interaction with another participant could occur (when compared to another sample).

Clarity describes the degree to which sought-after content is displayed with appropriate or expected visual and conceptual organization (logical placement, sequence, etc.), and with a generally acceptable level of accuracy, clear writing style and grammatical, spelling and punctuation standards. Content with a high level of clarity is easy to read, without obvious factual errors, and free from grammatical errors and other similar distractions, and would be expected to be positively correlated with high levels of interactivity. Clarity could be measured quantitatively by the number and severity of deliberate errors included in a given piece of content.

Relevance describes the degree to which available content is desirable and consistent with a user's goals for the communication event. Relevance is influenced by the communicated content's intuitiveness, appropriateness and congruity. At issue is whether the available content is the *right* content—that is, more or less desirable for that participant in that particular communication event. This outcome-oriented and user-centered variable is determined by the needs of the user rather than the intentions of the content producer, and therefore is consistent with both Uses and Gratifications Theory

(Katz, Blumler, & Gurevitch, 1974) and Expectancy-Value Theory (Palmgreen & Rayburn, 1985).

Recent marketing research has found that relevance and its influence on participant attitude play a substantial role in Web-based advertising. A number of researchers (Moore et al, 2005; Newman et al, 2002) found a positive correlation between user attitude and ad congruency, the level of connection between the Web site and banner ad subject matter.

Highly relevant content would be expected to be more engaging and to be positively correlated with the recognition of interactivity. Relevance could be measured as self-reported values using a Likert-type scale.

Vividness describes the degree to which available content is displayed using high levels of graphic richness, animation and audio/visual elements (when compared to traditional media). Steuer (1995) describes vividness as the ability of a technology to produce a “sensorially rich mediated environment” (p. 80). New media content is noteworthy for its typically higher level of vividness, which sets it apart by making the content presentation more appealing and engaging.

The relevance of vividness to interactivity is supported in online advertising research by Cho & Cheon (2004), Li et al (2002), and others indicating intrusiveness (as demonstrated by high levels of graphic richness) has a positive impact on brand awareness. Moore et al (2005) found color banner ads would yield higher click-through rates than equivalent black and white ads. Similarly, Li & Bukovac (1999) found that “animated” banner ads, which they define as display banner ads that are hyperlinked to an advertiser's Web site, result in quicker response and better recall than static banner ads. Also of interest, they found that larger banner ads lead to better comprehension and more clicks than small banner ads.

Vividness would be measured as self-reported values using a Likert-type scale. Moderate to high levels of vividness would be expected to positively influence the recognition of interactivity, although extreme levels of visual richness would be more likely to be viewed negatively as noise and interfere with desired outcomes, creating a curvilinear effect on vividness. However, an exploration of the specific limits of this curvilinear effect are beyond the scope of this study, and operationalizations of this variable are kept within those of generally accepted practice, as described later.

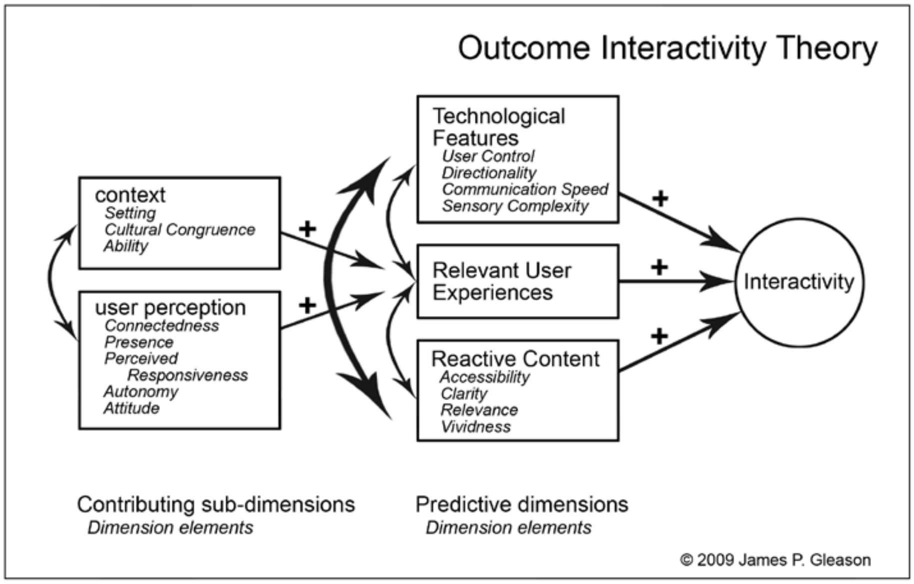
The next section describes how various technology, content and user experience elements are embodied in the OIT model.

Dimensions and Elements of Outcome Interactivity Theory

As discussed earlier, Outcome Interactivity Theory recognizes the influence of three predictive dimensions: *technological features*, *reactive content* and *relevant user experiences*. The user experiences dimension, in turn, is made up of two contributing sub-dimensions: *context* and *user perception*.

To expand, each predictive dimension and contributing sub-dimension of the OIT model consists of a number of *dimension elements* (see Figure 2.2) suggested by a wide body of extant literature. These elements influence one another, and together determine the manner and degree to which each participant's involvement in the communication event does or does not result in the recognition of interactivity, as well as the degree of interactivity perceived.

Figure 2.2: Dimensions and Elements of Outcome Interactivity Theory



It should be noted that, while each of the elements described below can influence the perception of interactivity by a given user, there is often considerable interplay and mutual influence among the elements themselves. The individual dimensions and elements within the OIT model are examined in detail below.

The *technological features* dimension of OIT considers the capacity of individual technologies and media, including specific actual features, functions, attributes or applications, to influence the recognition of interactivity by a participant as a result of a communication event. The technological features dimension of OIT is shaped by four specific elements: *user control*, *directionality*, actual *communication speed* and *sensory complexity*.

While technology clearly exerts an influence, it shares this influence with several other dimensions within the OIT model, and interactivity does not reside in the features or functions of a technology or medium in a concrete way, as some argue (Sundar, 2004).

The *relevant user experiences* dimension of OIT suggests that interactivity is confined by the ability and predilection of each participant to recognize the interactive functionality and potential for interactivity found within a particular communication event. The relevance of each participant's experience plays a central role in determining both the presence and degree of interactivity at play as a result of the communication event. How an individual responds to the dimension elements described below, and the potential for interactivity they present, helps determine the degree of interactivity recognized by the participant.

Each individual response is shaped by two interrelated influences that define each user's experiences—individual *user perception* and the *context* or environment within which the communication event occurs.

Context shapes a user's readiness and receptiveness to respond to specific interactive elements, including the physical and virtual environment in which the communication event occurs (Kiousis, 2002; Gleason, 2007). In this sense, it is an objective and concrete variable that is observable and easily measurable. The contextual manner in which a participant comes into contact with a particular medium and the computer-mediated content it delivers will have a positive or negative impact on how this content is received. The level of noise within a given communication exchange is mediated by the context within which the communication event occurs (Shannon, 1948; Schramm, 1954).

Depending on contextual or environmental factors, different users (or even the same user at different times) may perceive a range of options or levels of interactivity that are possible for the same medium, technology, application or content. Within the

OIT model, the context sub-dimension is shaped by three interrelated elements: *setting, cultural congruence* and *ability*.

According to Outcome Interactivity Theory, the participant must actively *recognize* the potential for interactivity offered by a given technology. The *user perception* contributing sub-dimension of OIT includes five dimension elements: *connectedness*, *presence*, *perceived responsiveness, autonomy* and *attitude*.

Each of these elements can play a role in influencing user perception within the communication event. However, there must be something to be perceived and communicated, and reactive content plays this role within Outcome Interactivity Theory.

The literature has rarely considered content separately in its ability to influence the recognition of interactivity. While some researchers (Massey & Levy, 1999; Goertz, 1995; Kenney et al., 2000; Stromer-Galley, 2000) have addressed aspects of content, few have elaborated on the specific role the content itself plays in facilitating the communication involved.

Within the OIT model, the *reactive content* dimension considers the capacity of interactive functionality within the communicated content to influence the recognition of interactivity. The *potential* impact of this dimension (intended interactivity) is shaped by the sender. However, as is the case with technological features, the user must recognize this potential for it to play a role in the recognition of interactivity. (Again, neither technologies nor content inherently foster or constitute interactivity by nature, and either can offer interactive functionality without actually eliciting the perception of interactivity by a given participant.) The reactive content dimension includes four dimension elements: *accessibility*, *clarity, relevance* and *vividness*.

The study proposed below operationalizes interactivity in an instructional context. The next section examines the relevance of interactivity scholarship to instructional design and the instructional context.

Interactivity and Its Relevance to Instructional Design

In investigating how to capitalize on interactivity within an instructional approach, it is worth examining exactly what is expected of this approach in terms of learning outcomes, and to explore measurements that can verify its promise is being realized in the classroom. A good place to begin is with a discussion of exactly what is meant when discussing the nature of learning and student learning outcomes.

Learning is a change in knowledge attributable to experience (Mayer, 2009). It includes three parts: a) learning is a change in the learner; b) what is changed is the learner's knowledge; and c) the cause of the change is the learner's experience in the learning environment. Learning can be thought of as relatively stable changes in student behavior as a function of an educational stimulus (such as lesson content delivered online rather than in the classroom). Mayer conceptualizes this learning as "understanding," while the study below operationalizes it as knowledge acquisition. All learning is *personal*, and prior knowledge and experience plays a substantial role in shaping this learning, a notion consistent with the OIT model.

Bloom (1956) describes three domains in which teaching behaviors influence student learning outcomes. The affective, cognitive and behavioral domains each describe separate but related manifestations of student learning outcomes.

Affective learning describes how students address or adapt their values, attitudes, beliefs and emotions as they relate to the knowledge or skills they've acquired

(Krathwohl, Bloom & Masia, 1964). This might be thought of as feeling positively toward or "liking" something, and is demonstrated by behaviors that indicate respect, appreciation, value and ownership of this knowledge.

Cognitive learning describes the acquisition of knowledge and the ability of a student to understand and apply it. Bloom's taxonomy describes six distinct hierarchical levels of how students use and apply knowledge: knowledge recall, comprehension, application, analysis, synthesis and evaluation. Anderson & Krathwohl (2001) expanded this taxonomy to incorporate four distinct types of knowledge: factual, conceptual, procedural and metacognitive.

Behavioral learning is demonstrated in the form of observable physical skills, actions or behaviors. Behavioral learning can take place as students observe or are instructed how to perform a new skill or set of behaviors, practice previously acquired skills or receive feedback to modify an existing one (Bandura, 1969).

Similarly, Mayer describes five kinds of knowledge that can be learned: facts (knowledge about things or events); concepts (knowledge about categories, principles or models); procedures (knowledge about specific step-by-step processes); strategies (general methods for orchestrating one's knowledge to achieve a goal); and beliefs (cognitions about oneself or about how one's learning works).

Each of these domains play a role within the learning construct, and help define and measure different aspects of student learning outcomes in the classroom. If the interactive functionality embodied in online lessons improves student learning outcomes (and it is not yet established that it does), it's unclear whether this impact affects some, all or no domains of students learning.

Instruction can be thought of as an instructor's manipulations of the learning environment in a manner intended to promote learning (Mayer, 2009). For the instructional designer, this definition implies two distinct parts: "a) instruction involves creating a learning environment for the learner, and b) the goal of the learning environment is to promote experiences in the learner that lead to learning" (p. 30).

Along the same lines, *instructional design* is a professional activity "concerned with understanding, improving and applying methods of instruction" in a way that leads toward optimal learning outcomes (Reigeluth, 1983). It's not a stretch to think of instructional design as being about clearly and effectively delivering content to achieve some specific goal. One might make the same claim about the application of interactivity.

The strategic application of interactive functionality contributes to student knowledge acquisition as a sense-making activity in which the learner seeks to build a coherent mental representation from the presented materials. Mayer (p. 17) notes, "Humans focus on the meaning of presented materials and interpret it in light of their prior knowledge." Knowledge is personally constructed by the learner as an outcome in response to the presented materials within the boundaries of each individual's experiences, prior knowledge and circumstances. The learner is an *active* sense-maker who experiences the presentation, a perspective consistent with the user experience dimension of Outcome Interactivity Theory.

Mayer's views are noteworthy as they relate to the subject of online instruction and learning, particularly given his long history or relevant scholarship. Building on cognitive science theories of how people learn, he has developed a cognitive theory of multimedia learning relevant to the design of online instruction. During the past two decades years he and his colleagues have conducted more than 100 experimental tests leading to 12 research-based principles for how to design online learning environments. These studies have been compiled in a new "Multimedia Learning" monograph (Mayer, 2009). The unifying theme of these projects is to develop research-based principles of instruction that contribute to cognitive science theories of how people learn.

In fact, his personal Web site describes ongoing research interests very relevant to interactivity scholarship as described above. Two areas in particular stand out: "*Multimedia learning*, such as determining how illustrations affect how people learn from scientific text, how people learn scientific explanations from computer-based animation and narration, or how people learn to solve problems from computer games, simulations, and virtual reality environments… and *human-computer interaction*, such as investigating how novices learn to interact with computers, how to design e-learning environments that promote learning, or how people learn with online pedagogical agents and computer-based tutors" (Mayer, 2009a).

Mayer's Cognitive Theory of Multimedia Learning offers an excellent example of both the bounty of this scholarship and its relevance to the interactivity construct. The theory is grounded by three fundamental assumptions. First, humans possess separate channels for processing visual and auditory information (Paivio, 1986; Baddeley, 1992), and instructional content is delivered (and more importantly, processed) in these two distinct channels as text and visuals. This dual-channel model is typically conceptualized in one of two ways. The *presentation-mode approach* concentrates on whether the presented content is verbal (meaning language-based such as as spoken or printed words) or nonverbal (such as illustrations, video, animation or background sounds). The *sensory-modality approach* focuses on whether learners process the presented materials through their eyes (as for illustrations, video, animation or printed words) or ears (for spoken words or background sounds). Either dual-channel conceptualizations can provide a useful framework for instructional design in terms of how to present and sequence lesson content, as well as how a variety of interactive functionality might be applied in a constructive manner toward the development of more effective instructive materials.

Second, humans are limited in the amount of information that they can process in each channel at any one time (Baddeley, 1998). These constraints force users to make decisions regarding which piece of presented content is (apparently) most relevant or valuable. The implications for instructional design are obvious in being judicious and strategic in how content is presented, as are those for the strategic application of interactive elements in the content. Clearly, more is not always better. (The recognition of this limitation gives additional weight to Bucy's conceptualization of the curvilinear nature of interactivity, as mentioned earlier.)

Third, humans engage in active learning by attending to relevant incoming information, organizing selected information into coherent mental representations, and integrating these mental representations with other knowledge in the form of prior experience or context (Mayer, 2008a). This view is consistent with the OIT model and the manner in which individual user experiences and context influence how interactive technological functions and content elements determine the recognition of interactivity and lead to positive learning outcomes.

Mayer argues that multimedia learning takes place in a learner's information-processing system—one that contains separate channels for visual and verbal processing, embodies serious limitations on the capacity of each channel, and requires coordinated cognitive processing in each channel in order for active learning to occur.

Consider two kinds of situations in which multimedia learning takes place: a book-based environment and a computer-based environment. In a book-based environment, the learner must decide how to interpret printed text and illustrations. (Mayer refers to the combined text and illustrations as "annotated illustrations.") One might think of this as an "analog" approach in that content is presented through traditional channels such as textbooks and classroom lectures. Alternately, a computer-based ("digital") version of the same content would also include narrated animation in which the animation is adapted from the line drawings or illustrations of the previous example, and the narration is a shortened version of the text described by an announcer. He applies this contrast to test his *static-media hypothesis* (Mayer et al., 2005), which states that "static media (such as static diagrams and printed text) offer cognitive processing affordances that lead to better learning (as measured by tests of retention and transfer) compared with dynamic media (such as animation and narration)." Interestingly, his findings support the hypothesis in the face of conventional wisdom to the contrary, an outcome that strongly suggests the need for ongoing research in the areas of multimedia learning, interactivity, and other related areas of instructional design and learning theory.

There is an important concern in examining Mayer's application of this model of multimedia learning situations. When considering the differences between the two environments, he appears to overlook (or discount) the considerable degree to which these environments have evolved and now overlap. The same textual content might be available to be read on paper, a computer monitor or a cell phone screen, yet each would be expected to elicit substantially different experiences and results. Mayer's binary conceptualization of book vs. computer categorizes on the basis of technology use, a yardstick he firmly rejects elsewhere in his book. Further refinements of his model would help illustrate and address convergence issues increasingly common in contemporary multimedia and interactive communication applications.

Similarly, he fails to establish equivalency for lesson content bridging these two approaches, nor does he offer any indication as to how such equivalency might be ensured. Mayer strongly (and correctly) endorses the importance of scientific method and empirical evidence as used in educational practice. He describes his extensive use of "experimental comparison in which an experimental group of learners receives a lesson that contains the to-be-tested feature while a comparison group of learners receives an otherwise identical lesson that lacks the to-be-tested feature" (p. 53). Yet it is unclear what steps (if any) were taken to ensure that lessons were "otherwise identical," given the potential for a number of confounding variables such as the extent of the copy edits or the quality of the production values in producing the animations. Additional details of his research methods would be a welcome complement to his otherwise valuable scholarship.

In general, Outcome Interactivity Theory and instructional design make for a good conceptual fit in that both are process-driven and results-oriented. In the context of instructional design, interactivity's contribution to a positive or desirable outcome in a communication event (as conceptualized by OIT) might easily be operationalized as a completed task based on a specific step within an instructional plan, or a sufficiently high score on a quiz indicating positive knowledge acquisition at the conclusion of an interactive or multimedia-based lesson.

Reigeluth (p. 24) describes a number of criteria for evaluating an instructional design theory, including several specifically relating to whether or not a particular theory is a good one or not. He cites Snelbecker (1974) for *parsimony* [that the theory should be simple with the fewer variables the better], and Snow (1971) for *usefulness* [that the theory should be useful for organizing existing data meaningfully and for producing useful hypotheses]. OIT meets this standard for both by leading to clear and concrete operationalizations of the interactivity construct that can be applied within an instructional design context.

To these, Reigeluth adds *comprehensiveness*, *optimality* and *breadth of applicability*. Again, these criteria demonstrate OIT can be a useful framework to apply within an instructional design program involving interactivity. OIT defines and operationalizes specific relevant dimensions and elements within the model in a manner that makes them easier to generalize across a wide range of contexts.

Ultimately, the application of interactive functionality can only be effective if it is used (as is similarly done in the instructional design process) in a strategic manner that considers the environment in which it is to be applied, including the technology available, the content to be communicated, and the individual circumstances of those involved in the communication or instructional event. In an instructional design context, these circumstances would include the skills, experiences and context of both the instructor and student. Designing for success in the instructional design, and in the application of interactive functionality to help facilitate that success, can help ensure positive outcomes for students, teachers and instructional designers alike.

The question remains, does interactivity contribute to this success? Early findings suggest the answer is yes. In an initial empirical test of the reactive content dimension of OIT (described below), high levels of vividness were shown to significantly increase interactivity *and* levels of satisfaction. Thus, the use of audio or video elements, color or other elements that increase the graphic or multimedia richness of lesson content would be expected to both increase interactivity and improve student knowledge retention. In this way, the strategic application of interactive functionality could be proactively used in the instructional design process to *directly* improve student outcomes.

The study described below operationalizes these positive student learning outcomes as knowledge acquisition. Trader (2007) defines knowledge as:

> …*usable information. In essence, knowledge is data that has been decoded and transformed into information and which also has a perceived and demonstrable potential application to human life either now or in a hypothetical future. Information, on the other hand, is data that has been organized (integrated and revised) and decoded, but which has not yet demonstrated use. Data is merely decoded or ignored.*

As an outcome knowledge acquisition is directly influenced by the manner in which lesson content is presented and communicated, making it a particularly apt measure of interactivity in the study proposed below. Trader's *Knowledge Acquisition Theory* (KAT) argues that message characteristics predict student knowledge acquisition behaviors, which in turn predict the quality of knowledge acquisition by students upon completion of higher education courses. Therefore, student knowledge acquisition is encouraged as students move from being passive message receivers (data decoders) to active message producers (knowledge wielders). In this way, the application of increased interactive functionality that encourages increased student involvement through increased interactivity should find a corresponding increase in student knowledge acquisition as an outcome of an instructional module.

Knowledge Acquisition Theory finds several parallels in Outcome Interactivity Theory. For example, instructional communication researchers argue that two specific message values—message clarity and message relevance—are important to student learning in the higher education context. Clear messages positively affect student cognitive learning outcomes such as recall (Chesebro & Wanzer, 2006; Roshenshine & Furst, 1971). Relevant messages have a moderately strong correlation with student motivation (Frymier & Shulman, 1995; Frymier, Shulman, & Houser, 1996). Thus, it appears likely that clear messages support the enactment of knowledge decoding behaviors and relevant messages provide the impetus to act. Accessibility, clarity and relevance play similar roles within the reactive content dimension of the OIT model.

The previous sections describe how Outcome Interactivity Theory provides a framework to both operationalize the interactivity construct and measure the impact of its various dimensions on the outcome of a communication event and, in the case of the proposed study, in an instructional context. An exploratory pilot study tested whether the presence of specific interactive elements in the content of a communication event have a positive impact on the recognition of interactivity by individual participants. The following section describes how this study was used to examine OIT in an empirical setting for the first time.

A Pilot Study of Outcome Interactivity Theory

This study examined the effect of the reactive content dimension of OIT on interactivity. Four individual elements—accessibility, relevance, clarity and vividness—contribute to the content dimension. However, this study measured subject recognition of and response to the potential interactivity embodied in the interactive functionality of the content, and focused on only two variables: clarity and vividness. The following three hypotheses were tested through a one-shot case study pre-experimental design:

H1 – Content perceived to display a high level of vividness will elicit a higher reported level of interactivity than will content perceived to display a low or moderate level of vividness.

H2 – Content perceived to display a high level of clarity will elicit a higher reported level of interactivity than will content perceived to display a low level of clarity.

The preceding two hypotheses were tested by eliciting responses to an online survey after viewing a sample Web site. In addition, a third hypothesis was tested.

H3 – A communication event with an outcome perceived to have a high level of interactivity will elicit a higher reported level of satisfaction than one with a low or moderate perceived level of interactivity.

Study participants were recruited from a population of students enrolled in an introductory communication class at a medium-sized Midwestern liberal arts university. The sample mirrored the demographic distribution of the university as a whole. The subject mean age was 23 years old. Students were recruited through a solicitation email introducing the researcher and the study, and offering an invitation to participate. The email messages were sent to the distribution list using the BCC address field, hiding the actual email addresses and ensuring anonymity of the individual email recipients.

Web site content for the study included details about a regional violence prevention initiative and was expected to be of interest to college students.

At the end of the four-minute online reading task, participants advanced to a subject questionnaire using scales designed to measure their evaluation of the sample Web site, including its clarity, vividness and level of interactivity, as well as their satisfaction with the experienced activity. The entire study required no more than ten minutes for each subject to complete. Survey responses were anonymous and collected online.

Outcome Interactivity Theory conceptually defines vividness as the degree to which communicated content is presented exhibiting a high level of graphic, audio or multimedia richness. In this study, the vividness variable was operationalized as high, moderate and low vividness conditions. The high vividness sample displayed underscored hotlinks that changed color and switched to a substantially larger font when cursored. The moderate vividness sample also displayed underscored hotlinks that changed color when cursored, but did not change size. The low vividness sample displayed hotlinks that were not highlighted (appearing as normal text), but changed to underscored when cursored.

Clarity is defined as the degree to which communicated content is well-organized and free from distracting errors. The clarity variable was operationalized as high and low clarity conditions. The high clarity sample displayed content free from errors. The low clarity sample included approximately 25 spelling, grammatical and punctuation errors distributed across all four Web pages of the sample.

Interactivity was operationalized in the survey instructions as “the degree to which you perceive the technology, the content and your experience work together to contribute to your communication experience of using this Web site.” Similarly, satisfaction was operationalized as “your satisfaction with this Web site.”

The original measures used in this study were adapted from existing measures but adjusted by the researcher to specifically examine and test the influence of reactive content elements within the Outcome Interactivity Theory model. While unique to this study, the newly designed research scales were informed by elements of a number of other scales (Bunz, 2001, 2003; Palmgreen, Wenner & Rayburn, 1980; Zaichkowsky, 1986). The nine scales used in this study employed a total of 62 separate questions and showed a high overall level of reliability ranging from α=.788 to α=.938. With the exception of demographic data, each survey question collected data using a seven-point Likert-type scale.

Results relating to each of the three hypotheses are presented after the descriptive statistics table (see Table 2.1) and correlation matrix (see Table 2.2) are provided for all variables. A descriptive statistics table is provided below (see Table 2.1) for all composite variables.

Table 2.1: Descriptive Statistics Table for All Composite Variables

	N	Min.	Max.	Mean	Standard Deviation
Internet Use	65	4.9192	5.8193	5.3692	1.81633
Relevant User Experiences	64	4.7054	4.4150	4.9957	1.16249
Technological Features	62	5.0140	5.5182	5.2661	.99267
Accessibility	55	5.6620	6.2380	5.9500	1.06545
Content Relevance	54	4.5701	5.1475	4.8588	1.05761
Content Clarity	54	5.0330	5.6583	5.3457	1.14552
Vividness	49	4.4913	5.0371	4.7642	.95005
Interactivity	49	4.1496	4.7244	4.4370	1.05299
Satisfaction	51	4.6013	5.2524	4.9269	1.19269

Pearson correlations are reported for all composite variables in Table 2.2.

Table 2.2: Correlation Matrix for All Variables

		IUSE	EXP	TECH	ACC	REL	CLAR	VIV	INTERACT	SAT	Perceived Clarity	Perceived Vividness
INTERNET_USE	Pearson Correlation	1.000										
	N	65.000										
USER_EXP	Pearson Correlation	.056	1.000									
	N	64	64.000									
TECH_FEATURES	Pearson Correlation	.265*	.174	1.000								
	N	62	61	62.000								
ACCESSIBILITY	Pearson Correlation	.347**	.295*	.680**	1.000							
	N	55	54	55	55.000							
RELEVANCE	Pearson Correlation	.008	.205	.306*	.434**	1.000						
	N	54	54	54	53	54.000						
CLARITY	Pearson Correlation	.324*	.241	.454**	.657**	.243	1.000					
	N	54	53	54	53	52	54.000					
VIVIDNESS	Pearson Correlation	.349*	.017	.421**	.573**	.250	.603**	1.000				
	N	49	48	49	48	47	47	49.000				

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 2.2: Correlation Matrix for All Variables (continued)

		IUSE	EXP	TECH	ACC	REL	CLAR	VIV	INTERACT	SAT	Perceived Clarity	Perceived Vividness
INTRACTIVITY	Pearson Correlation	.301*	.093	.444**	.320*	.201	.327*	.678**	1.000			
	N	54	53	54	53	52	52	47	54.000			
SATISFACTION	Pearson Correlation	.178	.122	.493**	.555**	.574**	.441**	.651**	.526**	1.000		
	N	54	53	54	53	52	52	47	54	54.000		
Perceived Clarity	Pearson Correlation	.314*	.208	.465**	.558**	.308*	.883**	.502**	.255	.287*	1.000	
	N	52	51	52	51	50	52	46	50	50	52.000	
Perceived Vividness	Pearson Correlation	.360*	.063	.329*	.531**	.309*	.565**	.908**	.615**	.606**	.498**	1.000
	N	46	45	46	45	44	44	46	44	44	43	46.000

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Hypothesis 1 tested whether content with varying levels of perceived vividness would result in differences in perceived interactivity. Results indicate a statistically significant difference between perceived vividness across three groups—*low vividness* (M = 1.5000, s.d. = .52223, n = 12), *moderate vividness* (M = 2.0000, s.d. = .79057, n = 17) and *high vividness* (M = 2.6000, s.d. = .63246, n = 15)—in terms of perceived interactivity [F (2,43) = 9.033, p=.001] (see Table 2.3). Thus, H1 was supported.

Table 2.3: Descriptive Statistics for Perceived Vividness

	N	Mean	Standard Deviation
Low Vividness	12	2.6000	.52223
Moderate Vividness	17	2.0000	.79057
High Vividness	15	1.5000	. 63246

In order to determine where the differences exist, LSD post hoc tests were calculated (see Table 2.4). Results clearly indicate significant differences in perceived interactivity between high and moderate (p=.016) and high and low (p<.001) levels of perceived vividness conditions, but no significant differences between moderate and low perceived vividness (p=.056).

Table 2.4: Post Hoc Results for Perceived Vividness

Perceived Interactivity
LSD

Perceived Vividness	Perceived Vividness	Mean Difference	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Low Vividness	Moderate Vividness	-.5000	.25395	.056	-1.0129	.0129
	High Vividness	-1.1000*	.26086	.000	-1.6268	-.5732
Moderate Vividness	Low Vividness	.5000	.25395	.056	-.0129	1.0129
	High Vividness	-.6000*	.23860	.016	-1.0819	-.1181
High Vividness	Low Vividness	1.1000*	.26086	.000	.5732	1.6268
	Moderate Vividness	.6000*	.23860	.016	.1181	1.0819

Based on observed means.
The error term is Mean Square(Error) = .454.
*. The mean difference is significant at the .05 level.

Hypotheses 2 tested whether content perceived to display a high level of clarity is related to a higher reported level of interactivity than would occur for content with a low level of perceived clarity. In this case, a significant main effect of clarity on perceived interactivity was not indicated [F (1,50) = 3.771, p=.058]. Thus, the hypothesis was not supported.

Hypothesis 3 tested whether a high level of perceived interactivity is related to a higher level of subject satisfaction with the communication event. Results indicate a statistically significant difference between perceived interactivity across three groups—*low interactivity* (M = 4.2778, s.d. = 1.17050, n = 18), *moderate interactivity* (M = 4.8694, s.d. = 1.12552, n = 18) and *high interactivity* (M = 5.6333, s.d. = 1.12552, n = 18)—in terms of satisfaction [F (2,54) = 7.215, p=.002] (see Table 2.5). Thus, H3 was supported.

Table 2.5: Descriptive Statistics for Perceived Interactivity

	N	Mean	Standard Deviation
Low Interactivity	18	4.2778	1.17050
Moderate Interactivity	18	4.8694	1.12552
High Interactivity	18	5.6333	.90554

LSD post hoc tests were calculated (see Table 2.6). Results clearly indicate significant differences in satisfaction between high and moderate (p=.038) and high and low (p<.001) levels of perceived interactivity conditions, but no significant differences between moderate and low satisfaction (p=.104).

Table 2.6: Post Hoc Results for Perceived Interactivity

SATISFACTION
LSD

Perceived Interactivity	Perceived Interactivity	Mean Difference	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Low Interactivity	Moderate Interactivity	-.5917	.35782	.104	-1.3100	.1267
	High Interactivity	-1.3556*	.35782	.000	-2.0739	-.6372
Moderate Interactivity	Low Interactivity	.5917	.35782	.104	-.1267	1.3100
	High Interactivity	-.7639*	.35782	.038	-1.4822	-.0455
High Interactivity	Low Interactivity	1.3556*	.35782	.000	.6372	2.0739
	Moderate Interactivity	.7639*	.35782	.038	.0455	1.4822

Based on observed means.
The error term is Mean Square (Error) = 1.152.
*. The mean difference is significant at the .05 level.

Data for the study were gathered over a two-week period in late 2008. Despite a potential sampling pool of n = 817 enrolled undergraduate students, a total of only 65 students participated in the Web-based study. It had been expected the response rate would provide a sufficiently large sample in excess of 130 participants, thus ensuring sufficient power to test the research hypotheses without committing a Type II error.

Unfortunately, the smaller than desirable sample of n = 65 was insufficient to provide adequate power to yield statistically valid results in several areas with respect to the research hypotheses.

Nonetheless, a number of significant results were reported. Despite the lack of statistical power, strong effects were indicated with regard to several variables, suggesting strong internal validity for Outcome Interactivity Theory.

Two elements of the reactive content dimension—vividness and clarity—were explicitly tested for their effects on perceived interactivity and satisfaction. Post hoc analysis for Hypothesis 1 found the strong effect of perceived vividness on interactivity ($p > .001$) was far more pronounced at higher levels of vividness, suggesting a threshold effect for vividness before it exerts a significant effect on perceived interactivity. However, the lack of statistically significant differences between low and high perceived vividness and perceived interactivity could also be a function of low power. Further study is recommended, and the issue of low statistical power is addressed in the study described below.

While a similar significant effect was not found for perceived clarity on interactivity, the results for Hypothesis 2 should be interpreted with caution. The lack of significant results could also be a function of low power rather than a flaw in the OIT model, and it would be premature to remove clarity from the model without more rigorous testing.

A key area of the pilot study was the examination of whether the presence of interactivity actually *enhances* communication outcomes. Interactivity was found to produce a very significant ($p = .002$) effect on satisfaction. Post hoc analysis for

Hypothesis 3 indicates the influence of interactivity on satisfaction was far more pronounced at higher levels, again suggesting either a threshold effect before perceived interactivity provides a significant effect or the impact of low statistical power. As in the case of Hypothesis 1, further study is recommended.

Another important positive aspect of this study involves the development of the measurement scales used in the study's survey instrument. All nine of the scales showed high factor-loading scores, indicating the accuracy with which each scale measured the desired dimension or contributing element. In addition, each of the scales showed a high level of reliability (α=.788 to α=.938). This is an important step forward given the general lack of clear operationalizations of the interactivity construct and its contributing dimensions, as well as the subsequent lack of reliable scales with which to test the construct under experimental conditions.

Considering these findings, there is good reason to trust the reliability of Outcome Interactivity Theory and its contributing dimensions, based on the high level of significance found in correlations between most dimensions within the model, many of which are at levels of p = .001 or better (see Table 2.2).

Outcome Interactivity Theory further departs from extant literature in that it quantifies the positive influence of interactivity as an outcome of the communication event. This influence is supported by the results of the pilot study described above and is examined more closely in the next section.

The Influence of Interactivity

Previous models of interactivity (including those combining elements of several) have failed to fully examine and articulate the manner in which interactivity actually influences a communication event. This gap highlights two major issues.

The first lies in the overall lack of a solid theoretical grounding that lays out what defines interactivity, its role within the communication process, and what specific elements constitute it, as discussed earlier. Without such a theory-driven model to operationalize the construct, the task of *applying* it in some meaningful way becomes that much more difficult. The development of Outcome Interactivity Theory and the study described below directly address this gap.

This leads to the second issue, the so-called "so what?" question. Why should we even care about interactivity at all? Bucy (2004) challenges scholars when he writes, "For interactivity to succeed as a concept, it must have some meaningful social and psychological relevance." The reason to examine the interactivity construct is in the hope of applying its lessons in a way that contributes to positive communication outcomes across a variety of contexts (such as instructional design, as described earlier). This empirical and theory-driven approach is consistent with the conceptual model of *use-inspired basic research* suggested by both Kreps, Frey & O'Hair (1991) and Stokes (1997).

Kerlinger (1986) defines a theory as "a set of interrelated constructs (concepts), definitions, and propositions that present a systematic view of phenomena by specifying relations among the variables, with the purpose of explaining and (or) predicting the phenomena." For theory to advance, there must be research. But of what nature?

Kreps et al. (1991) define *basic research* as that which is "conducted to test, clarify and refine theoretical issues." Researchers use basic research to "discover the laws that explain and predict human behavior." However, purely theoretical research offers no clear practical roadmap to guide practitioners in applying these findings in a meaningful way in the real world.

Applied research is defined as that "conducted to examine and solve practical problems" (Kreps et al.). Cissna (1982) continues, "Applied research sets out to contribute to knowledge by answering a real, pragmatic social problem." Well enough, but purely applied research lacks the theoretical grounding to produce results that are applicable in a generalizable or easily reproducible way. It fails to leave the confines of its own parochial application.

Both Kreps et al and Stokes (1997) reject the notion that the two approaches are mutually exclusive. Kreps' *Basic/Applied Research Grid* and Stokes' *Quadrant Model of Scientific Research* offer alternative (and strikingly similar) conceptual models that embrace both the theoretical rigor and practical applicability that a more holistic research approach can embody.

Each enables serious theory development to be applied in the service of addressing socially relevant problems. In the end, these similar approaches embody a powerful approach toward resolving the "so want?" question that all communication researchers must ultimately face.

The application of interactive functionality by developers enables digital media and technologies (from the Internet to smart phones, gaming workstations and even programmable toasters) to embrace more goal-oriented behaviors by users. In fact, the interactive functionality embodied in these technologies actually requires audiences to become active users. Internet users are aware of the motives they are attempting to gratify during online activities (Eighmey, 1997). Yoo (2007) frames this argument within a uses and gratifications (U&G) approach based on the assumption that interactivity is a part of "the media gratification-seeking process" (Palmgreen, 1984; Swanson, 1987), an approach consistent with Outcome Interactivity Theory as applied in this study.

If one believes interactivity contributes to communication outcomes in a positive way (and this researcher does), it's imperative to operationalize the construct in a concrete and generalizable way that can be applied and *tested* across the discipline and beyond.

A key area in which the proposed study advances the interactivity literature is by addressing the question of whether the presence of interactivity actually *enhances* communication outcomes. Interactivity is relevant to the degree that it positively contributes to a desirable (or at least predicted) outcome for the user in an individual communication exchange. In the study described below, this positive outcome is operationalized as knowledge acquisition and satisfaction as demonstrated as a result of participation in an online instructional module.

There is considerable reason to view this approach optimistically. As described above, a pilot study found interactivity to produce a very significant (p=.002) effect on participant satisfaction. Based on these empirical findings, interactivity does indeed appear to have a measurable positive effect on communication outcomes.

Bucy offers an interesting perspective by further suggesting interactivity is desirable *up to a point*, after which it has increasingly negative consequences. He describes a curvilinear model of interactivity in which a *moderate* degree of interactivity is thought to be optimal, a notion with considerable face validity that deserves further investigation, although beyond the scope of the current manuscript. In the study that follows, extreme levels are avoided for all variables in order to keep them within typically acceptable ranges.

This manuscript serves to accomplish three major objectives: 1) clarify the literature relating to the interactivity construct; 2) introduce Outcome Interactivity Theory as a new theory-based conceptualization of the interactivity construct; and 3) test Outcome Interactivity Theory using a pre-test post-test control group full experimental design. The next section describes how this study is designed to accomplish this third goal.

A Study of Outcome Interactivity Theory

Outcome Interactivity Theory (OIT) provides a theory-based empirical model to both operationalize the interactivity construct and test the impact of various individual elements within its model on interactivity as an outcome of a communication event. Further, it provides a framework through which to measure the influence of interactivity itself within the communication process.

This study tests whether and to what degree interactivity contributes toward positive and desirable outcomes of a communication event. It does so in an empirical and theory-driven manner consistent with the conceptual model of use-inspired basic research described by both et al. (1991) and Stokes (1997). In the case of this study, this outcome is defined as student knowledge acquisition and satisfaction with the lesson content following an online instructional model.

Considerable scholarship has been devoted to specific individual elements that are ultimately included in Outcome Interactivity Theory, particularly in the areas of technology and user perception. What is lacking in the literature to date is an exploration of the manner in which *the content itself* contributes to the perception of interactivity. Thus, this study also serves as a step toward that goal by testing whether interactive functionality embodied in communicated content has a positive impact on the recognition of interactivity by individual participants.

While graphically rich and offering considerable interactive functionality, there remains a key question regarding online instructional modules in terms of student achievement and positive learning outcomes. Basically, does interactivity contribute and, more importantly, how? If the positive impact of interactivity within the online teaching process is to be replicated and exploited, it is important to understand which elements contribute to student learning, in what ways, and to what degree. This study posits that, in an instructional context, both interactivity and positive student outcomes are facilitated by the use of interactive functionality embodied in the technology and communicated content of the lesson.

This study examines the influence of interactivity within an instructional context by using *Outcome Interactivity Theory* as a framework. The study examines the impact of interactive functionality in computer mediated content on student learning outcomes, specifically knowledge acquisition and satisfaction with the content, as employed in online instructional modules typical of a college-level curriculum. It also examines the influence of four separate elements of the reactive content dimension of the OIT model—*accessibility*, *clarity*, *relevance* and *vividness*—on participant recognition of interactivity.

The study measures the degree to which high levels of interactive functionality as a component of online instructional content contributes to increased student cognitive and affective learning. Variables were measured using a pre-test and post-test control group full experimental model comparing two groups of subjects participating in one of two equivalent online lessons. One lesson sample used content presented as text only (in the form of a simple HTML document), while the other sample will use content displaying considerably greater interactive functionality and graphic richness. It was expected that subjects using the high interactivity lesson sample will report a higher level of knowledge acquisition as indicated by higher quiz scores (cognition) and satisfaction with the lesson (affect) when compared to the low interactivity lesson.

Statement of the Problem

What elements within a communication event contribute to interactivity, and does a high level of interactive functionality in these elements produce different results for participants than elements with lower levels?

This research project asserts that college students can participate in the use of instructional content delivered online and be investigated from a framework of Outcome Interactivity Theory to demonstrate the significant impact of interactivity on student learning outcomes. Students using online instructional modules with a high degree of interactive functionality were expected to demonstrate higher levels of knowledge acquisition and satisfaction with the lesson content.

This study retained a traditional outcome measure of student knowledge acquisition operationalized by exam scores. Additionally, the impact of interactivity on student affect was assessed by content variables that operationalize learning from a student-centered paradigm such as changes in student satisfaction and content preference.

Do interactive online instructional modules produce different results than traditional static instructional modules? The specific question driving the current research, then, is whether the incorporation of interactive functionality into online instructional modules offers improvements in student knowledge acquisition and satisfaction when compared to traditional static instructional modules.

Research Questions

This study examines the role of interactivity in the learning process with a pre-test post-test control group full-experimental study that clearly defines learning from a student-centered perspective and measures learning as changes in student knowledge acquisition and satisfaction. This study seeks to determine if significant differences are produced in students who experience interactive online instructional modules as compared to those taught using traditional static online instructional modules. In addition, it determines if the incorporation of interactivity as a teaching strategy better meets the goals of communication education.

The following two research questions guide the current research:

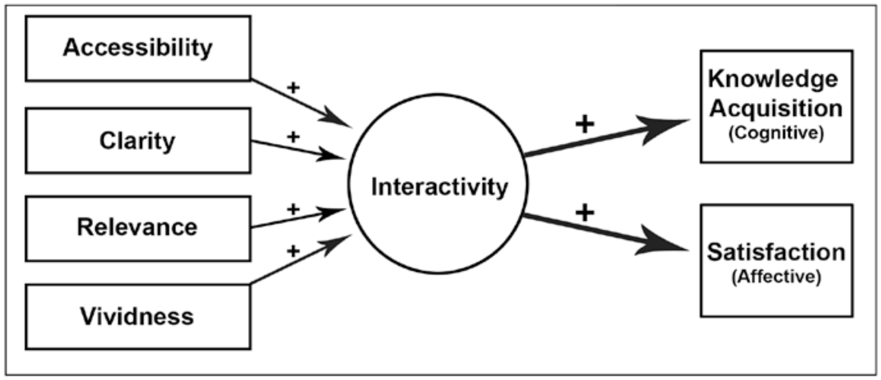
RQ1 –Do students participating in online instructional modules with high potential interactivity display a higher level of knowledge acquisition (as a measure of cognitive learning) after exposure to the online content than students using content with low potential interactivity?

RQ2 – Do students participating in online instructional modules with high potential interactivity display a higher level of satisfaction or content preference (as a measure of affective learning) after exposure to the online content than students using content with low potential interactivity?

Importantly, this study examines how practitioners might employ interactivity strategically as a contributing element within an instructional context to improve student learning outcomes. Similarly, it explores ways in which increased interactive functionality as a component of instructional design for online presentation contributes to higher levels of student affective and cognitive learning. The study hypothesizes that lesson content displaying high levels of interactive functionality (manipulated as high levels of accessibility, clarity, relevance and vividness) will positively influence student learning outcomes when compared to more static lesson content (low interactive functionality). It was expected that subjects in the treatment (high interactivity) group would report greater knowledge acquisition as reflected by higher post test scores (cognition) and a higher level of satisfaction or content preference (affect) when compared to the comparison (low interactivity) group.

A pilot study (described above) previously tested two elements of the reactive content dimension of the OIT model. This study seeks to extend that scholarship by measuring the effect of interactivity on student learning outcomes, specifically knowledge acquisition and satisfaction, by manipulating individual elements of the reactive content dimension of the OIT model—accessibility, clarity, relevance and vividness—(see Figure 2.3).

Figure 2.3: Study Model for Hypotheses H1a-H1f.



The following hypotheses were tested as repeated measures of group differences using an independent samples t-test.

H1a – Students participating in the treatment group (online instructional modules with high potential interactivity) will display a higher level of knowledge acquisition (cognitive learning) after exposure to the online content than students in the comparison (low potential interactivity) group.

H1b -- Students participating in the treatment group (online instructional modules with high potential interactivity) will display a higher level of satisfaction with the lesson content (as a measure of affective learning) after exposure to the online content than students in the comparison (low potential interactivity) group.

Accessibility, relevance, clarity and vividness were also measured for their influence on interactivity. The following additional hypotheses tested group differences between the treatment and comparison conditions using independent samples t-tests:

H1c – Content in the treatment condition (displaying a high level of accessibility) will elicit a higher reported level of interactivity than will content in the comparison condition (displaying a low level of accessibility).

H1d – Content in the treatment condition (displaying a high level of clarity) will elicit a higher reported level of interactivity than will content in the comparison condition (displaying a low level of clarity).

H1e – Content in the treatment condition (displaying a high level of relevance) will elicit a higher reported level of interactivity than will content in the comparison condition (displaying a low level of relevance).

H1f – Content in the treatment condition (displaying a high level of vividness) will elicit a higher reported level of interactivity than will content in the comparison condition (displaying a low level of vividness).

The preceding six hypotheses were measured by eliciting responses to an online survey tool after participating in an online instructional module.

In addition, the Outcome Interactivity Theory model was tested by measuring the effect of interactivity on knowledge acquisition and satisfaction (see Figure 2.4) and predicting interactivity as a function of accessibility, relevance, clarity and vividness (see Figure 2.4) using a linear regression.

Figure 2.4: Effect of Interactivity on Knowledge Acquisition and Satisfaction.

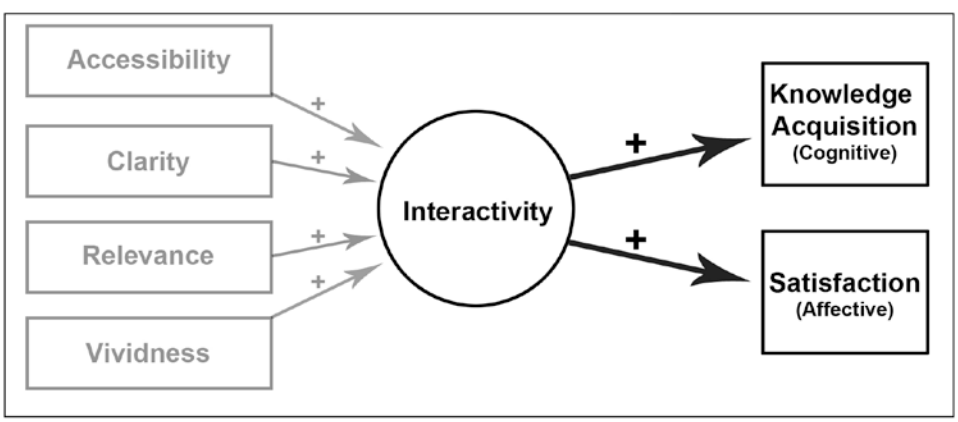
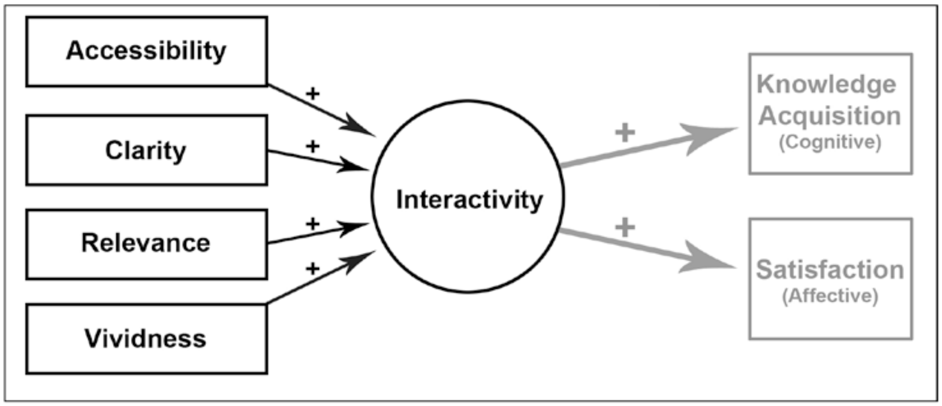


Figure 2.5: Effect of Accessibility, Relevance, Clarity and Vividness on Interactivity.



The following hypotheses were tested:

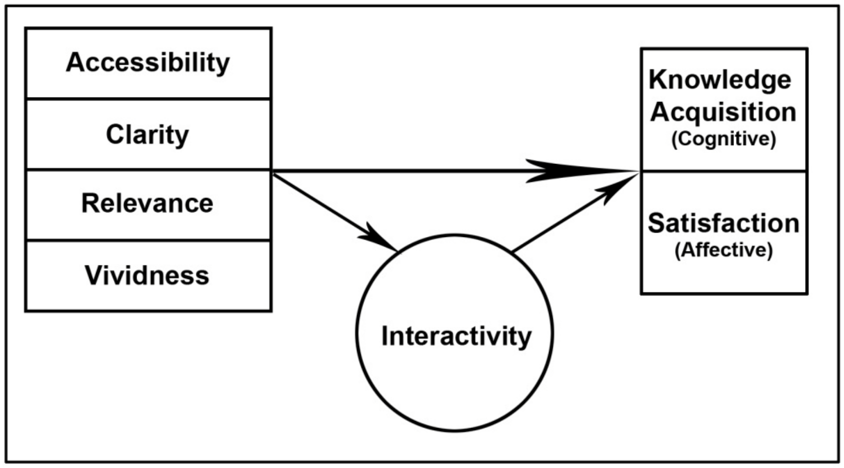
H2a – A high level of interactivity in online content will predict a high level of student knowledge acquisition after exposure to the content.

H2b – A high level of interactivity in online content will predict a high level of student satisfaction after exposure to the content.

H2c – High levels of accessibility, relevance, clarity and vividness in online content will predict a high level of student-reported interactivity after exposure to the content.

Finally, accessibility, relevance, clarity and vividness were measured for their influence on knowledge acquisition and satisfaction when moderated by interactivity (see Figure 2.6) using a linear regression.

Figure 2.6: Effect of Accessibility, Relevance, Clarity and Vividness on Knowledge Acquisition and Satisfaction When Moderated by Interactivity.



H2d – A high level of accessibility, relevance, clarity and vividness in online content and moderated by interactivity will predict a high level of student knowledge acquisition after exposure to the content.

H2e – A high level of accessibility, relevance, clarity and vividness in online content and moderated by interactivity will predict a high level of student satisfaction after exposure to the content.

Summary

Outcome Interactivity Theory should not be considered an abstract or academic framing of the interactivity construct. Its real value lies in the degree to which it can inform the development and incorporation of interactive functionality in all its forms—technology, user experience and content—in a manner that increases interactivity and improves communication outcomes.

As described earlier, this dissertation serves to accomplish three major objectives: 1) clarify the literature relating to the interactivity construct; 2) introduce Outcome Interactivity Theory as a new theory-based conceptualization of the interactivity construct; and 3) test Outcome Interactivity Theory using a pre-test post-test control group full experimental design.

The previous chapter accomplishes the first two goals by clarifying the existing interactivity literature, presenting a new and more comprehensive definition of the interactivity construct, and describing a new theory—Outcome Interactivity Theory—with which to operationalize and measure the influence of interactivity and its contributing dimensions. Further, it described a pilot study representing a first empirical test of OIT and the impact of its contributing dimensions on both interactivity and an individual's satisfaction with the related communication event.

The next chapter describes how Outcome Interactivity Theory was tested to achieve this third objective.

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Chapter 3

Methods

Study Design

To answer the research questions, a pre-test post-test control group full experimental design (Bailey, 1994) was used to test Outcome Interactivity Theory. This chapter describes the general procedures that were followed. It includes information regarding: a) subject selection, b) procedures for data collection, and c) measurement instruments that were employed for answering each research question.

Outcome Interactivity Theory describes three dimensions—technological features, relevant user experiences and content-- that contribute to interactivity within a communication event. This experiment tests the degree to which a high level of interactive functionality in the content dimension of the OIT model produces different results for participants than content with a lower level of interactive functionality. To achieve this goal, this research project measured the impact of interactivity on student learning outcomes. The experiment defined learning outcomes as changes in student knowledge acquisition and content satisfaction. The study hypothesizes that lesson content displaying high levels of interactive functionality (as demonstrated by high levels of accessibility, clarity, relevance and vividness) will exert a positive influence on student cognition and affect when compared to more static lesson content (low interactive functionality). Students using online instructional modules with a high degree of interactive functionality were expected to demonstrate higher levels of knowledge acquisition and satisfaction with the lesson content than for those using content presented in a less interactive manner.

Hypothesis 1a argues that students participating in online instructional modules with high interactive functionality will display a higher level of knowledge acquisition (indicative of cognitive learning) as an outcome than will students in equivalent low interactivity modules. Student knowledge acquisition was operationalized as positive variance in post test scores between comparison and treatment groups.

Hypothesis 1b argues that students participating in high interactive functionality online instructional modules will display a higher level of satisfaction with the lesson content (indicating affective learning) as an outcome than will students in equivalent low interactivity modules. The impact of interactivity on student affect was operationalized as a positive variance in satisfaction or content preference between groups as measured by a content preference measurement scale.

In addition, all four individual elements of the reactive content dimension—accessibility, clarity, relevance and vividness—were measured for their influence on interactivity.

Outcome Interactivity Theory conceptually defines accessibility as the manner in which communicated online content is structured, delivered and presented, including how it is written, designed or organized. Content with a high degree of accessibility enables each user to select and display this content in its most (personally) desirable form and sequence. In this study, the accessibility variable was operationalized as low and high conditions. High accessibility was displayed in the treatment sample in the following manner: pop-up links were available to provide additional information; if selected, an animated graphic could be displayed and manipulated by the subject; and a menu of selectable content display preferences was presented. Low accessibility was displayed in the comparison sample in the following manner: no pop-up links available; no animated graphics; and no content display preference options.

Clarity is conceptually defined as the degree to which sought-after content is displayed with appropriate visual and conceptual organization (logical placement, sequence, etc.), and with a generally acceptable level of accuracy, clear writing style and grammatical, spelling and punctuation standards. Content with high clarity is easy to read, without obvious factual errors, and free from grammatical errors and other similar distractions. In this study, the clarity variable was measured but not expressly manipulated.

Relevance is conceptually defined as the degree to which available content is desirable and consistent with a user's goals for the communication event. It is influenced by intuitiveness, appropriateness and congruity. Is the available content the *right* content? Is it the most desirable for *that* participant in *that* communication event? This outcome-oriented and user-centered variable is determined by the needs of the user rather than the intentions of the content producer.

The relevance variable was operationalized as low and high conditions. High relevance was displayed in the treatment sample by an introductory overview provided to indicate relevant topics within lesson content. For the low relevance (comparison) condition, no introductory overview was provided.

OIT conceptually defines vividness as the degree to which available content is displayed using high levels of graphic richness, animation and audio/visual elements (when compared to traditional media). It is the capability of a technology to produce a sensorially rich mediated environment. The vividness variable was operationalized as low and high conditions. High vividness was displayed in the treatment sample in the following manner: hotlinks displayed as buttons; bold, underlined and red used to indicate pop-up text links; the use of an appealing color layout; and an available animated graphic that presented content in alternative form. Low vividness was displayed in the comparison sample in the following manner: hotlinks displayed as text links; no color layout; and no color or animated graphics.

The degree of interactive functionality displayed by the comparison and treatment online instructional module samples (as an indication of interactivity) was manipulated as the independent variable and was expected to positively affect the subject's knowledge acquisition score and level of preference with the content as an outcome of the lesson (see Figure 3.1).

Figure 3.1: Description of Manipulations to Treatment Samples

	Comparison Sample (low interactivity outcome)	Treatment Sample (high interactivity outcome)
Accessibility The manner in which communicated online content is structured, delivered and presented, including how it is written, designed or organized. It enables each user to select and display this content in its most (personally) desirable form and sequence.	No pop-up links available. No animated graphics. No content display preference options.	Pop-up links available to provide additional information. If selected, animated graphic can be manipulated by subject. Menu of selectable content display preferences.
Clarity The degree to which sought-after content is displayed with appropriate visual and conceptual organization (logical placement, sequence, etc.), and with a generally acceptable level of accuracy, clear writing style and grammatical, spelling and punctuation standards. Content with high clarity is easy to read, without obvious factual errors, and free from grammatical errors and other similar distractions.	Content free from errors or distractions.	Not manipulated.
Relevance The degree to which available content is desirable and consistent with a user's goals for the communication event. It is influenced by intuitiveness, appropriateness and congruity. Is the available content the right content? Is it the most desirable for that participant in that communication event. This outcome-oriented and user-centered variable is determined by the needs of the user rather than the intentions of the content producer.	No introdutory overview provided.	Introductory overview provided to indicate relevant topics within lesson content.
Vividness The degree to which available content is displayed using high levels of graphic richness, animation and audio/visual elements (when compared to traditional media). It is the ability of a technology to produce a sensorially rich mediated environment.	Hotlinks displayed as text links. No color layout. No color or animated graphics.	Hotlinks displayed as buttons. Bold, underlined and red used to indicate pop-up text links. Appealing color layout. Available animated graphic presents content in alternative form.

Study Population

Study participants were recruited from a population of undergraduate students at the University of Kentucky. Subjects were enrolled in communication classes offering participation in a research-based activity for research credit, and came from a variety of majors. Participants were expected to have moderate to extensive experience with the Internet, which minimized skill-related obstacles toward participation in an online study. (See Appendix 8 for demographic questions.)

Data gathering commenced on September 24, 2009 and was completed two weeks later on October 8. While a large number (n=494) of students voluntarily agreed to take part in the study, not all were suitable subjects. First, all subjects (n=112) who did not participate to completion were removed, leaving n=382. Next, all those subjects (n=66) who took less than 10 minutes or greater than one hour to complete the study were removed. Additional outliers were removed from the dataset for those subjects (n=5) showing Z scores in excess of +/- 3.29 for any composite variables. The dataset was also examined for excessive skewness (in excess of +/- 2.0), although none was found. The resulting dataset yielded n=311 subjects (see Table 3.1).

Of the 311 undergraduate students, 114 (36.7%) were male and 197 (63.3%) were female (see Table 3.1). A Pearson chi-square test [χ^2 (1) = 2.650, p > .05] indicated no significant difference between males and females across the two experimental conditions.

The sample consisted of 86 (27.7%) first-year students, 83 (26.8%) sophomores, 76 (24.5%) juniors, and 65 (21.0%) seniors (see Table 3.2). A Pearson chi-square test [χ^2 (3) = 2.092, p > .05] indicated no significant difference among subject academic rank across the two experimental conditions.

Euro-Americans were approximately 88% of the sample. Ethnicity for the remainder of the sample was approximately distributed as: 3.5% African-Americans, 2.9% Asian or Pacific Islander, .3% Native Americans, 1.6% Latino-Americans, and 3.2% Other (see Table 3.3). A Pearson chi-square test [$\chi^2 (5) = 3.908$, $p > .05$] indicated no significant difference in subject ethnicity across the two experimental conditions.

Ten academic colleges were represented by students in the sample: Agriculture=31 (10.0%), Arts and Sciences=34 (11.0%), Business & Economics=62 (20.0%), Communication & Information Studies=61 (19.7%, Education=22 (7.1%), Engineering=48 (15.5%), Fine Arts=7 (2.3%), Health Services=8 (2.6%), Nursing=10 (3.2%, and Other=27 (8.7%) (see Table 3.4). A Pearson chi-square test [$\chi^2 (9) = 10.188$, $p > .05$] indicated no significant difference in the represented academic colleges across the two experimental conditions.

Approximately 90% of subjects were between 18 and 21 years of age (see Table 3.5). One student reported being younger than 18 and was removed from the study. A Pearson chi-square test [$\chi^2 (4) = 9.349$, $p > .05$] indicated no significant difference in age group distribution across the two experimental conditions.

More than 98% have been using the Internet for four years or more, indicating a substantial level of experience as anticipated (see Table 3.6). A Pearson chi-square test [$\chi^2 (4) = 3.368$, $p > .05$] indicated no significant difference in the amount of subject Internet experience across the two experimental conditions.

Subjects reported comfort level with math or statistics coursework across a wide range (see Table 3.7). There were 13.9% who were very uncomfortable, 22.6% uncomfortable, 26.5% neither comfortable nor uncomfortable, 27.1% comfortable, and

10.0% very comfortable with the subject matter. A Pearson chi-square test [χ^2 (4) = 4.878, p > .05] indicated no significant difference in subject comfort level with math or statistics coursework across the two experimental conditions.

In addition, subjects' need for cognition (Cacioppo et al., 1984) was measured to ensure the degree to which any variance between the comparison and treatment subject groups might be due to reluctance or discomfort with technical or complex lesson content was not statistically different between groups. A Pearson Chi-square test [χ^2 (29) = 27.180, p > .05] indicated no significant difference in subject need for cognition across the two experimental conditions.

Of the 311 subjects comprising the sample, 153 (49.2%) students were assigned to the comparison condition with a gender distribution of 90 (58.8%) female and 63 (41.2%) male students. The remaining 158 (50.8%) students were in the treatment condition with a gender distribution of 107 (67.7%) female and 51 (32.3%) male subjects (see Table 3.1).

Table 3.1: Student Gender Frequencies by Experimental Condition

			Experimental Condition		
			comparison	treatment	Total
Gender	Male	Count	63	51	114
		% within Experimental Condition	41.2%	32.3%	36.7%
		% of Total	20.3%	16.4%	36.7%
	Female	Count	90	107	197
		% within Experimental Condition	58.8%	67.7%	63.3%
		% of Total	28.9%	34.4%	63.3%
	Total	Count	153	158	311
		% within Experimental Condition	100.0%	100.0%	100.0%
		% of Total	49.2%	50.8%	100.0%

Table 3.2 reports the comparison and treatment student rank distribution.

Table 3.2: Student Rank Frequencies by Experimental Condition

			Experimental Condition		
			comparison	treatment	Total
Academic Standing	First-year	Count	41	45	86
		% within Experimental Condition	27.0%	28.5%	27.7%
		% of Total	13.2%	14.5%	27.7%
	Sophomore	Count	39	44	83
		% within Experimental Condition	25.7%	27.8%	26.8%
		% of Total	12.6%	14.2%	26.8%
	Junior	Count	35	41	76
		% within Experimental Condition	23.0%	25.9%	24.5%
		% of Total	11.3%	13.2%	24.5%
	Senior	Count	37	28	65
		% within Experimental Condition	24.3%	17.7%	21.0%
		% of Total	11.9%	9.0%	21.0%
	Total	Count	152	158	310
		% within Experimental Condition	100.0%	100.0%	100.0%
		% of Total	49.0%	51.0%	100.0%

Distribution of student ethnicity by experimental condition can be found in Table 3.3.

Table 3.3: Student Ethnicity Frequencies by Experimental Condition

			Experimental Condition		
			comparison	treatment	Total
Race	American Indian or Alaska Native	Count	0	1	1
		% within Experimental Condition	.0%	.6%	.3%
		% of Total	.0%	.3%	.3%
	African-American	Count	5	6	11
		% within Experimental Condition	3.3%	3.8%	3.5%
		% of Total	1.6%	1.9%	3.5%
	Asian or Pacific Islander	Count	3	6	9
		% within Experimental Condition	2.0%	3.8%	2.9%
		% of Total	1.0%	1.9%	2.9%
	Euro-American	Count	134	140	274
		% within Experimental Condition	88.2%	88.6%	88.4%
		% of Total	43.2%	45.2%	88.4%
	Latino-American	Count	3	2	5
		% within Experimental Condition	2.0%	1.3%	1.6%
		% of Total	1.0%	.6%	1.6%
	Other	Count	7	3	10
		% within Experimental Condition	4.6%	1.9%	3.2%
		% of Total	2.3%	1.0%	3.2%
	Total	Count	152	158	310
		% within Experimental Condition	100.0%	100.0%	100.0%
		% of Total	49.0%	51.0%	100.0%

Subjects were asked “which college best matches your eventual major?” The resulting distribution of student academic college by experimental condition can be found in Table 3.4.

Table 3.4: Academic College Frequencies by Experimental Condition

			Experimental Condition		
			comparison	treatment	Total
Major (Which college best matches your eventual major?)	College of Agriculture	Count	14	17	31
		% within Experimental Condition	9.2%	10.8%	10.0%
		% of Total	4.5%	5.5%	10.0%
	College of Arts & Sciences	Count	16	18	34
		% within Experimental Condition	10.5%	11.4%	11.0%
		% of Total	5.2%	5.8%	11.0%
	College of Business & Economics	Count	36	26	62
		% within Experimental Condition	23.7%	16.5%	20.0%
		% of Total	11.6%	8.4%	20.0%
	College of Communication & Information Studies	Count	29	32	61
		% within Experimental Condition	19.1%	20.3%	19.7%
		% of Total	9.4%	10.3%	19.7%
	College of Education	Count	10	12	22
		% within Experimental Condition	6.6%	7.6%	7.1%
		% of Total	3.2%	3.9%	7.1%
	College of Engineering	Count	21	27	48
		% within Experimental Condition	13.8%	17.1%	15.5%
		% of Total	6.8%	8.7%	15.5%
	College of Fine Arts	Count	2	5	7
		% within Experimental Condition	1.3%	3.2%	2.3%
		% of Total	.6%	1.6%	2.3%
	College of Health Services	Count	5	3	8
		% within Experimental Condition	3.3%	1.9%	2.6%
		% of Total	1.6%	1.0%	2.6%
	College of Nursing	Count	2	8	10
		% within Experimental Condition	1.3%	5.1%	3.2%
		% of Total	.6%	2.6%	3.2%
	Other	Count	17	10	27
		% within Experimental Condition	11.2%	6.3%	8.7%
		% of Total	5.5%	3.2%	8.7%
	Total	Count	152	158	310
		% within Experimental Condition	100.0%	100.0%	100.0%
		% of Total	49.0%	51.0%	100.0%

Table 3.5 describes the distribution of student age by experimental condition. One student reported being younger than 18 and was removed from the study.

Table 3.5: Student Age Frequencies by Experimental Condition

			Experimental Condition		
			comparison	treatment	Total
What is your approximate age?	Younger than 18	Count	1	0	1
		% within Experimental Condition	.7%	.0%	.3%
		% of Total	.3%	.0%	.3%
	18 - 19	Count	73	83	156
		% within Experimental Condition	47.7%	52.5%	50.2%
		% of Total	23.5%	26.7%	50.2%
	20 - 21	Count	60	61	121
		% within Experimental Condition	39.2%	38.6%	38.9%
		% of Total	19.3%	19.6%	38.9%
	22 - 24	Count	17	7	24
		% within Experimental Condition	11.1%	4.4%	7.7%
		% of Total	5.5%	2.3%	7.7%
	25 - 29	Count	0	4	4
		% within Experimental Condition	.0%	2.5%	1.3%
		% of Total	.0%	1.3%	1.3%
	30 and over	Count	2	3	5
		% within Experimental Condition	1.3%	1.9%	1.6%
		% of Total	.6%	1.0%	1.6%
	Total	Count	153	158	311
		% within Experimental Condition	100.0%	100.0%	100.0%
		% of Total	49.2%	50.8%	100.0%

Subjects were asked “how long have you been using the Internet (including using e-mail, texting, ftp, etc.)?” The resulting distribution of student internet experience by experimental condition can be found in Table 3.6.

Table 3.6: Student Internet Experience by Experimental Condition

			Experimental Condition		
			comparison	treatment	Total
How long have you been using the Internet (including using e-mail, texting, ftp, etc.)?	Less than 6 months	Count	0	1	1
		% within Experimental Condition	.0%	.6%	.3%
		% of Total	.0%	.3%	.3%
	6 to 12 months	Count	1	1	2
		% within Experimental Condition	.7%	.6%	.6%
		% of Total	.3%	.3%	.6%
	1 to 3 years	Count	0	2	2
		% within Experimental Condition	.0%	1.3%	.6%
		% of Total	.0%	.6%	.6%
	4 to 6 years	Count	30	26	56
		% within Experimental Condition	19.7%	16.5%	18.1%
		% of Total	9.7%	8.4%	18.1%
	7 years or more	Count	121	128	249
		% within Experimental Condition	79.6%	81.0%	80.3%
		% of Total	39.0%	41.3%	80.3%
	Total	Count	152	158	310
		% within Experimental Condition	100.0%	100.0%	100.0%
		% of Total	49.0%	51.0%	100.0%

Subjects were asked to access their personal comfort level with math or statistics coursework, since this is the content used in the experimental samples in the online modules. The resulting distribution of student comfort level by experimental condition can be found in Table 3.7.

Table 3.7: Student Comfort Level with Coursework by Experimental Condition

			Experimental Condition		
			comparison	treatment	Total
What is your personal comfort level with math or statistics coursework?	Very Uncomfortable	Count	18	25	43
		% within Experimental Condition	11.8%	15.8%	13.9%
		% of Total	5.8%	8.1%	13.9%
	Uncomfortable	Count	29	41	70
		% within Experimental Condition	19.1%	25.9%	22.6%
		% of Total	9.4%	13.2%	22.6%
	Neither Comfortable nor Uncomfortable	Count	42	40	82
		% within Experimental Condition	27.6%	25.3%	26.5%
		% of Total	13.5%	12.9%	26.5%
	Comfortable	Count	48	36	84
		% within Experimental Condition	31.6%	22.8%	27.1%
		% of Total	15.5%	11.6%	27.1%
	Very Comfortable	Count	15	16	31
		% within Experimental Condition	9.9%	10.1%	10.0%
		% of Total	4.8%	5.2%	10.0%
	Total	Count	152	158	310
		% within Experimental Condition	100.0%	100.0%	100.0%
		% of Total	49.0%	51.0%	100.0%

Finally, to further ensure the randomly assigned groups were not different at Time One, a pre-test was administered to both groups. While the treatment condition (M = 3.10, S.D. = 2.103) was slightly higher than the comparison group (M = 2.92, S.D. = 1.92), the difference was not statistically significant [t (309) = -.77, p > .05] and the two groups were not different.

Two groups of participants were used in the study, and participated using the same lesson content presented in one of two experimental conditions: the comparison sample as static HTML text files with minimal interactive functionality, and the treatment sample as more interactive and graphically rich content. A comparison of scores for a pre-test of initial knowledge of lesson content was also used to further ensure equivalency between subject groups.

Data for the study was analyzed using univariate and regression analyses to test the model.

Subject Recruitment Methods and Privacy

Subjects were solicited from students enrolled in undergraduate communication classes at the University of Kentucky. During the Fall 2009 semester, sufficient communication classes were offered on campus to provide a potential sampling frame of approximately n=2500 enrolled students.

Students registered for the study using the SONA Experiment Management System, a Web-based human subject pool management software product for universities. Students were instructed to log onto the SONA site and, if willing to participate, select this study from among the available studies listed on the page.

Students registered for the study using the SONA[tm] Experiment Management System, a Web-based human subject pool management software product for universities. (The SONA Experiment Management System provides universities with an easy-to-use, web-accessible interface to handle all the scheduling and management of human subject pool studies. Student research participants can sign up online, researchers can set up their studies online, and administrators can ensure students have completed all their requirements. The simple, easy-to-use interface is accessible with any web browser, 24 hours a day. SONA has been adopted by the UK Department of Communication as a recruitment and registration tool for student participation in department research studies.)

Students were instructed via a Department of Communication email message to log onto the SONA site and, if willing to participate, select this study from among the available studies listed on the page. Once the subject had successfully registered, SONA displayed a hotlink to the study itself, which used Qualtrics^{tm} online survey software to display the Web-based content and conduct data collection.

Upon completion of the study, the name and class affiliation of each participant were captured in a separate Qualtrics database to ensure subject confidentiality and complete isolation between study data and participant information. This information was captured to ensure accurate awarding of research credit. No other personally indentifying information was collected. The researcher had no other interaction with the subjects as part of the study. No advertising was used.

Qualtrics randomly assigned subjects to one of two subject groups, thereby ensuring a random distribution of subjects. No deception was involved in any aspect of the study.

Informed Consent Process

Once the subject had successfully registered, SONA displayed a hotlink to the study itself. Each subject followed that hotlink to a specific prepared Web page containing a welcome message in the form of a "consent to participate in a research study." This message included an explanation of the study, instructions for participating, and a description of the expected experience as a participant of the study in keeping with requirements of the university Office of Research Integrity.

This consent page provided an explicit "opt-in" informed consent opportunity in the form of a clearly visible "*next page*" button or hotlink that, when clicked, indicated the subject had read the information and agreed to participate in this research study. The subject was prevented from advancing to the start page of the study until informed consent had been expressly demonstrated by the clicked consent. Other pages were not accessible other than by clicking the consent button prior to advancing.

No emancipated individuals or non-English-speaking subjects were solicited or used as subjects in this study.

Research Procedures

The study was conducted entirely online. This approach is both efficient and consistent with the subject matter and the Web-based tools used in the study. In addition, the subject population is assumed to be comfortable and familiar with communicating using online Web-based tools and applications.

The study itself was hosted online separately from the SONA online registration application and used Qualtrics online survey software to display the Web-based content and conduct data collection.

The study activity included three parts. Part One consisted of taking a brief pre-test assessment. Part Two consisted of reading or interacting with the lesson content in the online instructional module. Part Three consisted of taking an post-test assessment and measurement survey.

Sample content involved a brief statistics instructional module. Lesson content for the comparison group was presented in the form of static HTML text files with minimal interactive functionality. The treatment sample presented the same content in a more interactive manner containing graphics and images, including some to be manipulated by the subject as part of the lesson (see Appendix 4).

Part One began when the subject clicked the "*next page*" consent button. The subject was then presented with pre-test instructions and a series of assessment questions. The pre-test assessment measured the subject's initial level of knowledge of the lesson subject matter. This task took no more than five minutes. Upon completion, subjects advanced to a new page displaying instructions for Part Two.

In Part Two, each subject was instructed to read the comparison or treatment instructional module content (as randomly assigned) "thoroughly enough to take a quiz at the end of the lesson and answer a brief survey as part of the study." Once this task was completed, which took approximately ten minutes, the subject advanced to Part Three.

Subjects began Part Three by taking an online survey instrument that measured their level of knowledge acquisition on the subject matter after participation in the lesson. In addition, it presented scales designed to measure their preference for the lesson content and the sample Web site's accessibility, relevance, clarity, vividness and level of interactivity.

Scores for the pre-test and post-test quizzes were captured for tabulation purposes. These scores and survey responses were confidential and were collected online. None of these data could be identified by individual subject.

After subjects completed the last page of the survey instrument, an exit page was displayed indicating the study was completed and thanking the subject for participating. Each subject was asked to indicate first and last name, course title and section number in order to receive research credit for participation. This information was collected to a separate "participation database." There was no way to enter this database without first completing the study. The participation data cannot be connected to the response data.

The entire study, including Parts One, Two and Three, should require 20-30 minutes for a subject to complete. Participation duration was recorded for each subject, and those taking less than 10 minutes or longer than one hour were considered outliers and removed from the dataset.

Sampling procedures, survey instruments and all other aspects of the experiment were approved by the university Office of Research Integrity.

Measures

The identical pre-test and post-test assessments consisted of ten questions relating to the content subject matter, and used a five-point multiple choice scale to determine knowledge acquisition by calculating the total number of correct responses. The level of subject knowledge acquisition for each experimental condition was measured as the difference between pre-test and post-test scores.

Each subject also completed a brief post-test survey to measure preference for the lesson content, as well as levels of accessibility, relevance, clarity and vividness of the sample content. While not specifically in the current experimental design, the level of interactivity was also measured post-test, along with subject internet use, user experience, technology use and need for cognition in order to facilitate future tests of Outcome Interactivity Theory.

With the exception of the pre-test and post-test assessments and demographic data, each survey question collected data using a five-point Likert-type scale. Codes are as follows: 1=strongly disagree. 2=disagree, 3=neither agree nor disagree, 4=agree, 5=strongly agree. All items were recoded so that a high score indicates a high value for that variable.

The newly developed research scales (see Table 3.8) are informed and influenced by elements of a number of other existing scales (Bunz, 2001, 2003; Palmgreen, Wenner & Rayburn, 1980; Zaichkowsky, 1986). However, they were adjusted by the researcher to specifically examine and test the influence of dimensions in the Outcome Interactivity Theory model, and are unique to this study (with the exception of Need For Cognition, which is measured using a scale developed by Cacioppo et al. (1984)).

Table 3.8: Measurement Scale Reliability

Variable	**N**	**Variable Range**	**Reliability**
Satisfaction	8	1 -5	.862
Accessibility	4	1 -5	.812
Clarity	5	1 -5	.806
Relevance	5	1 -5	.822
Vividness	8	1 -5	.844
Interactivity	9	1 -5	.876
Internet Use	5	1 -5	.756
Technological Features	4	1 -5	.866
Relevant User Experience	6	1 -5	.692
Cognition	12	1 -5	.796
Manipulation Check	6	1 -5	

The scales for satisfaction (content preference), accessibility, clarity, relevance, vividness, interactivity, internet use, technological features and relevant user experiences were tested in the pilot study described above, and showed a high overall level of reliability ranging from α=.788 to α=.938 in that study.

The ten measurement scales used in this study employ a total of 66 separate questions and showed a high overall level of reliability ranging from α=.692 to α=.876. Overall reliability across all ten composite scales was α=.756 (n=311).

For the purposes of most analyses, a composite scale was created from all multidimensional scales and each was treated as a unidimensional scale. The ten measurement scales are described below.

Satisfaction is conceptualized by OIT as an outcome of the communication event, and in operationalized in this study as the subjects' preference for the content. Content preference (PREF) employs an eight-item multidimensional scale (α=.862, n=311) to explain 64.85% of the variance (51.57% and 13.28% respectively).

Factor analysis indicated that questions two (*Overall, the Web site was easy to use*.) and five (*I was able to find the information I was looking for on this Web site.*) were double-loading (see Table 3.10). These two questions appeared to measure ease of use more than personal satisfaction, as in the case of the remaining six questions. However, the researcher considered both ease of use and satisfaction to be contributors to a subject's preference for the content, and therefore a composite multidimensional scale reflecting both elements is an appropriate measure of content preference in this experiment.

Below are a descriptive statistics chart (Table 3.9), component matrix (Table 3.10) and correlation matrix (Table 3.11) for content preference.

Table 3.9: Descriptive Statistics for Content Preference Scale (n=311)

	Mean	Std. Deviation	N
This Web site made me feel like I was communicating with someone.	2.38	1.037	311
Overall, the Web site was easy to use.	3.94	.888	311
This Web site helped me do well in this lesson.	3.06	1.018	311
This Web site made me want to learn more about statistics.	2.17	1.058	311
I was able to find the information I was looking for on this Web site.	3.58	.926	311
This Web site made learning about statistics more enjoyable.	2.44	.985	311
I would recommend this Web site to a friend.	2.71	1.089	311
I think my friends would enjoy visiting this Web site.	2.23	.962	311

Table 3.10: Component Matrix for Content Preference Scale (n=311)

	Component	
	1	2
This Web site made learning about statistics more enjoyable.	.833	-.166
I would recommend this Web site to a friend.	.832	-.239
I think my friends would enjoy visiting this Web site.	.790	-.334
This Web site helped me do well in this lesson.	.764	.259
This Web site made me want to learn more about statistics.	.730	-.251
This Web site made me feel like I was communicating with someone.	.664	-.075
Overall, the Web site was easy to use.	.517	.636
I was able to find the information I was looking for on this Web site.	.539	.572

Extraction Method: Principal Component Analysis.
a. 2 components extracted.

Table 3.11: Correlation Matrix for Content Preference Scale (n=311)

		This Web site made me feel like I was communicating with someone.	Overall, the Web site was easy to use.	This Web site helped me do well in this lesson.	This Web site made me want to learn more about statistics.	I was able to find the information I was looking for on this Web site.	This Web site made learning about statistics more enjoyable.	I would recommend this Web site to a friend.	I think my friends would enjoy visiting this Web site.
This Web site made me feel like I was communicating with someone.	Pearson Correlation	1.000							
	N	311.000							
Overall, the Web site was easy to use.	Pearson Correlation	.265**	1.000						
	N	311	311.000						
This Web site helped me do well in this lesson.	Pearson Correlation	.447**	.457**	1.000					
	N	311	311	311.000					
This Web site made me want to learn more about statistics.	Pearson Correlation	.427**	.252**	.491**	1.000				
	N	311	311	311	311.000				
I was able to find the information I was looking for on this Web site.	Pearson Correlation	.280**	.367**	.444**	.233**	1.000			
	N	311	311	311	311	311.000			
This Web site made learning about statistics more enjoyable.	Pearson Correlation	.468**	.327**	.541**	.613**	.358**	1.000		
	N	311	311	311	311	311	311.000		
I would recommend this Web site to a friend.	Pearson Correlation	.457**	.291**	.533**	.531**	.342**	.684**	1.000	
	N	311	311	311	311	311	311	311.000	
I think my friends would enjoy visiting this Web site.	Pearson Correlation	.463**	.244**	.461**	.523**	.274**	.632**	.756**	1.000
	N	311	311	311	311	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach's alpha for the eight-item scale is .862.

Four elements of the reactive content dimension of OIT are measured separately. *Accessibility* (ACC) uses a four-item unidimensional scale (α=.812, n=311) to explain 64.19% of the variance. Below are a descriptive statistics chart (Table 3.12) and correlation matrix (Table 3.13) for accessibility.

Table 3.12: Descriptive Statistics for Accessibility Scale (n=311)

	N	Mean	Std. Deviation	Factor Loading
This Web site was easy to navigate.	311	4.22	.713	.772
The organization of this Web site made it comfortable to use.	311	3.92	.889	.826
The content on this Web site was appropriate for its subject.	311	4.14	.690	.776
The content on this Web site was organized logically.	311	4.03	.819	.829
Valid N (listwise)	311			

Table 3.13: Correlation Matrix for Accessibility Scale (n=311)

		This Web site was easy to navigate.	The organization of this Web site made it comfortable to use.	The content on this Web site was appropriate for its subject.	The content on this Web site was organized logically.
This Web site was easy to navigate.	Pearson Correlation	1.000			
	N	311.000			
The organization of this Web site made it comfortable to use.	Pearson Correlation	.618**	1.000		
	N	311	311.000		
The content on this Web site was appropriate for its subject.	Pearson Correlation	.421**	.450**	1.000	
	N	311	311	311.000	
The content on this Web site was organized logically.	Pearson Correlation	.449**	.566**	.627**	1.000
	N	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach's alpha for the four-item scale is .812.

Clarity (CLAR1) employs a seven-question multidimensional scale (α=.720, n=311) to explain 59.56% of the variance (42.68% and 16.88% respectively).

Factor analysis indicated that questions four (*Grammatical errors on a Web site make me uncomfortable.*) and five (*Clear writing style is important to me.*) loaded in a second component (see Table 3.15). Varimax rotation offered no improvement. These two questions measure subject attitudes about Web sites in general rather than those used in *this* experiment, as in the case of the remaining five questions. Therefore, the researcher opted to remove the two questions from the composite scale, thereby creating a new five-question unidimensional scale (α=.806, n=311) that explains 57.15% of the variance.

Below are a descriptive statistics chart for the original seven-item scale (Table 3.14), component matrix for the original seven-item scale (Table 3.15), and descriptive statistics (Table 3.16) and correlation matrix (Table 3.17) for the revised unidimensional five-item (1, 2, 3, 6 and 7) scale for clarity.

Table 3.14: Descriptive Statistics for Original Clarity Scale (n=311)

	N	Mean	Std. Deviation
Errors on this Web site made it hard to find the information I wanted.	311	3.9293	.76294
The way the content of this Web site was presented was confusing.	311	3.6045	1.00700
This Web site was free from errors.	311	3.29	.897
Grammatical errors on a Web site make me uncomfortable.	311	3.1125	1.14872
Clear writing style is important to me.	311	3.98	.749
The content of this Web site was distracting.	311	3.5305	.91838
The content of this Web site was clear.	311	3.66	.827
Valid N (listwise)	311		

Table 3.15: Component Matrix for Original Clarity Scale (n=311)

	Component	
	1	2
The content of this Web site was distracting.	.820	.034
The way the content of this Web site was presented was confusing.	.795	-.044
The content of this Web site was clear.	.794	.059
Errors on this Web site made it hard to find the information I wanted.	.733	.011
This Web site was free from errors.	.578	.300
Clear writing style is important to me.	.045	.841
Grammatical errors on a Web site make me uncomfortable.	.423	-.614

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Table 3.16: Descriptive Statistics for Revised Clarity Scale (n=311)

	N	Mean	Std. Deviation	Factor loading
Errors on this Web site made it hard to find the information I wanted.	311	3.9293	.76294	.736
The way the content of this Web site was presented was confusing.	311	3.6045	1.00700	.800
This Web site was free from errors.	311	3.29	.897	.597
The content of this Web site was distracting.	311	3.5305	.91838	.827
The content of this Web site was clear.	311	3.66	.827	.797
Valid N (listwise)	311			

Table 3.17: Correlation Matrix for Revised Clarity Scale (n=311)

		Errors on this Web site made it hard to find the information I wanted.	The way the content of this Web site was presented was confusing.	This Web site was free from errors.	The content of this Web site was distracting.	The content of this Web site was clear.
Errors on this Web site made it hard to find the information I wanted.	Pearson Correlation	1.000				
	N	311.000				
The way the content of this Web site was presented was confusing.	Pearson Correlation	.459**	1.000			
	N	311	311.000			
This Web site was free from errors.	Pearson Correlation	.477**	.286**	1.000		
	N	311	311	311.000		
The content of this Web site was distracting.	Pearson Correlation	.468**	.611**	.340**	1.000	
	N	311	311	311	311.000	
The content of this Web site was clear.	Pearson Correlation	.411**	.591**	.311**	.627**	1.000
	N	311	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach’s alpha for the five-item scale is .806.

Relevance uses an eight-item multidimensional scale (α=-.725, n=311) to explain 59.97% of the variance (38.54% and 31.43% respectively).

Factor analysis indicated that questions four (*I trusted the content found on this Web site.*), seven (*The method of selecting options (e.g., from a menu) was consistent throughout the Web site.*) and eight (*Overall, the content on this Web site was inconsistent*.) loaded in a second component (see Table 3.19). Varimax rotation offered no improvement. The researcher opted to remove the three questions from the composite scale, thereby creating a new five-question unidimensional scale (α=.822, n=311) that explains 60.50% of the variance.

Below are a descriptive statistics chart for the original eight-item scale (Table 3.18), component matrix for the original eight-item scale (Table 3.19), and descriptive statistics (Table 3.20) and correlation matrix (Table 3.21) for the revised unidimensional five-item (1, 2, 3, 5 and 6) scale for relevance.

Table 3.18: Descriptive Statistics for Original Relevance Scale (n=311)

	N	Mean	Std. Deviation
I was very interested in this Web site's content.	311	2.17	.918
I would like to learn more about statistics.	311	2.21	1.028
The content on this Web site was written with me in mind.	311	2.68	1.069
I trusted the content found on this Web site.	311	3.91	.788
This Web site was easy to use because I liked the content.	311	2.41	.953
This Web site was easy to use because I'm familiar with the subject matter of the content.	311	2.54	1.180
The method of selecting options (e.g., from a menu) was consistent throughout the Web site.	311	3.86	.870
Overall, the content on this Web site was inconsistent.	311	3.99	.803
Valid N (listwise)	311		

Table 3.19: Component Matrix for Original Relevance Scale (n=311)

	Component	
	1	2
I was very interested in this Web site's content.	.857	-.105
This Web site was easy to use because I liked the content.	.841	-.120
I would like to learn more about statistics.	.835	-.123
The content on this Web site was written with me in mind.	.668	.230
This Web site was easy to use because I'm familiar with the subject matter of the content.	.635	-.213
The method of selecting options (e.g., from a menu) was consistent throughout the Web site.	.182	.729
I trusted the content found on this Web site.	.243	.726
Overall, the content on this Web site was inconsistent.	-.048	.720

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Table 3.20: Descriptive Statistics for Revised Relevance Scale (n=311)

	N	Mean	Std. Deviation	Factor Loading
I was very interested in this Web site's content.	311	2.17	.918	.864
I would like to learn more about statistics.	311	2.21	1.028	.848
The content on this Web site was written with me in mind.	311	2.68	1.069	.649
This Web site was easy to use because I liked the content.	311	2.41	.953	.846
This Web site was easy to use because I'm familiar with the subject matter of the content.	311	2.54	1.180	.650
Valid N (listwise)	311			

Table 3.21: Correlation Matrix for Revised Relevance Scale (n=311)

		I was very interested in this Web site's content.	I would like to learn more about statistics.	The content on this Web site was written with me in mind.	This Web site was easy to use because I liked the content.	This Web site was easy to use because I'm familiar with the subject matter of the content.
I was very interested in this Web site's content.	Pearson Correlation	1.000				
	N	311.000				
I would like to learn more about statistics.	Pearson Correlation	.729**	1.000			
	N	311	311.000			
The content on this Web site was written with me in mind.	Pearson Correlation	.450**	.458**	1.000		
	N	311	311	311.000		
This Web site was easy to use because I liked the content.	Pearson Correlation	.662**	.633**	.421**	1.000	
	N	311	311	311	311.000	
This Web site was easy to use because I'm familiar with the subject matter of the content.	Pearson Correlation	.432**	.391**	.277**	.510**	1.000
	N	311	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach's alpha for this five-item scale is .822.

Vividness is measured using a 10-item multidimensional scale (α=.831, n=311) to explain 58.64% of the variance in interactivity. The two factors account for 42.17% and 16.47% respectively.

Factor analysis indicated that questions three, four and seven loaded in a second component (see Table 3.23). Varimax rotation produced two more clearly defined factors in which both questions four (*The bright colors on this Web site were distracting*.) and five (*The colors on this Web site helped make the content clear*.) double loaded and were removed by the researcher.

The resulting eight-item multidimensional scale (α=.844, n=311) explains 66.26% of the variance (34.24% and 32.02% respectively). The four questions in the first factor considered the appearance of the content, while the remaining four dealt more with navigation. The researcher considered both appearance and navigation to be contributors to the vividness of the content, and therefore a composite multidimensional scale reflecting both elements is an appropriate measure of vividness in this experiment.

Below are a descriptive statistics chart for the original ten-item scale (Table 3.22), component matrix for the original ten-item scale (Table 3.23), and component matrix (Table 3.24) and correlation matrix (Table 3.25) for the revised multidimensional eight-item (1, 2, 3, 6, 7, 8, 9 and 10) scale for vividness.

Table 3.22: Descriptive Statistics for Original Ten-item Vividness Scale (n=311)

	N	Mean	Std. Deviation
The content of this Web site was visually appealing.	311	2.82	1.075
The content of this Web site made it easy to navigate.	311	3.57	.862
The design of this Web site made it easy to navigate.	311	3.74	.775
The bright colors on this Web site were distracting.	311	3.8682	.77791
The colors on this Web site helped make the content clear.	311	3.19	.993
The content on this Web site was easy to see and read.	311	3.72	.867
Overall, the content appeared uncluttered.	311	3.42	1.000
Compared to traditional media such as textbooks, this Web site was displayed using a high degree of graphic richness.	311	3.03	1.095
Compared to traditional media, this Web site was displayed with a high degree of animation.	311	2.54	1.011
Compared to traditional media, this Web site was displayed using a high degree of graphic effects.	311	2.65	1.042
Valid N (listwise)	311		

Table 3.23: Component Matrix for Original Ten-item Vividness Scale (n=311)

	Component	
	1	2
Compared to traditional media such as textbooks, this Web site was displayed using a high degree of graphic richness.	.788	-.182
Compared to traditional media, this Web site was displayed using a high degree of graphic effects.	.750	-.489
The content of this Web site was visually appealing.	.747	-.147
Compared to traditional media, this Web site was displayed with a high degree of animation.	.692	-.506
The content on this Web site was easy to see and read.	.675	.415
The colors on this Web site helped make the content clear.	.659	-.087
The content of this Web site made it easy to navigate.	.658	.396
The design of this Web site made it easy to navigate.	.583	.502
Overall, the content appeared uncluttered.	.578	.354
The bright colors on this Web site were distracting.	-.016	.619

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Table 3.24: Component Matrix for Revised Eight-item Vividness Scale (n=311)

	Component	
	1	2
Compared to traditional media, this Web site was displayed using a high degree of graphic effects.	.912	.116
Compared to traditional media, this Web site was displayed with a high degree of animation.	.892	.065
Compared to traditional media such as textbooks, this Web site was displayed using a high degree of graphic richness.	.763	.347
The content of this Web site was visually appealing.	.631	.402
The content of this Web site made it easy to navigate.	.168	.795
The design of this Web site made it easy to navigate.	.086	.779
The content on this Web site was easy to see and read.	.238	.761
Overall, the content appeared uncluttered.	.197	.665

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table 3.25: Correlation Matrix for Revised Eight-item Vividness Scale (n=311)

		VIV1	VIV2	VIV3	VIV6	VIV7.	VIV8	VIV9	VIV10
The content of this Web site was visually appealing.	Pearson Correlation	1.000							
	N	311.000							
The content of this Web site made it easy to navigate.	Pearson Correlation	.453**	1.000						
	N	311	311.000						
The design of this Web site made it easy to navigate.	Pearson Correlation	.342**	.608**	1.000					
	N	311	311	311.000					
The content on this Web site was easy to see and read.	Pearson Correlation	.361**	.481**	.464**	1.000				
	N	311	311	311	311.000				
Overall, the content appeared uncluttered.	Pearson Correlation	.309**	.372**	.320**	.556**	1.000			
	N	311	311	311	311	311.000			
Compared to traditional media such as textbooks, this Web site was displayed using a high degree of graphic richness.	Pearson Correlation	.529**	.370**	.268**	.465**	.403**	1.000		
	N	311	311	311	311	311	311.000		
Compared to traditional media, this Web site was displayed with a high degree of animation.	Pearson Correlation	.503**	.231**	.208**	.253**	.202**	.581**	1.000	
	N	311	311	311	311	311	311	311.000	
Compared to traditional media, this Web site was displayed using a high degree of graphic effects.	Pearson Correlation	.520**	.251**	.218**	.312**	.256**	.674**	.780**	1.000
	N	311	311	311	311	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach's alpha for this revised eight-item scale is .844.

Interactivity, conceptualized by OIT as outcomes of the communication event, uses a ten-item multidimensional scale (α=.894, n=311) to explain 64.57% of the variance (52.23% and 12.33% respectively).

Factor analysis indicated that questions three (*How important to you is the amount of interactivity on this Web site?*) and ten (*How important is it to you that a Web site contains a lot of interactivity?*) were double loaded (see Table 3.27). Varimax rotation produced two more clearly defined factors in which only question eight was double loaded, and it was removed by the researcher.

The resulting rotated nine-item multidimensional scale (α=.876, n=311) explains 64.19% of the variance (38.46% and 25.73% respectively). The four questions in the first factor considered the appearance of the content, while the remaining four dealt more with navigation. The researcher considered both appearance and navigation to be contributors to the vividness of the content, and therefore a composite multidimensional scale reflecting both elements is an appropriate measure of vividness in this experiment.

Below are a descriptive statistics chart for the original ten-item scale (Table 3.26), component matrix for the original ten-item scale (Table 3.27), and component matrix (Table 3.28) and correlation matrix (Table 3.29) for the revised multidimensional nine-item (1, 2, 3, 4, 5, 6, 7, 9 and 10) scale for interactivity.

Table 3.26: Descriptive Statistics for Original Ten-item Interactivity Scale (n=311)

	N	Mean	Std. Deviation
To what degree does this Web site possess or contain interactivity?	311	3.62	1.377
To what degree did this Web site react to your direction or influence?	311	3.58	1.293
How important to you is the amount of interactivity on this Web site?	311	4.00	1.491
To what degree did the amount of interactivity on this Web site affect how you used it?	311	3.81	1.400
To what degree did the amount of interactivity on this Web site make it seem more appealing?	311	3.67	1.476
To what degree did the amount of interactivity on this Web site affect how interesting the content was?	311	3.70	1.528
To what degree did your experience help you appreciate any interactive features of this Web site?	311	3.74	1.415
To what degree did the technological features on this Web site affect how interactive it was?	311	3.71	1.388
To what degree did the content on this Web site affect how interactive it was?	311	3.87	1.421
How important is it to you that a Web site contains a lot of interactivity?	311	4.71	1.522
Valid N (listwise)	311		

Table 3.27: Component Matrix for Original Ten-item Interactivity Scale (n=311)

	Component	
	1	2
To what degree did the technological features on this Web site affect how interactive it was?	.832	-.205
To what degree did the amount of interactivity on this Web site make it seem more appealing?	.823	-.220
To what degree did your experience help you appreciate any interactive features of this Web site?	.798	-.128
To what degree did the amount of interactivity on this Web site affect how interesting the content was?	.798	-.088
To what degree did the content on this Web site affect how interactive it was?	.738	.064
To what degree did this Web site react to your direction or influence?	.704	-.290
To what degree does this Web site possess or contain interactivity?	.676	-.358
To what degree did the amount of interactivity on this Web site affect how you used it?	.669	.370
How important to you is the amount of interactivity on this Web site?	.625	.529
How important is it to you that a Web site contains a lot of interactivity?	.493	.697

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Table 3.28: Component Matrix for Revised Nine-item Interactivity Scale (n=311)

	Component	
	1	2
To what degree did the amount of interactivity on this Web site make it seem more appealing?	.813	.260
To what degree does this Web site possess or contain interactivity?	.785	.052
To what degree did this Web site react to your direction or influence?	.771	.126
To what degree did your experience help you appreciate any interactive features of this Web site?	.739	.327
To what degree did the amount of interactivity on this Web site affect how interesting the content was?	.722	.360
To what degree did the content on this Web site affect how interactive it was?	.561	.468
How important is it to you that a Web site contains a lot of interactivity?	.034	.854
How important to you is the amount of interactivity on this Web site?	.252	.776
To what degree did the amount of interactivity on this Web site affect how you used it?	.381	.665

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table 3.29: Correlation Matrix for Revised Nine-item Interactivity Scale (n=311)

		INTER1	INTER2	INTER3	INTER4	INTER5	INTER6	INTER7	INTER9	INTER10
To what degree does this Web site possess or contain interactivity?	Pearson Correlation	1.000								
	N	311.000								
To what degree did this Web site react to your direction or influence?	Pearson Correlation	.585**	1.000							
	N	311	311.000							
How important to you is the amount of interactivity on this Web site?	Pearson Correlation	.315**	.334**	1.000						
	N	311	311	311.000						
To what degree did the amount of interactivity on this Web site affect how you used it?	Pearson Correlation	.332**	.337**	.512**	1.000					
	N	311	311	311	311.000					
To what degree did the amount of interactivity on this Web site make it seem more appealing?	Pearson Correlation	.561**	.571**	.429**	.501**	1.000				
	N	311	311	311	311	311.000				
To what degree did the amount of interactivity on this Web site affect how interesting the content was?	Pearson Correlation	.472**	.466**	.374**	.490**	.636**	1.000			
	N	311	311	311	311	311	311.000			

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach's alpha for the rotated nine-item scale is .876.

Table 3.29a: Correlation Matrix for Revised Nine-item Interactivity Scale (continued)

		INTER1	INTER2	INTER3	INTER4	INTER5	INTER6	INTER7	INTER9	INTER10
To what degree did your experience help you appreciate any interactive features of this Web site?	Pearson Correlation	.481**	.524**	.378**	.444**	.636**	.654**	1.000		
	N	311	311	311	311	311	311	311.000		
To what degree did the content on this Web site affect how interactive it was?	Pearson Correlation	.358**	.412**	.427**	.432**	.531**	.587**	.524**	1.000	
	N	311	311	311	311	311	311	311	311.000	
How important is it to you that a Web site contains a lot of interactivity?	Pearson Correlation	.161**	.233**	.531**	.433**	.212**	.315**	.329**	.349**	1.000
	N	311	311	311	311	311	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach's alpha for the rotated nine-item scale is .876.

While not specifically in the current experimental design, Internet use, user experience and technology use were also measured in order to facilitate future tests of Outcome Interactivity Theory.

Subjects' level of *Internet use* is measured using a five-item unidimensional scale (α=.756, n=311) that accounts for 52.78% of the variance. Below are a descriptive statistics chart (Table 3.30) and correlation matrix (Table 3.31) for internet use.

Table 3.30: Descriptive Statistics for Internet Use Scale (n=311)

	N	Mean	Std. Deviation	Factor Loading
I rely heavily upon internet technology such as my computer and cell phone for getting me through the day.	311	4.40	.792	.835
I communicate using internet technology such as my computer and cell phone almost constantly.	311	4.26	.880	.820
I can easily go a week without communicating via internet technology such as my computer or cell phone.	311	4.09	1.120	.741
I am a heavy user of computer-mediated communication.	311	4.03	.912	.654
If I can avoid using a computer for communicating, I do.	311	3.86	.998	.541
Valid N (listwise)	311			

Table 3.31: Correlation Matrix for Internet Use Scale (n=311)

		I rely heavily upon internet technology such as my computer and cell phone for getting me through the day.	I communicate using internet technology such as my computer and cell phone almost constantly.	I can easily go a week without communicating via internet technology such as my computer or cell phone.	I am a heavy user of computer-mediated communication.	If I can avoid using a computer for communicating, I do.
I rely heavily upon internet technology such as my computer and cell phone for getting me through the day.	Pearson Correlation	1.000				
	N	311				
I communicate using internet technology such as my computer and cell phone almost constantly.	Pearson Correlation	.708**	1.000			
	N	311	311			
I can easily go a week without communicating via internet technology such as my computer or cell phone.	Pearson Correlation	.427**	.363**	1.000		
	N	311	311	311		
I am a heavy user of computer-mediated communication.	Pearson Correlation	.474**	.532**	.316**	1.000	
	N	311	311	311	311	
If I can avoid using a computer for communicating, I do.	Pearson Correlation	.224**	.287**	.340**	.324**	1.000
	N	311	311	311	311	311

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach's alpha for the five-item scale is .756.

Relevant user experiences uses a seven-item multidimensional scale with an overall reliability of .746 (*n*=311). The three factors account for 77.78% of the variance (40.46%, 22.24% and 15.08% respectively).

Factor analysis indicated that five of the seven questions were double loading (see Table 3.33). After Varimax rotation, the three factors in the scale loaded cleanly. (Only question three double loaded after rotation and was removed by the researcher.)

The resulting rotated six-item multidimensional scale (α=.692, n=311) explains 83.50% of the variance (29.51%, 27.56% and 26.43% respectively). Questions in the first factor consider ability to use communication technologies. The second factor considers familiarity with CMCs, and the remaining factor considers personal frustration with technology. The researcher considered all three to be contributors to the a subject's experiences as they relate to interactivity, and therefore a composite multidimensional scale reflecting all three elements is an appropriate measure of relevant user experiences in this experiment.

Below are a descriptive statistics chart for the original seven-item scale (Table 3.32), component matrix for the original seven-item scale (Table 3.33), and component matrix (Table 3.34) and correlation matrix (Table 3.35) for the revised multidimensional six-item (1, 2, 4, 5, 6 and 7) scale for relevant user experiences.

Table 3.32: Descriptive Statistics for Original User Experiences Scale (n=311)

	N	Mean	Std. Deviation
I am very competent in learning and using communication technology.	311	4.03	.778
I am completely capable of using almost all currently available communication technologies.	311	3.96	.751
My colleagues/friends look to me frequently for help with their technology questions or needs.	311	3.28	.971
I spend a lot of time just exploring CMCs just to see what I can do with them.	311	2.72	1.017
I am excited by the prospect of getting and learning new CMCs.	311	2.97	1.035
I find changes in technologies very frustrating.	311	3.4598	.96928
Having to learn new technologies makes me nervous.	311	3.7138	.99601
Valid N (listwise)	311		

Table 3.33: Component Matrix for Original User Experiences Scale (n=311)

	Component		
	1	2	3
My colleagues/friends look to me frequently for help with their technology questions or needs.	.729	.074	-.114
I am completely capable of using almost all currently available communication technologies.	.729	-.192	-.425
Having to learn new technologies makes me nervous.	.626	-.509	.397
I am very competent in learning and using communication technology.	.606	-.254	-.592
I find changes in technologies very frustrating.	.580	-.446	.550
I spend a lot of time just exploring CMCs just to see what I can do with them.	.587	.716	.146
I am excited by the prospect of getting and learning new CMCs.	.574	.693	.172

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Table 3.34: Component Matrix for Revised User Experiences Scale (n=311)

	Component		
	1	2	3
I spend a lot of time just exploring CMCs just to see what I can do with them.	.931	.104	.022
I am excited by the prospect of getting and learning new CMCs.	.911	.082	.045
I am very competent in learning and using communication technology.	-.006	.882	.067
I am completely capable of using almost all currently available communication technologies.	.148	.827	.208
I find changes in technologies very frustrating.	.077	.089	.907
Having to learn new technologies makes me nervous.	.017	.245	.865

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

Table 3.35: Correlation Matrix for Revised User Experiences Scale (n=311)

		RELEXP1	RELEXP2	RELEXP4	RELEXP5.	RELEXP6	RELEXP7
I am very competent in learning and using communication technology.	Pearson Correlation	1.000					
	N	311.000					
I am completely capable of using almost all currently available communication technologies.	Pearson Correlation	.581**	1.000				
	N	311	311.000				
I spend a lot of time just exploring CMCs just to see what I can do with them.	Pearson Correlation	.115*	.219**	1.000			
	N	311	311	311.000			
I am excited by the prospect of getting and learning new CMCs.	Pearson Correlation	.133*	.227**	.760**	1.000		
	N	311	311	311	311.000		
I find changes in technologies very frustrating.	Pearson Correlation	.172**	.306**	.088	.144*	1.000	
	N	311	311	311	311	311.000	
Having to learn new technologies makes me nervous.	Pearson Correlation	.301**	.336**	.093	.077	.645**	1.000
	N	311	311	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Cronbach’s alpha for the seven-item scale is .692.

The influence of *technological features* is measured using a four-item unidimensional scale (α=.866, n=311) to account for 71.54% of the variance. Below are a descriptive statistics chart (Table 3.36) and correlation matrix (Table 3.37) for technological features.

Table 3.36: Descriptive Statistics for Technological Features Scale (n=311)

	N	Mean	Std. Deviation	Factor Loading
The technological features of this Web site made it easy to navigate around it.	311	3.68	.891	.880
The technological features of this Web site helped me feel in control.	311	3.44	.928	850
Having a lot of technological features on this Web site was beneficial.	311	3.30	.874	.841
This website had all the technological features I needed.	311	3.34	.961	.811
Valid N (listwise)	311			

Table 3.37: Correlation Matrix for Technological Features Scale (n=311)

		The technological features of this Web site made it easy to navigate around it.	The technological features of this Web site helped me feel in control.	Having a lot of technological features on this Web site was beneficial.	This website had all the technological features I needed.
The technological features of this Web site made it easy to navigate around it.	Pearson Correlation	1.000			
	N	311.000			
The technological features of this Web site helped me feel in control.	Pearson Correlation	.706**	1.000		
	N	311	311.000		
Having a lot of technological features on this Web site was beneficial.	Pearson Correlation	.588**	.665**	1.000	
	N	311	311	311.000	
This website had all the technological features I needed.	Pearson Correlation	.575**	.592**	.593**	1.000
	N	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
Cronbach's alpha for the four-item scale is .866.

In addition, subjects' need for cognition (Cacioppo et al., 1984) was measured in order to assess the degree to which any variance between the comparison and treatment subject groups might be due to reluctance or discomfort with technical or complex lesson content rather than because of manipulated levels of interactive functionality in the treatment content.

The influence of *need for cognition* was measured using a 12-item multidimensional scale (α=.796, n=311) to account for 60.94% of the variance (38.23%, 13.39% and 9.33% respectively).

Factor analysis indicated that three of the 12 questions were double loading (see Table 3.39). After Varimax rotation, the three factors in the scale loaded cleanly with no double loading. No questions were removed by the researcher.

The resulting rotated 12-item multidimensional scale (α=.796, n=311) explains 60.94% of the variance (24.75%, 20.86% and 15.33% respectively). Questions in the first factor consider thinking, while the second factor considers learning, and the remaining factor considers personal comfort level with challenging learning situations. The researcher considered all three to be contributors to a subject's desire for learning, and therefore a composite multidimensional scale reflecting all three elements is an appropriate measure of need for cognition in this experiment.

Below are a descriptive statistics chart for the original 12-item scale (Table 3.38), component matrix for the original scale (Table 3.39), and component matrix (Table 3.40) and correlation matrix (Table 3.41) for the rotated multidimensional 12-item scale for need for cognition.

Table 3.38: Descriptive Statistics for Original Need for Cognition Scale (n=311)

	N	Mean	Std. Deviation
I like thinking.	311	4.05	.705
I only think as hard as I have to.	311	3.3119	.94825
Thinking is not fun.	311	3.8264	.74189
I like solving puzzles.	311	3.84	.871
Thinking for a long time is rewarding.	311	3.56	.866
I like tasks where I have to think a lot.	311	3.35	.893
I enjoy solving hard problems.	311	3.32	1.043
I feel relief after finishing a hard problem.	311	4.19	.718
I feel satisfied after finishing a hard problem.	311	1.7331	.65954
I like knowing how things work.	311	4.08	.756
I get bored when I have to think too much.	311	3.3955	.92693
Learning new ways to think is not exciting.	311	3.5273	.88994
Valid N (listwise)	311		

Table 3.39: Component Matrix for Original Need for Cognition Scale (n=311)

	Component		
	1	2	3
I like tasks where I have to think a lot.	.766	.122	-.345
I like thinking.	.749	.046	-.121
I enjoy solving hard problems.	.716	-.004	-.421
Thinking for a long time is rewarding.	.690	-.004	-.219
Thinking is not fun.	.678	.268	.342
I get bored when I have to think too much.	.658	.275	.233
Learning new ways to think is not exciting.	.635	.224	.375
I like solving puzzles.	.612	-.141	-.378
I like knowing how things work.	.517	-.339	.073
I only think as hard as I have to.	.501	.315	.434
I feel relief after finishing a hard problem.	.253	-.799	.258
I feel satisfied after finishing a hard problem.	-.446	.721	-.213

Extraction Method: Principal Component Analysis.

a. 3 components extracted.

Table 3.40: Component Matrix for Rotated Need for Cognition Scale (n=311)

	Component		
	1	2	3
I enjoy solving hard problems.	.810	.158	.088
I like tasks where I have to think a lot.	.796	.295	.015
I like solving puzzles.	.705	.062	.192
Thinking for a long time is rewarding.	.654	.275	.146
I like thinking.	.630	.397	.150
Thinking is not fun.	.263	.757	.081
Learning new ways to think is not exciting.	.208	.733	.118
I only think as hard as I have to.	.071	.730	.014
I get bored when I have to think too much.	.323	.676	.032
I feel relief after finishing a hard problem.	.005	-.035	.876
I feel satisfied after finishing a hard problem.	-.177	-.088	-.852
I like knowing how things work.	.326	.211	.486

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

Table 3.41: Correlation Matrix for Need for Cognition Scale (n=311)

		I like thinking.	I only think as hard as I have to.	Thinking is not fun.	I like solving puzzles.	Thinking for a long time is rewarding.	I like tasks where I have to think a lot.	I enjoy solving hard problems.	I feel relief after finishing a hard problem.	I feel satisfied after finishing a hard problem.	I like knowing how things work.	I get bored when I have to think too much.	Learning new ways to think is not exciting.
I like thinking.	Pearson Correlation	1.000											
	N	311.000											
I only think as hard as I have to.	Pearson Correlation	.274**	1.000										
	N	311	311.000										
Thinking is not fun.	Pearson Correlation	.505**	.449**	1.000									
	N	311	311	311.000									
I like solving puzzles.	Pearson Correlation	.408**	.173**	.297**	1.000								
	N	311	311	311	311.000								
Thinking for a long time is rewarding.	Pearson Correlation	.494**	.203**	.372**	.339**	1.000							
	N	311	311	311	311	311.000							
I like tasks where I have to think a lot.	Pearson Correlation	.559**	.300**	.395**	.416**	.607**	1.000						
	N	311	311	311	311	311	311.000						
I enjoy solving hard problems.	Pearson Correlation	.476**	.258**	.313**	.542**	.430**	.648**	1.000					
	N	311	311	311	311	311	311	311.000					

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Cronbach's alpha for the 12-item scale is .796.

Table 3.41: Correlation Matrix for Need for Cognition Scale (continued)

		I like thinking.	I only think as hard as I have to.	Thinking is not fun.	I like solving puzzles.	Thinking for a long time is rewarding.	I like tasks where I have to think a lot.	I enjoy solving hard problems.	I feel relief after finishing a hard problem.	I feel satisfied after finishing a hard problem.	I like knowing how things work.	I get bored when I have to think too much.	Learning new ways to think is not exciting.
I feel relief after finishing a hard problem.	Pearson Correlation	.113*	-.035	.050	.125*	.161**	.066	.109	1.000				
	N	311	311	311	311	311	311	311	311.000				
I feel satisfied after finishing a hard problem.	Pearson Correlation	-.232**	-.130*	-.168**	-.298**	-.252**	-.201**	-.256**	-.601**	1.000			
	N	311	311	311	311	311	311	311	311	311.000			
I like knowing how things work.	Pearson Correlation	.404**	.208**	.267**	.304**	.266**	.278**	.287**	.245**	-.352**	1.000		
	N	311	311	311	311	311	311	311	311	311	311.000		
I get bored when I have to think too much.	Pearson Correlation	.372**	.384**	.480**	.293**	.394**	.431**	.393**	.052	-.170**	.171**	1.000	
	N	311	311	311	311	311	311	311	311	311	311	311.000	
Learning new ways to think is not exciting.	Pearson Correlation	.412**	.347**	.506**	.232**	.348**	.382**	.308**	.095	-.172**	.234**	.509**	1.000
	N	311	311	311	311	311	311	311	311	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Cronbach’s alpha for the 12-item scale is .796.

Thus, the ten measurement scales used in this study employ a total of 66 separate questions and show a high overall level of reliability ranging from α=.692 to α=.876. Overall reliability across all ten composite scales was α=.756 (n=311).

The effectiveness of the manipulations used to test the hypotheses was evaluated using a manipulation check scale designed by the researcher expressly for this study. The manipulation check tested whether a high level of interactive functionality in lesson content (operationalized as high levels of accessibility, relevance and vividness) elicited a higher reported level of interactivity than content displaying less interactive functionality. The manipulation check was measured using a six-item unidimensional scale (α=.823, n=311) to account for 53.80% of the variance.

The interactivity scale described above was used to determine if the manipulation was successful. An independent samples t-test confirmed that the perceived interactivity of the treatment group (M = 36.32, S.D. = 8.92) was higher than the comparison group (M = 32.99, S.D. = 9.13) and the difference was statistically significant [t (309) = -.325, p<.001]. The scales used to measure interactivity and check the manipulations of the experiment showed a high degree of correlation (see Table 3.42).

Table 3.42: Correlation Matrix for Manipulation Check (n=311)

		Manipulation Check	Interactivity final scale
Manipulation Check	Pearson Correlation	1	
	N	311	
Interactivity	Pearson Correlation	.535**	1
	N	311	311

**. Correlation is significant at the 0.01 level (2-tailed).

Resources

The work of compiling and analyzing data obtained during this study were conducted by the primary researcher. Additional support was provided on an as-needed basis by the researcher's Faculty Advisor, Dr. Derek R. Lane.

Web site hosting and online survey tools will be provided and administered by the UK Department of Communication. Data analysis tools will be provided by the researcher.

Data Analysis Strategies

The pilot study described above found a large effect size for several variables. It was expected that the new study would also find large effects for its variables. Two *a priori* power analyses were conducted using the computer program *G*Power 3.0.10* to compute the required sample size for this study. For this analysis, alpha was set at .05 and power at .95.

The following analyses were calculated for a *t* test of Hypotheses 1-2 (see Appendix 2). The results are as follows: for a medium effect size, d = .5, noncentrality parameter $\delta = 3.316625$, critical t = 1.653658, minimum n = 176; and for a large effect size, d = .8, noncentrality parameter $\delta = 3.346640$, critical t = 1.667572, minimum n = 70.

The following analyses were calculated for a multiple regression to test Hypotheses 3-6 (see Appendix 2). The results are as follows: for a medium effect size, $f^2 = .15$, F (5, 132) = 2.283, noncentrality parameter $\lambda = 20.70$, minimum n = 138; and for a large effect size, $f^2 = .35$, F (5, 57) = 2.377, noncentrality parameter $\lambda = 22.05$, minimum n = 63.

A sample of *n* = 70-176 subjects should be sufficient to minimize Type II error and to test the first two hypotheses of the study. A sample of *n* = 63-138 subjects should also be sufficient to minimize Type II error and to test the other four hypotheses of the study. Therefore, a sample in excess of n=176 subjects would maximize the likelihood of finding statistically significant results in this study.

The response rate provided a sufficiently large sample (*n* = 316) to yield statistically valid results in the study.

Tests of Subject Homogeneity

Eight tests confirmed the homogeneity of subjects in the two groups. First, a chi-square test [χ^2 (1) = 2.650, p < .05] indicated no significant difference between males and females across the two experimental conditions. Second, a chi-square test [χ^2 (3) = 2.092, p < .05] indicated no significant difference among subject academic rank across the two experimental conditions. Third, a chi-square test [χ^2 (5) = 3.908, p > .05] indicated no significant difference in subject ethnicity across the two experimental conditions. Fourth, a chi-square test [χ^2 (9) = 10.188, p < .05] indicated no significant difference in subject major across the two experimental conditions. Fifth, a chi-square test [χ^2 (4) = 9.349, p < .05] indicated no significant difference in age group distribution across the two experimental conditions. Sixth, a Pearson chi-square test [χ^2 (4) = 3.368, p > .05] indicated no significant difference in the amount of subject Internet experience across the two experimental conditions. Seventh, a chi-square test [χ^2 (4) = 4.878, p < .05] indicated no significant difference in subject comfort level with math or statistics coursework across the two experimental conditions.

In addition, subjects' need for cognition (Cacioppo et al., 1984) was measured to ensure the degree to which any variance between the comparison and treatment subject groups might be due to reluctance or discomfort with technical or complex lesson content was not different between groups. A chi-square test [χ^2 (29) = 27.180, p > .05] indicated no significant difference in subject need for cognition across the two experimental conditions.

Equivalence between the subject groups was further examined using an independent samples t-test in which the means for the comparison group were slightly higher than those of the treatment group (see Table 3.45), but were not statistically significantly different [t (309) = .333, p > .05] (see Table 3.46).

Table 3.45: Group Statistics for Need for Cognition Scale

	Experimental Condition	N	Mean	Std. Deviation	Std. Error Mean
Need for Cognition	comparison	153	42.3007	4.97637	.40232
	treatment	158	42.0886	6.17410	.49118

Table 3.46: Independent Samples Test for Need for Cognition Scale

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference
Need for Cognition	Equal variances assumed	6.713	.010	.333	309	.739	.21205
	Equal variances not assumed			.334	299.217	.739	.21205

Therefore, subjects in control and treatment conditions can be considered equally represented in terms of gender, rank, ethnicity, major, age, Internet experience, comfort level with math or statistics coursework, and need for cognition.

Summary

Earlier chapters of this dissertation clarified the existing interactivity literature, presented a new and more comprehensive definition of the interactivity construct, and described a new theory—Outcome Interactivity Theory—with which to operationalize and measure the influence of interactivity and its contributing dimensions. They also described a pilot study representing a first empirical test of OIT and the impact of its contributing dimensions on both interactivity and an individual's satisfaction with the related communication event. Finally, research questions and hypotheses were presented for an empirical study to test Outcome Interactivity Theory.

This chapter described a pre-test post-test control group full experimental design (Bailey, 1994) to answer the research questions. It presented the general procedures that were followed, including information regarding subject selection, procedures for data collection, and measurement instruments that were employed for answering each research question, as well as data analysis strategies and tests to ensure subject homogeneity.

The next chapter describes the results of this pre-test post-test control group full experiment.

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Chapter 4

Results

The current study uses a pre-test post-test control group full experimental design to test the influence of interactive functionality in the content dimension of the Outcome Interactivity Theory model. To achieve this goal, the study tested the impact of interactivity on knowledge acquisition and satisfaction student learning outcomes using a series of independent sample t-tests. In addition, the OIT model was tested using several regression analyses to measure the effect of interactivity on knowledge acquisition and satisfaction.

Results relating to each of the hypotheses are presented after the descriptive statistics table (see Table 4.1) for all composite variables. In addition, correlation matrices are presented for the comparison group (see Table 4.2), treatment group (see Table 4.3) and combined sample (see Table 4.4).

A descriptive statistics table is provided below (see Table 4.1) for all composite variables.

Table 4.1: Descriptive Statistics Table for All Composite Variables by Group

	Comparison		Treatment		Combined Sample	
	Mean n=153	Std. Deviation	Mean n=158	Std. Deviation	Mean n=311	Std. Deviation
ACCESSIBILITY	4.0343	.64319	4.1187	.60630	4.0772	.62514
CLARITY	3.5647	.63706	3.6367	.69203	3.6013	.66546
RELEVANCE	2.2993	.75746	2.4987	.81005	2.4006	.78969
VIVIDNESS	2.6708	.55473	2.9937	.56094	2.8348	.57999
INTERACTIVITY	3.6659	1.01479	4.0359	.99066	3.8539	1.01798
SATISFACTION	2.6985	.66121	2.9241	.74224	2.8131	.71143
KNOWLEDGE ACQ	5.1242	2.41247	5.3101	2.31281	5.2186	2.36038
Valid N (listwise)						

Composite means computed with range of 1-5

Table 4.2: Correlation Matrix for All Composite Variables, Comparison Group

Experimental Condition			ACC	CLAR	REL	VIV	INTER	SAT	K ACQ
.00 comparison	ACCESSIBILITY	Pearson Correlation	1						
		N	153						
	CLARITY	Pearson Correlation	.540**	1					
		N	153	153					
	RELEVANCE	Pearson Correlation	.314**	.146	1				
		N	153	153	153				
	VIVIDNESS	Pearson Correlation	.521**	.439**	.378**	1			
		N	153	153	153	153			
	INTERACTIVITY	Pearson Correlation	.288**	.147	.497**	.523**	1		
		N	153	153	153	153	153		
	SATISFACTION	Pearson Correlation	.497**	.341**	.642**	.513**	.528**	1	
		N	153	153	153	153	153	153	
	KNOWLEDGE ACQ	Pearson Correlation	.239**	.156	.319**	.034	.151	.358**	1
		N	153	153	153	153	153	153	153

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.3: Correlation Matrix for All Composite Variables, Treatment Group

Experimental Condition			ACC	CLAR	REL	VIV	INTER	SAT	K_ACQ
1.00 treatment	ACCESSIBILITY	Pearson Correlation	1						
		N	158						
	CLARITY	Pearson Correlation	.631**	1					
		N	158	158					
	RELEVANCE	Pearson Correlation	.241**	.238**	1				
		N	158	158	158				
	VIVIDNESS	Pearson Correlation	.610**	.598**	.321**	1			
		N	158	158	158	158			
	INTERACTIVITY	Pearson Correlation	.292**	.381**	.474**	.492**	1		
		N	158	158	158	158	158		
	SATISFACTION	Pearson Correlation	.462**	.421**	.754**	.574**	.529**	1	
		N	158	158	158	158	158	158	
	KNOWLEDGE ACQ	Pearson Correlation	.188*	.215**	.364**	.131	.112	.364**	1
		N	158	158	158	158	158	158	158

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Table 4.4: Correlation Matrix for All Composite Variables, Combined Sample

		ACC	CLAR	REL	VIV	INTER	SAT	K_ACQ
ACCESSIBILITY	Pearson Correlation	1.000						
	N	311.000						
CLARITY	Pearson Correlation	.587**	1.000					
	N	311	311.000					
RELEVANCE	Pearson Correlation	.282**	.201**	1.000				
	N	311	311	311.000				
VIVIDNESS	Pearson Correlation	.560**	.517**	.366**	1.000			
	N	311	311	311	311.000			
INTERACTIVITY	Pearson Correlation	.297**	.274**	.495**	.529**	1.000		
	N	311	311	311	311	311.000		
SATISFACTION	Pearson Correlation	.480**	.389**	.709**	.561**	.541**	1.000	
	N	311	311	311	311	311	311.000	
KNOWLEDGE ACQ	Pearson Correlation	.216**	.188**	.343**	.090	.137*	.362**	1.000
	N	311	311	311	311	311	311	311.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Hypotheses 1a and 1b

The first set of hypotheses tested group mean differences between the treatment and comparison groups for student learning outcomes (knowledge acquisition and satisfaction).

Hypothesis 1a tested whether students participating in the treatment group (online instructional modules with high interactive functionality) would display a higher level of knowledge acquisition after exposure to the online content than students in the comparison (low interactive functionality) group. Results of the independent samples t-test revealed higher post-test means for the treatment group (M = 5.3101, S.D. = 2.31281) than for the comparison group (M = 5.1242, S.D. = 2.41247). However, the differences were not statistically significant [t (309) = -.694, $p > .05$], and therefore Hypothesis 1a is not supported.

Hypothesis 1b tested whether students participating in the treatment (high interactive functionality) group would display a higher level of satisfaction after exposure to the online content than students in the comparison (low interactive functionality) group. Results of the independent samples t-test revealed higher means for satisfaction for the treatment group (M = 2.9241, S.D. = .74224) than for the comparison group (M = 2.6985, S.D. = .66121), and the differences were statistically significant [t (309) = -2.826, $p < .005$]. Therefore, Hypothesis 1b is supported.

Hypotheses 1c, 1d, 1e and 1f

The next set of hypotheses tested group mean differences between the treatment and comparison groups for the four elements—accessibility, clarity, relevance and vividness—of the relevant content dimension of the OIT model. Hypotheses 1c through

1f tested whether content in the treatment condition (displaying a high level of accessibility, clarity, relevance and vividness respectively) elicited a higher reported level of interactivity than content in the comparison condition (displaying a low level of each of the four elements).

In examining the independent samples t-tests for each, the means for all five scales were higher for the treatment group than for the comparison group. However, not all of the four hypotheses reflected statistically significant results.

Results of the independent samples t-test revealed higher means for accessibility for the treatment group (M = 4.1187, S.D. = .60630) than for the comparison group (M = 4.0343, S.D. = .64319). However, the differences were not statistically significant [t (309) = -1.191, $p > .05$], and Hypothesis 1c is not supported.

The means for clarity for the treatment group (M = 3.6367, S.D. = .69203) were higher than for the comparison group (M = 3.5647, S.D. = .63706). However, the differences were not statistically significant [t (309) = -.954, $p > .05$], and Hypothesis 1d is not supported.

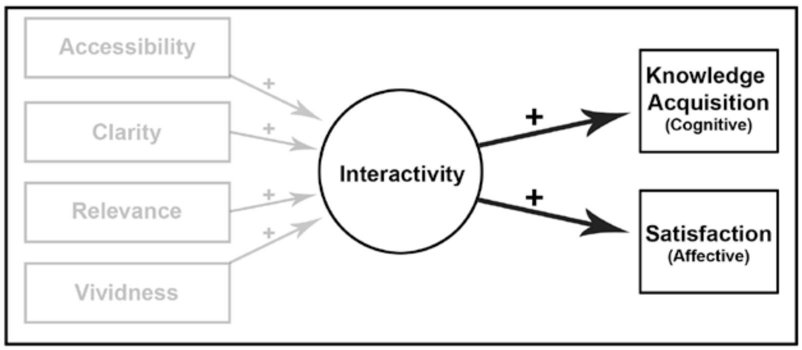
However, the independent samples t-test revealed higher means for relevance for the treatment group (M = 4.1187, S.D. = .60630) than for the comparison group (M = 4.0343, S.D. = .64319), and the differences were statistically significant [t (309) = -2.240, $p = .026$]. Therefore, Hypothesis 1e is supported.

Similarly, the means for vividness for the treatment group (M = 2.9937, S.D. = .56094) were higher than for the comparison group (M = 2.6708, S.D. = .55473), and the differences showed statistical significance among the four variables [t (309.984) = -5.721, $p > .001$]. Thus, Hypothesis 1f is supported.

Hypotheses 2a and 2b

In addition to the tests described above, the Outcome Interactivity Theory model was tested using several regression analyses. Hypothesis 2a tested whether interactivity predicts knowledge acquisition, while Hypothesis 2b tested whether interactivity predicts satisfaction (see Figure 4.1).

Figure 4.1: Model for Hypotheses 2a and 2b (Effect of Interactivity on Knowledge Acquisition and Satisfaction)



Hypothesis 2a tested whether interactivity would predict a sufficient portion of variance in knowledge acquisition.

Prior to regression analysis, it is common practice to examine the intercorrelations between all independent variables for multicollinearity issues. According to Meyers, Gamst & Guarino (2006), multicollinearity exists when bivariate correlations of .90 and higher exist between independent variables (although some may consider bivariate correlations of .80 and higher problematic). Because the correlation between interactivity and knowledge acquisition was slight (r = .137, p = .016) and indicated an almost negligible relationship, multicolinearity does not exist.

The regression analysis revealed that interactivity sufficiently predicted knowledge acquisition [F (1) = 5.871, p = .016]. R^2 for interactivity was .019, and the adjusted R^2 was .015. Interactivity [t = 2.423, p = .016, β = .137] significantly predicted knowledge acquisition (see Table 4.5), and Hypothesis 2a is supported. However, interactivity only accounted for 1.5% of the variance with regards to knowledge acquisition.

Table 4.5: Regression Model for Interactivity and Knowledge Acquisition

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.998	.521		7.677	.000
	INTERACTIVITY	.317	.131	.137	2.423	.016

Dependent Variable: KNOWLEDGE_ACQ
Note: Adj. R^2 = .015

Similarly, Hypothesis 2b predicted that interactivity could account for a sufficient proportion of variance for student satisfaction. Interactivity and satisfaction showed moderate correlation ($r = .541$, $p < .001$), indicating a substantial but not multicollinear relationship.

The regression analysis revealed that interactivity sufficiently predicted satisfaction [F (1) = 127.794, $p < .001$]. R^2 for interactivity was .293, and the adjusted R^2 was .290. Interactivity predicted satisfaction [$t = 11.305$, $p < .001$, $\beta = .541$] at a very high level of statistical significance (see Table 4.6). Hypothesis 2b was strongly supported, and interactivity accounted for 29% of the variance with regards to satisfaction.

Table 4.6: Regression Model for Interactivity and Satisfaction

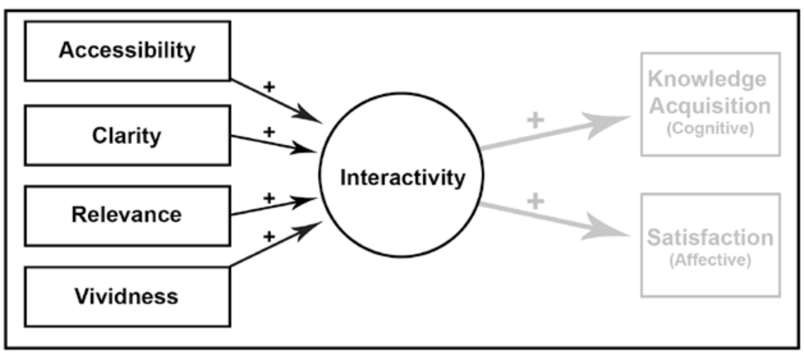
Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.356	.133		10.176	.000
	INTERACTIVITY	.378	.033	.541	11.305	.000

a. Dependent Variable: SATISFACTION
Note: Adj. R^2 = .290

Hypothesis 2c

The OIT model was further tested by examining four antecedent variables (accessibility, relevance, clarity and vividness) that predict interactivity in the OIT model (see Figure 4.2).

Figure 4.2: Model for Hypothesis 2c (Effects of Accessibility, Relevance, Clarity and Vividness on Interactivity)



Hypothesis 2c predicted that high levels of accessibility, clarity, relevance and vividness in online content would produce a high level of perceived interactivity after exposure to that content.

Together, accessibility, clarity, relevance and vividness showed moderate correlation (r = .622, p < .001) with interactivity, indicating a substantial but not multicollinear relationship.

The regression analysis revealed that the four variables sufficiently predicted interactivity [F (4) = 48.166, $p < .001$]. R^2 for the model was .386, and adjusted R^2 was .378.

In terms of individual relationships between the predictor variables and interactivity, accessibility [t = -.745, p > .05, β = -.045] and clarity [t = .224, p > .05, β = .013] did not significantly predicted interactivity (see Table 4.7). However, both relevance [t = 7.271, p < .001, β = .352] and vividness [t = 7.184, p < .001, β = .419] showed statistical significance in predicting interactivity. Thus, Hypothesis 2c was partially supported. Together, the four variables predicted 37.8% of the variance.

Table 4.7: Regression Model for Hypothesis 2c (Accessibility, Clarity, Relevance, Vividness and Interactivity)

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	.906	.320		2.832	.005
	ACCESSIBILITY	-.073	.097	-.045	-.745	.457
	CLARITY	.020	.088	.013	.224	.823
	RELEVANCE	.454	.062	.352	7.271	.000
	VIVIDNESS	.735	.102	.419	7.184	.000

a. Dependent Variable: INTERACTIVITY

In order to further examine Hypothesis 2c, a second linear regression was performed with accessibility and clarity removed from the model (see Table 4.8). In this case, the regression analysis revealed that remaining two variables (relevance and vividness) still sufficiently predicted interactivity [F (2) = 96.499, $p < .001$]. R^2 for the revised model was .385, and the adjusted R^2 was .381.

In terms of individual relationships between the predictor variables and interactivity, both relevance [t = 7.249, p < .001, β = .348] and vividness [t = 8.372, *p* < .001, *β* = .402] both predicted interactivity with statistical significance. There was no change in the variance in predicting interactivity, and together, relevance and vividness they still accounted for 38.1%.

Table 4.8: Revised Regression Model for Hypothesis 2c
(Relevance, Vividness and Interactivity)

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.777	.235		3.305	.001
	RELEVANCE	.449	.062	.348	7.249	.000
	VIVIDNESS	.706	.084	.402	8.372	.000

a. Dependent Variable: INTERACTIVITY

Hypotheses 2d

Finally, accessibility, relevance, clarity and vividness were examined with interactivity in the model for their influence on knowledge acquisition and satisfaction.

Hypothesis 2d predicted that high levels of accessibility, clarity, relevance and vividness in online content, with interactivity in the model path, would produce a high level of student knowledge acquisition after exposure to the content.

The regression analysis first revealed that accessibility, clarity, relevance and vividness sufficiently predicted knowledge acquisition [*F* (4) = 14.264, *p* < .001]. R^2 for the model was .157, and the adjusted R^2 was .146.

In terms of individual relationships between the independent variables and knowledge acquisition, accessibility [*t* = 2.113, *p* = .035, *β* = .148], relevance [*t* = 6.054, *p* < .001, *β* = .343] and vividness [*t* = -2.691, *p* = .008, *β* = -.184] predicted knowledge acquisition at a statistically significant level. However, clarity [*t* = 1.878, *p* = .061, *β* =

.127] was not significant (see Table 4.9). Together, the variables accounted for 14.6% of the variance.

Table 4.9: Regression for Hypothesis 2d (Accessibility, Relevance, Clarity and Vividness on Knowledge Acquisition)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.975	.869		1.122	.263
	ACCESSIBILITY	.560	.265	.148	2.113	.035
	CLARITY	.450	.240	.127	1.878	.061
	RELEVANCE	1.026	.170	.343	6.054	.000
	VIVIDNESS	-.748	.278	-.184	-2.691	.008

Dependent Variable: KNOWLEDGE ACQ

Next, the regression analysis revealed that accessibility, clarity, relevance and vividness sufficiently predicted knowledge acquisition with interactivity in the model path [F (5) = 11.405, p < .001]. R^2 for the model was .158, and the adjusted R^2 was .144.

In terms of individual relationships between the independent variables and knowledge acquisition, accessibility [t = 2.092, p = .037, β = .147], relevance [t = 5.721, p < .001, β = .352] and vividness [t = -2.349, p = .019, β = -.174] again showed statistical significance in predicting knowledge acquisition, while clarity [t = 1.880, p = .061, β = .127] was not significant (see Table 4.10). With interactivity in the model path, the four variables showed almost no increase in variance, still accounting for only 14.4%.

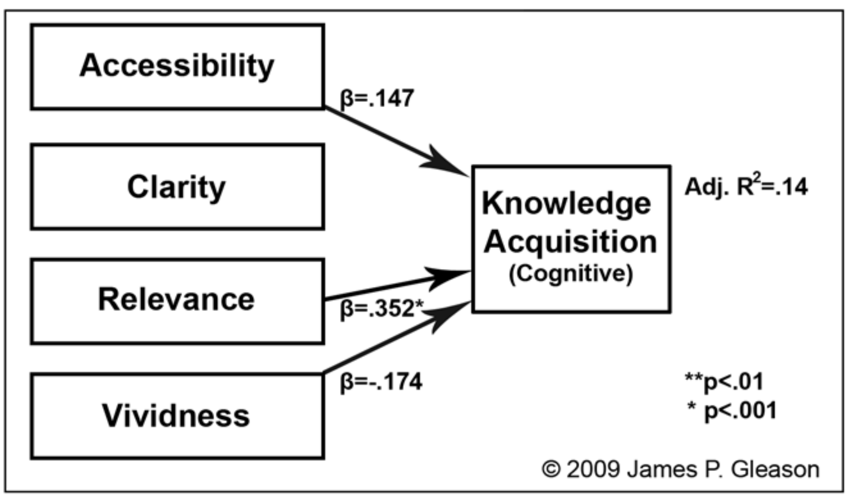
Table 4.10: Regression for Hypothesis 2d (Accessibility, Relevance, Clarity and Vividness With Interactivity on Knowledge Acquisition)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
2	(Constant)	1.026	.882		1.163	.246
	ACCESSIBILITY	.555	.265	.147	2.092	.037
	CLARITY	.451	.240	.127	1.880	.061
	RELEVANCE	1.052	.184	.352	5.721	.000
	VIVIDNESS	-.707	.301	-.174	-2.349	.019
	INTERACTIVITY	-.056	.156	-.024	-.361	.718

a. Dependent Variable: KNOWLEDGE ACQ

In this case, interactivity did not account for any unique variance in predicting knowledge acquisition [t = -.361, p > .05, β = .024] and was not part of the model (see Figure 4.3).

Figure 4.3: Knowledge Acquisition Predicted by Accessibility, Relevance and Vividness.



Hypothesis 2d was not supported. However, because clarity did not show statistical significance in predicting knowledge acquisition, either with or without interactivity, a second linear regression for Hypothesis 2d was performed with clarity removed from the model.

In this revised regression analysis, the remaining variables (accessibility, relevance and vividness) still sufficiently predicted knowledge acquisition [*F* (3) = 17.697, $p < .001$]. R^2 for the model was .157, and the adjusted R^2 was .146.

In terms of individual relationships between the independent variables and knowledge acquisition, accessibility [$t = 3.184$, $p = .002$, $\beta = .204$], relevance [$t = 5.977$, $p < .001$, $\beta = .340$] and vividness [$t = -2.248$, $p = .025$, $\beta = -.148$] predicted knowledge acquisition at a statistically significant level (see Table 4.11). Together, the three variables accounted for 14.6% of the variance.

Table 4.11: Revised Regression for Hypothesis 2d (Accessibility, Relevance and Vividness on Knowledge Acquisition)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.354	.849		1.595	.112
	ACCESSIBILITY	.768	.241	.204	3.184	.002
	RELEVANCE	1.017	.170	.340	5.977	.000
	VIVIDNESS	-.603	.268	-.148	-2.248	.025

Dependent Variable: KNOWLEDGE ACQ

Next, the revised regression analysis revealed that accessibility, relevance and vividness still sufficiently predicted knowledge acquisition with interactivity in the model path [*F* (4) = 13.262, $p < .001$]. R^2 for the model was .148, and the adjusted R^2 was .137.

In terms of individual relationships between the independent variables and knowledge acquisition, accessibility [$t = 3.163$, $p = .002$, $\beta = .203$] and relevance [$t = 5.640$, $p < .001$, $\beta = .340$] again showed statistical significance in predicting knowledge acquisition, while vividness [$t = -1.929$, $p = .055$, $\beta = -.139$] was not significant (see Table 4.12). With interactivity in the model path, the three variables accounted for 14.8% in variance, a small decrease.

In the revised regression analysis, interactivity did not account for any unique variance in predicting knowledge acquisition when in the model path [$t = -.335$, $p > .05$, $\beta = .023$]. Thus, in the revised regression, Hypothesis 2d was still not supported.

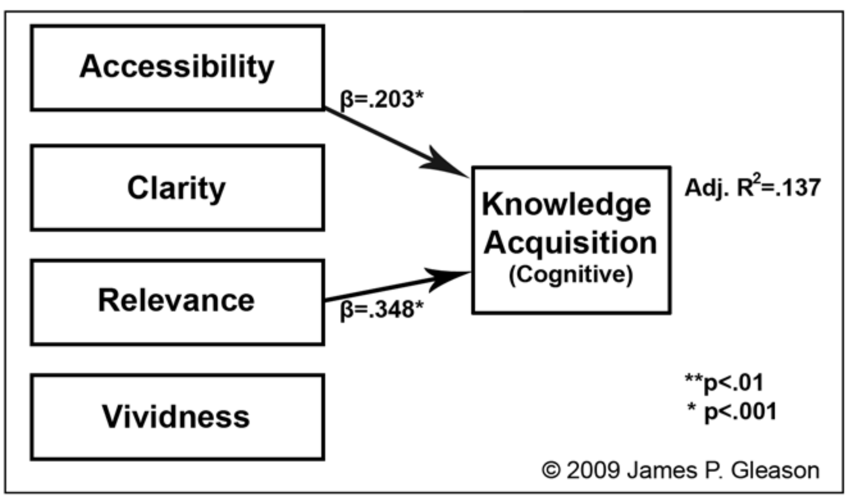
Table 4.12: Revised Regression for Hypothesis 2d (Accessibility, Relevance and Vividness With Interactivity on Knowledge Acquisition)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
2	(Constant)	1.402	.862		1.627	.105
	ACCESSIBILITY	.765	.242	.203	3.163	.002
	RELEVANCE	1.041	.184	.348	5.640	.000
	VIVIDNESS	-.564	.293	-.139	-1.929	.055
	INTERACTIVITY	-.052	.156	-.023	-.335	.738

Dependent Variable: KNOWLEDGE ACQ

In the revised regression for Hypothesis H2d, vividness and interactivity did not contribute any unique variance and, thus, both were removed from the model (see Figure 4.4).

Figure 4.4: Knowledge Acquisition Predicted by Accessibility and Relevance.



Hypotheses 2e

Similarly, Hypothesis 2e predicted that high levels of accessibility, clarity, relevance and vividness in online content with interactivity in the model would produce a high level of student satisfaction after exposure to the content.

This regression analysis first revealed that accessibility, clarity, relevance and vividness sufficiently predicted satisfaction [F (4) = 131.687, p < .001]. R^2 for the model was .633, and adjusted R^2 was .628.

In terms of individual relationships between the independent variables and satisfaction (see Table 4.13), accessibility [t = 3.249, p = .001, β = .150], relevance [t = 15.161, p < .001, β = .568] and vividness [t = 5.225, p < .001, β = .236] predicted satisfaction at a statistically significant level. However, clarity [t = 1.450, p = .148, β = .065] was not significant. Together, the variables accounted for 62.8% of the variance.

Table 4.13: Regression for Hypothesis 2e (Accessibility, Relevance, Clarity and Vividness on Satisfaction)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.182	.173		-1.050	.295
	ACCESSIBILITY	.171	.053	.150	3.249	.001
	CLARITY	.069	.048	.065	1.450	.148
	RELEVANCE	.511	.034	.568	15.161	.000
	VIVIDNESS	.289	.055	.236	5.225	.000

a. Dependent Variable: SATISFACTION

Next, the regression analysis revealed that accessibility, clarity, relevance and vividness sufficiently predicted satisfaction when interactivity was part of the model path [F (5) = 108.972, p < .001]. R^2 for the model was .641, and the adjusted R^2 was .635.

In terms of individual relationships between the independent variables and satisfaction, accessibility [$t = 3.394$, $p = .001$, $\beta = .156$], relevance [$t = 13.107$, $p < .001$, $\beta = .526$] and vividness [$t = 3.857$, $p < .001$, $\beta = -.186$] predicted knowledge acquisition at a statistically significant level. However, clarity [$t = 1.430$, $p = .154$, $\beta = .063$] was not significant (see Table 4.14). With interactivity in the model path, the four variables accounted for 63.5% of the variance, a slight increase.

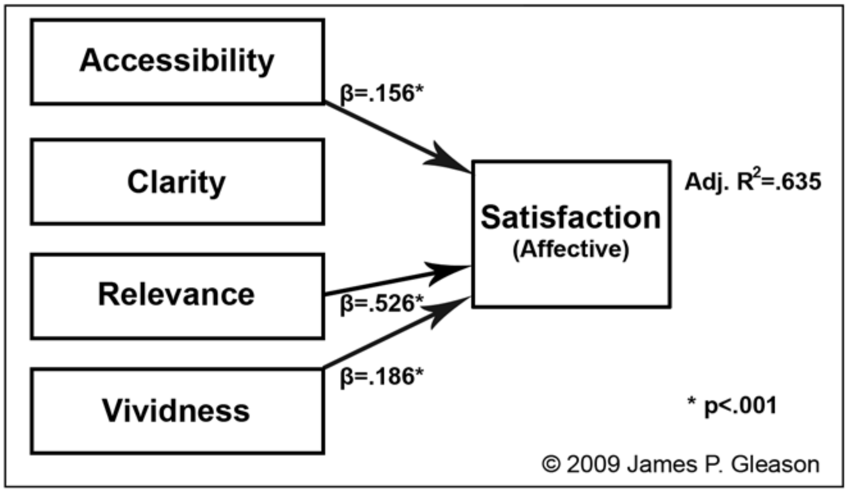
Table 4.14: Regression for Hypothesis 2e (Accessibility, Relevance, Clarity and Vividness With Interactivity on Satisfaction)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
2	(Constant)	-.256	.173		-1.478	.140
	ACCESSIBILITY	.177	.052	.156	3.394	.001
	CLARITY	.068	.047	.063	1.430	.154
	RELEVANCE	.474	.036	.526	13.107	.000
	VIVIDNESS	.228	.059	.186	3.857	.000
	INTERACTIVITY	.083	.031	.118	2.700	.007

a. Dependent Variable: SATISFACTION

In this case, interactivity increased the unique variance in predicting satisfaction when part of the model path [$t = 2.700$, $p = .007$, $\beta = .118$]. Therefore, Hypothesis 2e was supported (see Figure 4.5).

Figure 4.5: Satisfaction Predicted by Accessibility, Relevance and Vividness With Interactivity in the Model.



However, because clarity did not contribute any unique variance in predicting satisfaction, either with or without interactivity, a second linear regression for Hypothesis 2e was performed with clarity removed from the model. In this revised regression analysis, the remaining variables (accessibility, relevance and vividness) sufficiently predicted satisfaction [F (3) = 174.256, $p < .001$]. R^2 for the new model was .630, and the adjusted R^2 was .626.

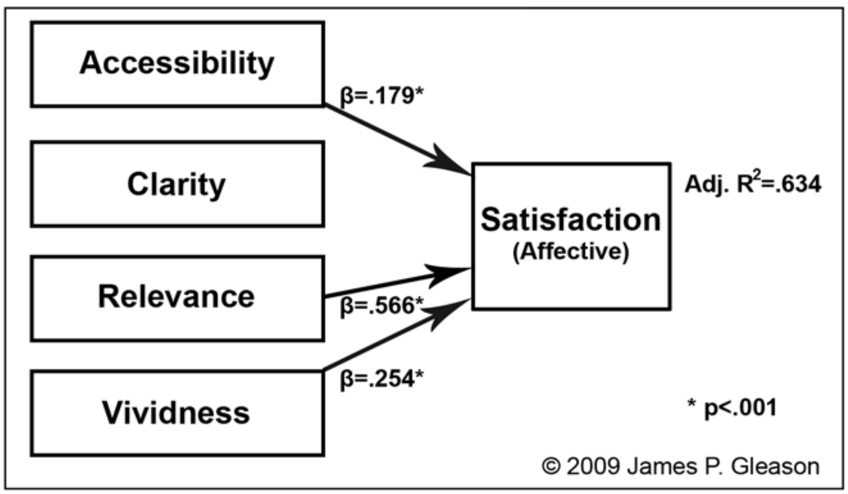
In terms of individual relationships between the independent variables and satisfaction, accessibility [$t = 4.243$, $p < .001$, $\beta = .179$], relevance [$t = 15.098$, $p < .001$, $\beta = .566$] and vividness [$t = 5.849$, $p < .001$, $\beta = .254$] predicted satisfaction at a statistically significant level (see Table 4.15). Together, the three variables accounted for 62.6% of the variance (see Figure 4.6).

Table 4.15: Revised Regression for Hypothesis 2e (Accessibility, Relevance and Vividness on Satisfaction)

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-.123	.169		-.732	.465
	ACCESSIBILITY	.203	.048	.179	4.243	.000
	RELEVANCE	.510	.034	.566	15.098	.000
	VIVIDNESS	.312	.053	.254	5.849	.000

a. Dependent Variable: SATISFACTION

Figure 4.6: Satisfaction Predicted by Accessibility, Relevance and Vividness (Revised Regression)



Next, the revised regression analysis revealed that accessibility, relevance and vividness each contributed unique variance to satisfaction with interactivity in the model [*F* (4) = 135.241, $p < .001$]. R^2 for the model was .639, and the adjusted R^2 was .634.

In terms of individual relationships between the independent variables and satisfaction, accessibility [$t = 4.394$, $p < .001$, $\beta = .183$], relevance [$t = 13.045$, $p < .001$, $\beta = .524$] and vividness [$t = 4.352$, $p < .001$, $\beta = .204$] again were statistically significant and predicted 63.4% of the variance in satisfaction (see Table 4.16).

Table 4.16: Revised Regression for Hypothesis 2e (Accessibility, Relevance and Vividness With Interactivity on Satisfaction)

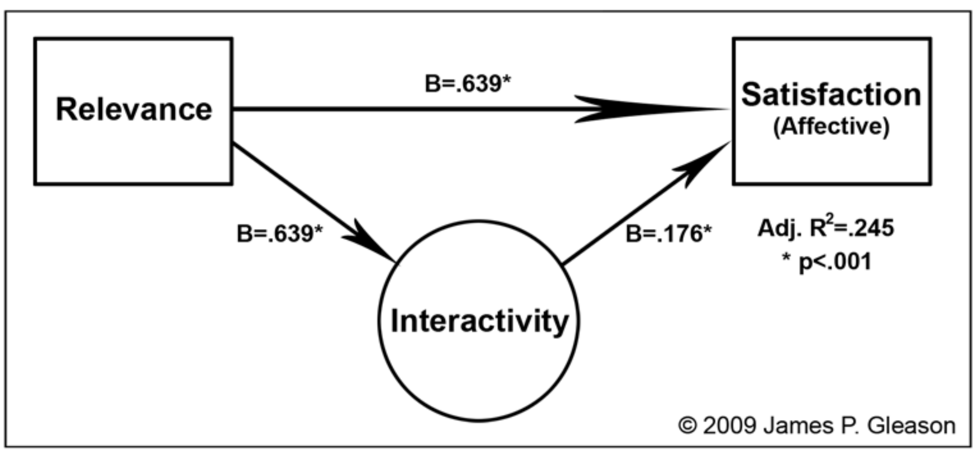
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
2	(Constant)	-.200	.169		-1.182	.238
	ACCESSIBILITY	.209	.047	.183	4.394	.000
	RELEVANCE	.472	.036	.524	13.045	.000
	VIVIDNESS	.250	.057	.204	4.352	.000
	INTERACTIVITY	.083	.031	.119	2.713	.007

a. Dependent Variable: SATISFACTION

In this case, interactivity remained in the model to predict satisfaction [t = 2.713, p = .007, β = .119]. Therefore, in the revised regression, Hypothesis 2e was again supported.

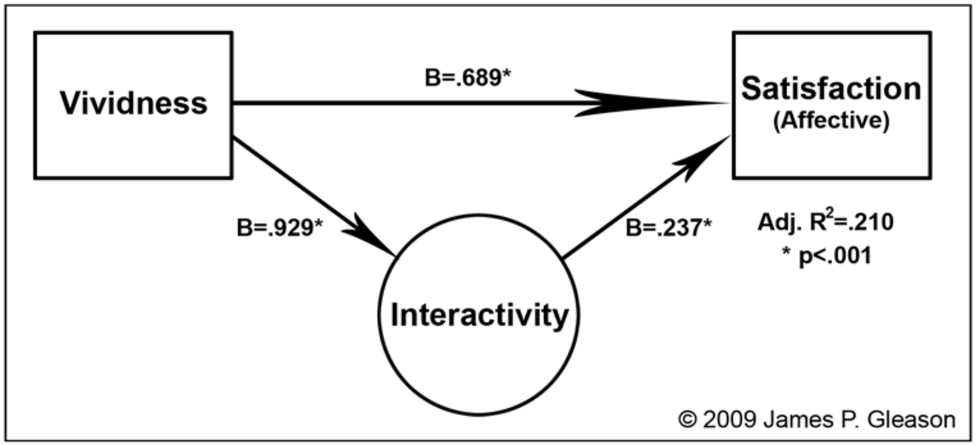
To test the indirect mediation effect of interactivity on relevance and vividness for satisfaction, a Preacher and Hayes (2008) assessment to estimate the indirect effects in simple mediation models was used. Interactivity showed a statistically significant mediating effect on relevance (Z=4.9446; p<.001) for satisfaction (see Figure 4.7).

Figure 4.7: Indirect Mediation Effect of Interactivity on Relevance for Satisfaction



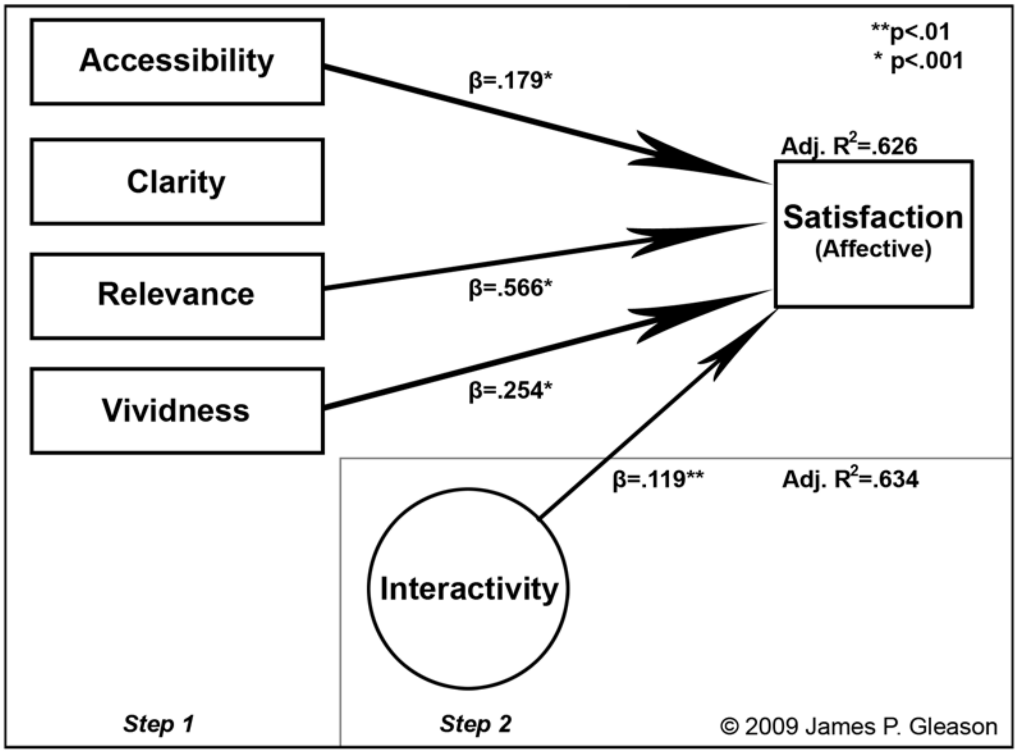
Similarly, interactivity showed a statistically significant mediating effect on vividness (Z=5.5721; p<.001) for satisfaction (see Figure 4.8).

Figure 4.8: Indirect Mediation Effect of Interactivity on Vividness for Satisfaction



Thus, a hierarchical regression shows the final model for Hypotheses 2e in which the inclusion of interactivity contributes a small but significant increase in variance in the degree to which accessibility, relevance and vividness predict high levels of satisfaction (see Figure 4.9).

Figure 4.9: Hierarchical Regression for Accessibility, Relevance and Vividness With Interactivity on Satisfaction



Summary

This chapter described the results of a pre-test post-test control group full experiment that answered the research questions posed in earlier chapters.

The first six hypotheses tested the impact of interactivity on knowledge acquisition and satisfaction student learning outcomes using a series of independent sample t-tests.

Hypothesis 1a, which tested the impact of content with high interactive functionality produced a higher level of knowledge acquisition, was not supported. However, in Hypothesis 1b where the same test was applied to higher levels of student satisfaction, the results were statistically significant.

Relevance (H1e) and vividness (H1f) yielded a statistically significant change in reported interactivity between the treatment and comparison groups, while accessibility (H1c) and clarity (H1d) were not statistically significant.

Five additional hypotheses tested the OIT model using several regression analyses to measure the effect of interactivity on knowledge acquisition and satisfaction.

Hypotheses 2a and 2b tested whether interactivity would predict a sufficient portion of variance in knowledge acquisition and satisfaction. In both cases, the hypotheses were supported with statistically significant results, particularly in the case of satisfaction. However, while Hypothesis 2b accounted for 29% of the variance, Hypothesis 2a only predicted 2%.

Hypothesis 2c predicted high levels of accessibility, clarity, relevance and vividness in online content would produce high interactivity. Together, they sufficiently predicted interactivity with a high level of statistical significance. However, in terms of individual relationships between the predictor variables and interactivity, only relevance and vividness showed statistical significance in predicting interactivity. Accessibility and clarity did not, leaving Hypothesis 2c with only partial support. Together, the four variables predicted 38% of the variance.

Finally, Hypotheses 2d and 2e predicted that high levels of accessibility, clarity, relevance and vividness in online content, with interactivity in the model path, would produce high levels of knowledge acquisition and satisfaction respectively.

Accessibility, clarity, relevance and vividness, alone and with interactivity in the model path, sufficiently predicted both knowledge acquisition and satisfaction.

Individual relationships between the independent variables and knowledge acquisition were tested alone and with interactivity in the model path, and in both cases accessibility, relevance and vividness predicted knowledge acquisition at a statistically significant level, while clarity did not in either case. A revised regression analysis was performed with clarity removed from the model, again yielding statistically significant results in all cases with the exception of vividness, which was not significant. Interactivity was not statistically significant and Hypothesis 2d was not supported.

Individual relationships between the independent variables and satisfaction were tested alone and with interactivity in the model path, and in both cases accessibility, relevance and vividness predicted satisfaction at a statistically significant level, while clarity did not in either case. However, in this case, interactivity did show significance in predicting satisfaction when part of the model path. Therefore, Hypothesis 2e was supported.

The final chapter provides a discussion of these results, including the implications of the results, limitations to the study, and directions for future research.

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Chapter 5

Discussion

The purpose of the current study was to examine the influence of interactivity in general and within the instructional development context specifically. The study tested the impact of interactivity on knowledge acquisition and satisfaction as student learning outcomes. In addition, Outcome Interactivity Theory was tested for the ability of interactivity to predict knowledge acquisition and satisfaction. The OIT model was further tested by examining four antecedent dimensional elements (accessibility, clarity, relevance and vividness) that predict interactivity in the OIT model.

The pre-test post-test control group experimental design used in this study served several major goals. First, it allowed for tests of group differences between treatment and comparison groups to determine whether student learning outcomes (knowledge acquisition and satisfaction) would be positively influenced by interactivity (as reflected by interactive functionality displaying high levels of accessibility, clarity, relevance and vividness) using appropriate independent sample t-tests. In addition, this study examined the relevant content dimension of the OIT model by testing whether highly interactive content in the treatment condition (displaying a high level of accessibility, clarity, relevance and vividness) elicited a higher reported level of interactivity than less interactive content in the comparison condition (displaying a low level for each of the four variables).

An equally important purpose of the study was to test the Outcome Interactivity Theory model using three specific analysis strategies. First, the study allowed for regression tests of the extent to which interactivity predicted both student knowledge acquisition and satisfaction outcomes. Next, the study allowed for tests of whether the four elements of the relevant content dimensions of the OIT model (accessibility, clarity, relevance and vividness) predict interactivity. Finally, the study allowed for tests of whether accessibility, clarity, relevance and vividness predict knowledge acquisition and satisfaction, with interactivity in the model path.

One additional purpose of the study was to examine the psychometric properties—under experimental conditions—of nine new scales created by the researcher to measure interactivity and the contributing dimensions and elements found in the OIT model.

This final chapter is organized in three major sections. The first section interprets and analyzes the results of the study and discusses a number of implications of these findings. The next section describes limitations of the study. Finally, the last section presents directions for future research.

Interpretation, Analysis and Implications of the Results

This section interprets the results of this study and explores the implications both for future researchers studying the interactivity construct and for practitioners who wish to apply the lessons of this study in a particular context.

The first two hypotheses in this study examined the role of interactivity as it was manipulated within the treatment condition to determine if interactivity impacts student learning outcomes.

Results for Hypothesis 1a did not support the impact of interactivity (as embodied by a high level of interactive functionality in online lesson content) on student knowledge acquisition between treatment and comparison groups. Although Hypothesis 1a suggests a link between the application of interactivity and actual student knowledge acquisition, such a link has not been supported by this study despite conventional wisdom to the contrary, which often suggests that all technology is good and, since students like it, it *must* play a positive role in student learning. That is not the case, as this study clearly illustrates. In fact, the failure of Hypothesis 1a to yield statistically significant increases in cognitive student learning outcomes finds considerable consonance in the literature.

The research of Richard Mayer is particularly relevant. His views reflect more than 100 experimental tests during the past two decades that yielded 12 research-based principles for how to design online learning environments. “Multimedia Learning” (Mayer, 2009) describes these studies in detail and reflects his long history of relevant scholarship on the subject of online instruction and learning. (Indeed, this is just the sort of practical “roadmap” that reflects the kind of potential application this study’s findings might elicit.)

In testing his *static-media hypothesis,* Mayer approaches the contrast between interactive and static content in a fashion similar to this study, and his results are consistent with those of this study in that they challenge the presumption that technology use *inexorably* leads to improved student cognitive learning. In fact, he argues for the opposite view. He found that “static media (such as static diagrams and printed text) offer cognitive processing affordances that lead to better learning (as measured by tests of retention and transfer) compared with dynamic media (such as animation and narration)” (Mayer et al., 2005).

Yet, in the test of Hypothesis 1b, students in the treatment group did display a significantly higher level of satisfaction than the comparison group. As we interpret the results of Hypothesis 1b, interactivity clearly impacts satisfaction positively. Such results suggest the skillful application of interactive functionality in an instructional context can have a positive effect on student attitudes toward lesson content, which in turn could lead to decreased resistance and increased attention to the lessons and online assignments. This finding suggests that introducing interactive functionality in instructional technology and lesson content (and thereby increasing interactivity) may encourage a student to pay closer attention, work harder and study longer. The implications of such findings (and the obvious need for additional research in this area) are considerable in light of the current rapid growth of (and accelerated momentum toward) distance learning and online degree programs at the university level in the United States. As instruction migrates online, the need for improved tools, techniques and strategies in the digital domain becomes manifest.

A second set of hypotheses (H1c - H1f) examined the differences between high and low interactive content. Specifically, Hypotheses 1c-1f examined whether group differences exist in terms of perceived interactivity between content samples with high and low levels of accessibility, clarity, relevance and vividness. (The scales described above were also used to successfully ensure that the manipulations were successful.)

While the means for all five scales were higher for the treatment group than for the comparison group, not all tests revealed statistically significant results.

There were statistically significant differences between the two groups for both relevance and vividness, resulting in confirmation of Hypotheses 1e and 1f.

Relevance describes the degree to which available content is desirable and consistent with a user's goals for the communication event, and is influenced by the communicated content's intuitiveness, appropriateness and congruity. *Vividness* describes the degree to which available content is displayed using high levels of graphic richness, animation and audio/visual elements, making the content presentation more appealing and engaging.

Both relevance and vividness are outcome-oriented and user-centered variables determined by the needs of the user rather than the intentions of the content producer. They are perceptual and responsive by nature, and the levels that are reported reflect the individual views and reactions of each subject to the content.

Accessibility and clarity reported quite a different outcome. There were no significant differences reported between the treatment and comparison groups for either accessibility or clarity, resulting in the rejection of Hypotheses 1c and 1d.

Accessibility describes the manner in which communicated online content is structured, delivered and presented, including how it is written, designed or organized. Clarity describes the degree to which sought-after content is displayed with appropriate or expected visual and conceptual organization (logical placement, sequence, etc.), and with a generally acceptable level of accuracy, clear writing style and grammatical, spelling and punctuation standards. Content with a high level of clarity is easy to read, without obvious factual errors, and free from grammatical errors and other similar distractions.

An examination of these four variables suggests a possible explanation for the differing results. Accessibility and clarity are more concrete and objective in nature than relevance and vividness, and less a function of the subject's perception. For this reason, the value each contributes to the interactivity construct is more elusive and abstract than expected, as explained below.

In this experiment the researcher did not manipulate clarity in the treatment sample, which would have required introducing grammatical and typographical errors into the content. In retrospect, the difficulty and ambiguity the researcher faced in introducing errors into the sample content suggests the challenge in applying clarity as a variable within the interactivity construct in a meaningful way in practice.

It may be that a high level of accuracy, craftsmanship and freedom from errors is not viewed by subjects as conceptually related to the interactivity construct, but rather is a simple baseline assumption for professionally created and delivered content. In this sense, though accessibility and clarity are certainly relevant to the success of the communication event, each may not be acting in the role of a contributing variable within the OIT model after all. Indeed, a subject's comfort level or even his or her definition of clarity may be contextual to a pronounced degree, and shaped by gender, age, or a variety of cultural or colloquial influences (Campbell, 2000). As one example, the spelling conventions applied most frequently by young adults in texting and "tweeting" reflect greater concern for speed and expedience than for traditional spelling. Yet conversations using this "Twitter dialect" don't appear to suffer for lack of clarity, at least for some.

Alternately, accessibility and clarity may be antecedent conditions that affect the outcome of *any* communication event whether it involves interactivity or not, placing it outside the OIT model. Issues regarding both accessibility and clarity are discussed further in regard to later hypotheses.

The next set of hypotheses (H2a – H2b) relied on regression analyses to test the predictive abilities of the Outcome Interactivity Theory model by testing whether interactivity predicts student knowledge acquisition and satisfaction.

Hypothesis 2a posited that a high level of interactivity (resulting from exposure to online content with a high level of interactive functionality) would predict an increase in student knowledge acquisition. Given the negative results of hypothesis 1a, which anticipated, but did not reveal, a higher level of knowledge acquisition between subject groups due to greater interactivity functionality, it was surprising that interactivity explained a small proportion of the variance in knowledge acquisition when tested as part of the model. However, although the hypothesis was confirmed, the *actual* influence of interactivity on knowledge acquisition was slight, accounting for about 2% of the variance. Thus, in practice, the social significance of this influence was minimal, and consistent with the results for Hypothesis 1a.

Given that the interactive functionality measured in the first hypothesis (H1a) for the four antecedent variables leads to the perception of interactivity tested in the latter hypothesis (H2a), it is not surprising that little or no effect for interactivity was found in either case.

As for the other 98% of the variance for knowledge acquisition, a number of explanations are possible—including level of student preparedness, the environmental conditions under which the instruction was delivered, or even the content's level of difficulty. Although certainly relevant to this discussion, these questions are beyond the scope of this study.

Similarly, Hypothesis 2b posited that a high level of interactivity resulting from online content would predict an increase in student satisfaction after exposure to that content. The results were again consistent with the earlier hypothesis (H1b) regarding satisfaction. In this case, the influence of interactivity in predicting satisfaction was statistically significant. Since the perception of interactivity tested in this hypothesis stems from the manipulations to the interactive functionality of the content used in the former hypothesis (H1b), the positive result for this hypothesis (H2b) was expected.

As conventional wisdom, the idea that students like and readily embrace technology in an instructional context is far easier to accept and grounded in theory. What these results do *not* suggest is that extending this affective outcome to more cognitive results is automatically successful. What *is* supported is that the application of interactivity results in increased student satisfaction and leads to substantial motivational and self-esteem benefits as discussed earlier. And increased satisfaction is a worthy and useful goal.

The next hypothesis (H2c) was designed to test the OIT model to determine the extent to which the four elements of the relevant content dimension of the OIT model (accessibility, clarity, relevance and vividness) would predict interactivity.

As in the earlier test of these four variables (H1c – H1f), the results were mixed. Consistent with the results for H1e and H1f, both relevance and vividness significantly predicted interactivity. As with H1c and H1d, both accessibility and clarity failed to yield statistically significant results.

The questionable role played by accessibility and clarity in the model was further tested with a post-hoc linear regression where both variables were removed from the model. In the revised model, the results for both relevance and vividness were still statistically significant and showed small increases in their standardized betas, indicating a slight increase in effect size. With accessibility and clarity removed, the model fit for relevance and vividness was better, reinforcing the role that relevance and vividness play within the content dimension of the OIT model.

These findings also strengthen the argument that accessibility and clarity may not play a substantial role as antecedent variables contributing to interactivity within the OIT model, but in fact are simply viewed as expected standards of quality and accuracy for instructional content.

The final two hypotheses posited whether accessibility, clarity, relevance and vividness would predict knowledge acquisition and satisfaction when interactivity was included in the model path. Since the four variables are antecedent contributors to the perception of interactivity, the expectation was that they were essentially synonymous with interactivity as they relate to the OIT model, and therefore the inclusion of interactivity to the hypothesis model path should not lead to additional variance.

In the first case (H2d), accessibility, relevance and vividness predicted knowledge acquisition with sufficient statistical significance while, as in the case of earlier hypothesis, the influence of clarity was not significant. Together, the four elements accounted for 14.6% of the variance. With interactivity included in the model path, the results were strikingly similar. Accessibility, relevance and vividness again significantly predicted knowledge acquisition, while clarity did not. With interactivity in the model path, variance was still 14.4%. A second regression with clarity removed offered similar results. In both regressions, interactivity did not show statistical significance in predicting knowledge acquisition.

The lack of additional variance contributed by interactivity is not surprising, since accessibility, clarity, relevance and vividness are antecedent variables of interactivity within the OIT model, and additional variance for interactivity would seem redundant.

The high overall variance explained (14.4%) seems more robust when compared to the earlier test of group differences (H1a) in which interactivity accounted for only 2%. It may be that individual variables within the regression are accounting for the majority of the higher variance figure, since interactivity itself is not significant within either regression. Also, in the group differences test of Hypotheses 1a, the influence of interactivity (as it relates to knowledge acquisition) may simply be overshadowed by other, more dominant influences as mentioned earlier. Additional research in this area is needed.

The results of these regression analyses further reinforce the earlier conclusion that this experiment fails to support the influence of interactivity or the application of interactivity functionality to *directly* increase knowledge acquisition or other aspects of cognitive learning. This is not to say that interactivity and knowledge acquisition are not related; simply that the data *in this study* did not show unique variance for interactivity. What is clear is that this is an important and relevant topic that demands additional research.

Finally, accessibility, clarity, relevance and vividness were tested to determine whether they predict satisfaction with interactivity included in the model path. The outcome was again consistent with earlier results (H1c – H1f).

In directly predicting satisfaction and doing so with interactivity in the model path, accessibility, relevance and vividness revealed statistically significant results in both cases, while clarity was not significant in either case. The presence of interactivity in the model path was statistically significant, but it only increased the variance accounted for by .8%, again suggesting little practical influence for the variable. As discussed earlier, interactivity's lack of additional contributing variance is not surprising, since most of this role obviously is played in the OIT model by the four antecedent variables (accessibility, clarity, relevance and vividness) included in the test for this hypothesis. Again, it is clear that interactivity *directly* contributes to student satisfaction with online lesson content, a finding that reinforces the application of interactive functionality as a valuable tool for practitioners.

This dissertation clarifies and advances the existing literature relating to the interactivity construct by presenting Outcome Interactivity Theory as a more balanced and theory-driven model of interactivity; one that incorporates a variety of contributing elements within a wider unifying construct that ultimately predicts the influence of interactivity on user behaviors and communication outcomes. More importantly, OIT represents a conceptual and operational model whose dimensions and influence can be measured reliably in an experimental setting.

According to Outcome Interactivity Theory, an individual's recognition of interactivity as an outcome *requires* the integration and mutual influence of three separate and distinct dimensions—actual features and functions of the technology employed, the content being communicated, and the individual experience of and specific context under which a user encounters this technology and content.

In addition to providing a first test of the OIT model itself, this study explores how the practical application of OIT within a specific communication context (in this case, instructional design) can provide a practical example of theory-centered applied research, one that may provide practitioners with *specific* tools to help improve communication outcomes.

In this respect, the specificity of the OIT model represents a clear departure from previous literature. The results provided by this study illustrate a number of ways Outcome Interactivity Theory might be applied in practice. For example, the interactivity measurement scale used in this study is a composite scale that includes a number of antecedent dimensions and contributing elements, and offers a high degree of reliability. This scale might improve message-testing research by enabling scholars to directly measure the interactivity variable, thereby streamlining both experimental design and data analysis. Similarly, the granularity of the OIT model might inform practitioners in using individual dimensional elements within the model as separate variables to guide construction and application within a given context.

Instructional design was selected by the researcher as a particularly relevant context within which to apply OIT in an empirical setting for two reasons. First, the instructional design context offers an appealing ease and precision with which data can be gathered, measured and analyzed. Second, its applied nature offers tangible opportunities to capitalize on the lessons of this study in ways that may help instructors, trainers and other practitioners apply interactivity in a manner that clearly and measurably improves student learning and other communication outcomes.

Apart from the results, it’s worth taking a moment to reflect on the value of nine newly developed research measurement scales developed by the researcher expressly to examine and test the influence of the Outcome Interactivity Theory model. As described earlier, these scales are unique to this study.

The nine measurement scales used in this study show a high overall level of reliability, both for individual scales and across all composite scales. In addition, the solid psychometric properties of the scales display high content validity.

These new scales offer researchers the opportunity to reliably measure and test a wide variety of relevant interactivity dimensions and elements under empirical conditions. By more effectively operationalizing the interactivity construct, they can serve as valuable tools for researchers and scholars in the application of interactivity toward improved communication outcomes. Since this study is exploratory in nature and represents the first empirical use of these scales, future use and commentary is encouraged.

The preceding section interpreted the results of the dissertation study and offered specific implications for the findings. While not every hypothesis revealed statistically significant results, most were supported and, as such, this study represents a considerable new body of empirically-tested and theory-driven scholarship surrounding the interactivity construct.

However, no study is perfect. The next section examines limitations and threats to both the internal and external validity of the study.

Limitations

Even the most carefully designed research study is not without limitations, and so it is with this one. This next section examines three threats to the internal validity of the study, including lesson content, subject motivation and the manner in which research credit was awarded, followed by three threats to external validity, including the randomness and make-up of the sample, and the dimensions of the OIT model tested in the experiment.

One limitation to internal validity involves the lesson content used in the study. In order to limit the likelihood of prior familiarity, the researcher selected a statistics lesson expecting that most students in these introductory communication classes would not yet have encountered this subject matter. It was felt that the general lack of familiarity with the subject matter would help ensure different groups in the experiment, which was the case in this study.

However, individual motivation may have been systematically lower for some (or all) of the subjects. In an effort to ensure that knowledge was low across the sample at time one, you may have negatively impacted participant motivation (Indeed, based on the number of subjects who fell outside the 10 to 60-minute participation window and were removed from the dataset as outliers, it is clear many did not.) Because the content had no direct connection to any class curriculum for which the participants would be held accountable, participants may have found the content uninteresting or unmotivating, and therefore failed to give the lesson sufficient attention—regardless of the level of interactivity—to achieve more representative results. Alternately, participants may have found the content to be too long or too difficult. In either case, a lack of sufficient subject motivation would limit internal validity for the study.

The inability of the researcher to accurately assess this lack of motivation would similarly limit internal validity. Although participants who completed the study in less than ten minutes or more than one hour were removed from the dataset as outliers, it was difficult to separate those who engaged fully with the study content from those who simply skimmed it while remaining within the time constraints.

Since the study was conducted online, participants were able to access the survey from any Internet-enabled remote location (home, library, Starbucks, etc). The researcher had no direct contact with the participants, and therefore had no awareness (or control) of environmental distractions influencing the participants and their level of attention to the study. Participation under supervision in a classroom or campus computer lab might have encouraged more focused involvement in two ways. It would provide participants with a more focused distraction-free environment in which to participate in the study—though these type of environmental changes would just as likely be limited by the Hawthorne Effect. That is, the presence of the researcher (or a proctor) might provide an additional nonverbal motivational influence beyond those measured by the OIT. On the other hand, researcher observations of inattentive or off-handed participation would enable the identification of outliers which could then be removed from the study.

Another threat to internal validity—and thus a limitation of the current study—is the manner in which research credit was awarded to students for participation. It is possible that some subjects were motivated to give the study full attention so as to better serve the research agenda of the academy. However, it is far more likely that most students completed the task mainly for the research credit given by their instructors. Since subjects received credit for merely completing the study, with no specific measurement criteria for how well or thoroughly they attended to the task, it may be that research credit not sufficient motivation for subjects to fully engage with the study and its content. Again, more relevant content may increase subject motivation, particularly if measured for grades in an actual classroom environment. The possible lack of participant motivation may make it more difficult to trust the accuracy of the conclusions drawn from the study, though great care was taken at all levels of the study.

Several possibilities involve the sample itself. Subject selection was administered with the use of SONA Systems software from a pool of students in a number of introductory Communication classes. Subjects were recruited online in a confidential manner. However, since students self-selected into the study from among several available choices, the sampling method was not random, thereby limiting external validity. It is important to note, however, that after the subjects agreed to participate in the study, they *were* randomly assigned to either the treatment or comparison conditions. Several tests were used to ensure difference between groups (refer to Tests of Subject Homogeneity at the end of the Methods chapter.)

However, since the study sample was selected for practical purposes from only one university, it may reflect the cultural identity of the University of Kentucky. In addition, the ability to generalize the findings beyond the current sample is limited because the study sample was relatively homogenous in terms of age, student rank, ethnicity, level of Internet experience and comfort level with math or statistics lesson content.

In particular, the overall high level of technological experience within the sample population might impact the external validity of the study. Subjects reported substantial technological experience going into the study, with 98% using the Internet for four years or more. In analyzing the results, it is suggested that subjects display a high level of confidence with interactive tools and applications that is typical of college students, but certainly atypical of the general population. Selecting from a population with less experience in the digital domain or a wider range of Internet experience may have resulted in a sample where subjects would be more engaged with the content rather the technology used to deliver it. Using subjects from a broader population would help ensure a more normal distribution of Internet skills and experience, and potentially increase the generalizability of the results.

Finally, considerable earlier scholarship has contributed to the specific elements included in the Outcome Interactivity Theory model as described above. In fact, many researchers have made a compelling case for the influence of both technology and user experiences as they relate to interactivity. However, because of the complexity of the OIT model, this study measured the technological features and relevant user experiences dimensions as global constructs without either manipulating them or measuring their individual elements. More detailed measurements would strengthen both internal and external validity in this study, but would require a far more complex study model and experiment design than possible in this case. Likewise, the new measures for accessibility and vividness should be reviewed to ensure that questions are not leading or biased. In this case, the researcher opted to focus on the content dimension of the OIT model since it has received far less scholarly scrutiny, and leave the detailed study of the technological features and user experiences dimensions for future studies.

Similarly, researchers who apply Outcome Interactivity Theory in other contexts or test it using the measurement scales from this study will find valuable pragmatic advice in the Instructional Design literature, in particular recent work by Lohr (2000), Ertmer & Newby (2008) and Mayer (2009).

This section examined three threats to the internal validity of the study. The use of statistics lesson content may have had a negative impact on subject motivation, an issue compounded by the difficulty faced by the researcher in assessing the level and impact of these decreases. Potential motivation issues involving the awarding of research credit made it more difficult to trust the accuracy of the study conclusions, despite great care taken throughout the study. Three threats to external validity were also considered, including the randomness and make-up of the sample. In addition, only part of the OIT model was tested in the experiment.

This initial test of Outcome Interactivity Theory serves as a platform for further vigorous study surrounding the interactivity construct. Researchers and scholars are enthusiastically encouraged to explore new ways in which interactivity can contribute to improved communication outcomes. The next section offers thoughts and suggestions for future research directions regarding Outcome Interactivity Theory and the interactivity construct.

Directions for Future Research

As the initial empirical test of this new theory, the current study was exploratory in nature and limited in scope. While this initial research step is useful for what it teaches us today, it also is noteworthy for the opportunities for future research it suggests. Thus, the next section of this dissertation looks forward.

This section describes a number of potentially fruitful avenues in which to pursue future research surrounding the interactivity construct. The first avenue suggests approaches to expanding on methods used in the current study. The second avenue advances the goals of this dissertation by more closely examining other dimensions in the OIT model. The third avenue suggests applying and testing the OIT model across other contexts and disciplines.

The results of the current study highlight two potential areas for future research. First, while the results of the current study were informative and generally positive, future research needs to expand on these findings by increasing the variance of the sample composition. Beyond salient demographic variables (ethnicity, age, student rank), other important sample characteristics—particularly with respect to the variance in the range of Internet experiences of subjects—demands increased scrutiny. As emerging technologies such as smart phones bring new levels of interactive functionality into homes, business and classrooms, it would be valuable to examine the behaviors and reactions of those "newbies" who are somewhat further from the leading edge of technology use and familiarity. For example, there remain substantial barriers and resistance to Internet and other technology use among seniors, even as new tools and applications become nearly unavoidable. Similarly, while no gender differences were evident between subject groups in this study, scholars have pointed to the evolving nature of the "typical" technology user as another area of potential study. Additional research into the ways a variety of demographic and psychographic groups perceive and embrace interactivity could prove particularly valuable to product designers and content developers. Further, testing different subject groups would allow tests for group differences of cognitive load using a variety of content approaches, topics, amounts and levels of complexity when measured under time constraints. Future research must examine how technological interactivity either contributes to the expansion of (or helps to narrow) the digital divide.

Second, while it's unclear to what degree the level of motivation shown by participants had an impact on the results of the current study, it seems reasonable that efforts to increase participant motivation is important to increase the internal validity of future research. Researchers may wish to investigate ways to improve subject motivation and participation in a study such as this, including developing better metrics to measure and evaluate the actual quality of the participation (rather than simply determining whether subjects completed the study). For example, different stimulus content that is more relevant to actual class curricula and which students would need to be accountable, would increase participant engagement. Similarly, researchers may find that more rigorous controls of the environment in which the study takes place may help eliminate distractions or other possible confounding influences. Participants may feel compelled to participate with a greater degree of concentration or focus if required to do so in a campus-based computer lab during a specifically scheduled session.

This study represented the first opportunity to examine the various antecedent dimensions and elements that contribute to interactivity within the Outcome Interactivity Theory model, and to do so under empirical conditions. The second potentially fruitful avenue for researchers involves expanding future studies to explore all dimensions embraced by the OIT model, including those not specifically tested in this study.

As described in the previous section, a reoccurring theme in the results of this experiment is the surprising lack of influence offered by clarity within the OIT model. To a lesser degree, the same can be said about the influence of accessibility. While it is premature to remove either from the OIT model, the results of the current study suggest a need for additional analysis regarding the reactive content dimension of the model.

The current study (and the pilot study that preceded it) measured the influence of technological features and relevant user experiences, the remaining two dimensions of the OIT model. However, they were measured as separate global constructs, and not as the individual elements that make up each dimension (as was done with accessibility, clarity, relevance and vividness for the content dimension in this study). To more thoroughly evaluate the merits of the OIT model, future studies should examine the roles of specific technological features and relevant user experiences in greater detail, including all antecedent dimensional elements.

Finally, the third potentially fruitful avenue for researchers involves expanding studies of interactivity in the instructional design context, and exploring additional applications and communication contexts in which to apply the interactivity construct.

This study reveals how the practical application of Outcome Interactivity Theory within a specific communication context (in this case, instructional design) can provide a practical example of theory-centered applied research, one that may provide practitioners with *specific* tools to help improve communication outcomes. Yet, the shape of these tools is not always obvious. When a scholar the stature of Mayer fails to find support for increased knowledge acquisition due to high interactive functionality in the face of fad wisdom to the contrary, it's clear there is much yet to learn about the broad practical application of interactivity. This gap strongly suggests the need for ongoing research regarding the interactivity construct, as well as in areas of multimedia learning, instructional design and learning theory. Scholars in a variety of contexts could learn a great deal by taking the best of communication research and pragmatic advice from instructional designers, and test the degree to which interactivity and other interface influences impact learning outcomes (Fleming & Levie, 1993).

This initial test of Outcome Interactivity Theory opens the door to further rigorous examinations of the interactivity construct and encourages researchers to explore new ways in which interactivity can contribute to improved communication outcomes.

Conclusion

As described earlier, a simple shift in perspective can radically reshape an individual's perception. This study of interactivity shifts its perspective to that of a receiver-oriented construct—with profound results, as described above.

This dissertation set out to accomplish three major objectives: 1) clarify the literature relating to the interactivity construct; 2) introduce Outcome Interactivity Theory as a new theory-based conceptualization of the interactivity construct; and 3) test Outcome Interactivity Theory under experimental conditions.

The literature has typically been conceptualized interactivity as relating directly to the presence of particular technological features, a user's perception of the communication process, or a combination of both. In each case, interactivity is generally framed as something embodied within or an antecedent of the communication process. In fact, interactivity scholarship has suffered from the lack of a unifying theory-based construct. This study addresses this gap by presenting a new and more meaningful definition of the interactivity construct:

> *Interactivity is an observable feature of a communication event that reflects the degree to which interactive technology and content elements are influenced by relevant experiences to empower a participant to achieve a desired communication goal or outcome.*

Thus, this manuscript first clarifies this earlier literature in a manner that presents a context within which to illustrate the genesis of Outcome Interactivity Theory as a new theory-driven conceptualization of the interactivity construct.

Outcome Interactivity Theory breaks with earlier scholarship by presenting interactivity as something that occurs *as a result* of a communication event embodying the mutual influence of a number of contributing antecedent dimensions. According to OIT, an individual's recognition of interactivity as an outcome *requires* the integration and mutual influence of three separate and distinct dimensions—actual features and functions of the technology employed, the content being communicated, and the individual experience of and specific context under which a user encounters this technology and content. The central role of content within this process has not previously been examined in communication literature.

This manuscript also described how the current study tested the influence of interactivity (or interactive functionality) in the content dimension of the Outcome Interactivity Theory model. With the exception of those hypotheses relating directly to knowledge acquisition, all other results were statistically significant and, in the case of several, at the $p < .001$ level. In particular, interactivity was found to have a pronounced effect on student satisfaction. Taken together, these results reinforce the integrity of Outcome Interactivity Theory and the dimensions and elements of its model.

Finally, this study presented a set of highly reliable interactivity measurement scales to quantify the influence of specific individual dimensions and elements on interactivity as defined by the OIT model.

Earlier scholarship displayed an overall lack of a solid theoretical grounding that lays out what defines interactivity, its role within the communication process, and what specific elements constitute it, as discussed earlier. Empirical studies such as this one are critical because, without them, any discussion of interactivity remains abstract and lacking a practical application, no matter how interesting the topic. Without such a theory-driven model to operationalize the construct, the task of *applying* it in some meaningful way becomes that much more difficult. The development of Outcome Interactivity Theory and the study described above directly target this gap.

Bucy (2004) directly addresses the "so what?" question when he writes, "For interactivity to succeed as a concept, it must have some meaningful social and psychological relevance." The interactivity construct is worth studying *because* of the opportunity such scholarship provides to apply interactivity in a way that contributes to positive communication outcomes across a variety of contexts. Thus, this development and testing of Outcome Interactivity Theory as a new theory-driven conceptualization of the interactivity construct must also include a practical application that attempts to demonstrate its practical value. This manuscript serves both ends.

Based on this study, three things have become clearer regarding interactivity scholarship. Outcome Interactivity Theory is a clear and robust conceptualization of the interactivity construct. Improving student satisfaction is a good first step in its application, but there are more opportunities regarding research surrounding interactivity.

The Outlook Interactivity Theory model provides the necessary shift in perspective to treat interactivity as a receiver-based construct and, from this new perspective, the future looks bright.

Notes

1. Outcome Interactivity Theory was previously conceptualized as The Responsive Multi-Dimensional Model of Interactivity (Gleason, 2007),

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Appendix 1: Interactivity Conceptualizations and Sources

Source	***Date***	***Definition***
Rafaeli	1988	• Interactivity is a variable characteristic of communication settings. • Interactivity is an expression of the extent that in a given series of communication exchanges, any third (or later) transmission (or message) is related to the degree to which previous exchanges referred to even earlier transmissions.
Heeter	1989	Interactivity is a multidimensional concept with six dimensions. • Complexity of choice • Effort users must exert • Responsiveness to the user • Monitoring information use • Ease of adding information • Facilitation of interpersonal communication
Steuer	1995	Interactivity is the degree to which users of a medium can influence the form or content of the mediated environment.
Ha & James	1998	Interactivity is the extent to which the communicator and the audience respond to or are willing to facilitate each other's communication need. Five dimensions: • Playfulness • Choice • Connectedness • Information collection • Reciprocal communication.
Jensen	1998	Interactivity is a measure of a media's potential ability to let the user exert an influence on the content and/or form of the mediated communication. • Transmissional interactivity • Consultational interactivity • Conversational interactivity • Registrational interactivity
Massey & Levy	1999	• Content interactivity, defined generally as the degree to which journalists technologically empower consumers over content. • Interpersonal interactivity, or the extent to which news audiences can have computer-media ted conversations through journalists' technological largess.
Downes & McMillan	2000	• For message-based dimensions, interactivity increases as: o Two-way communication enables all participants to actively communicate. o Timing of communication is flexible to meet the time demands of participants. o The communication environment creates a sense of place.

		• For participant-based dimensions, interactivity increases as: o Participants perceive that they have greater control of the communication environment. o Participants find the communication to be responsive. o Individuals perceive that the goal of communication is more oriented to exchanging information than to attempting to persuade.
Stromer-Galley	2000	Two distinct phenomena: • Interactivity between people – orients research on the process of interactivity. • Interactivity between people and computers or networks -- orients research on the product of interactivity.
Kiousis	2002	• Interactivity can be defined as the degree to which a communication technology can create a mediated environment in which participants can communicate (one-to-one, one-to-many, and many-to-many), both synchronously and asynchronously, and participate in reciprocal message exchanges (third-order dependency). With regard to human users, it additionally refers to their ability to *perceive* the experience as a simulation of interpersonal communication and increase their awareness of telepresence. • Interactivity is operationally composed of three principal elements: properties of technology, attributes of communication contexts, and user perceptions.
Bucy	2004	• Reciprocal communication • Interactivity… should be reserved to describe reciprocal communication exchanges that involve some form of *media*, or information and communication technology. o Interactivity is best (though not exclusively) understood as a perceptual variable that involves communication mediated by technology. o Interactivity is desirable up to a point and then has negative consequences. o Interactivity effects may occur at an individual as well as social level of analysis. o Interactivity effects at the individual level may influence outcomes at the social level.

Appendix 2: A Priori Power Analysis

Power Analysis for Hypotheses 1 and 2

Medium effect size:
t tests - Means: Difference between two independent means (two groups)

Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	One
	Effect size d	=	0.5
	α err prob	=	0.05
	Power (1-β err prob)	=	0.95
	Allocation ratio N2/N1	=	1
Output:	Noncentrality parameter δ	=	3.316625
	Critical t	=	1.653658
	Df	=	174
	Sample size group 1	=	88
	Sample size group 2	=	88
	Total sample size	=	176
	Actual power	=	0.951425

Large effect size:
t tests - Means: Difference between two independent means (two groups)

Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	One
	Effect size d	=	0.8
	α err prob	=	0.05
	Power (1-β err prob)	=	0.95
	Allocation ratio N2/N1	=	1
Output:	Noncentrality parameter δ	=	3.346640
	Critical t	=	1.667572
	Df	=	68
	Sample size group 1	=	35
	Sample size group 2	=	35
	Total sample size	=	70
	Actual power	=	0.952363

Power Analysis for Hypotheses 3-6

Medium effect size:

F tests - Multiple Regression: Omnibus (R^2 deviation from zero)

Analysis:	A priori: Compute required sample size		
Input:	Effect size f^2	=	0.15
	α err prob	=	0.05
	Power (1-β err prob)	=	0.95
	Number of predictors	=	5
Output:	Noncentrality parameter λ	=	20.700000
	Critical F	=	2.282856
	Numerator df	=	5
	Denominator df	=	132
	Total sample size	=	138
	Actual power	=	0.950764

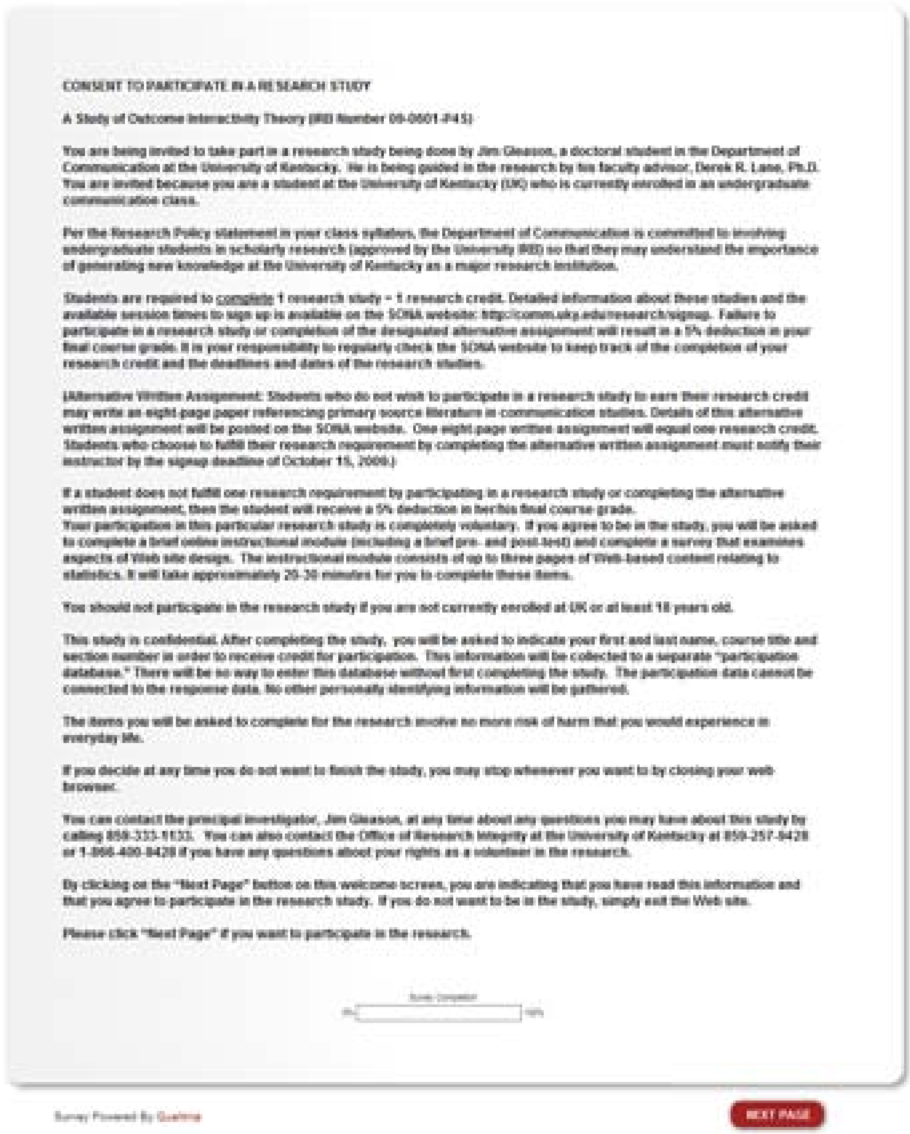
Large effect size:

F tests - Multiple Regression: Omnibus (R^2 deviation from zero)

Analysis:	A priori: Compute required sample size		
Input:	Effect size f^2	=	0.35
	α err prob	=	0.05
	Power (1-β err prob)	=	0.95
	Number of predictors	=	5
Output:	Noncentrality parameter λ	=	22.050000
	Critical F	=	2.376684
	Numerator df	=	5
	Denominator df	=	57
	Total sample size	=	63
	Actual power	=	0.952489

Appendix 3: Consent Form Copy

Figure A3.1: Sample Web page of Consent To Participate in a Research Study



CONSENT TO PARTICIPATE IN A RESEARCH STUDY

A Study of Outcome Interactivity Theory (IRB Number 09-0601-P4S)

You are being invited to take part in a research study being done by Jim Gleason, a doctoral student in the Department of Communication at the University of Kentucky. He is being guided in the research by his faculty advisor, Derek R. Lane, Ph.D. You are invited because you are a student at the University of Kentucky (UK) who is currently enrolled in an undergraduate communication class.

Per the Research Policy statement in your class syllabus, the Department of Communication is committed to involving undergraduate students in scholarly research (approved by the University IRB) so that they may understand the importance of generating new knowledge at the University of Kentucky as a major research institution.

Students are required to complete 1 research study = 1 research credit. Detailed information about these studies and the available session times to sign up is available on the SONA website: http://comm.uky.edu/research/signup. Failure to participate in a research study or completion of the designated alternative assignment will result in a 5% deduction in your final course grade. It is your responsibility to regularly check the SONA website to keep track of the completion of your research credit and the deadlines and dates of the research studies.

(Alternative Written Assignment: Students who do not wish to participate in a research study to earn their research credit may write an eight-page paper referencing primary source literature in communication studies. Details of this alternative written assignment will be posted on the SONA website. One eight-page written assignment will equal one research credit. Students who choose to fulfill their research requirement by completing the alternative written assignment must notify their instructor by the signup deadline of October 15, 2009.)

If a student does not fulfill one research requirement by participating in a research study or completing the alternative written assignment, then the student will receive a 5% deduction in her/his final course grade.
Your participation in this particular research study is completely voluntary. If you agree to be in the study, you will be asked to complete a brief online instructional module (including a brief pre- and post-test) and complete a survey that examines aspects of Web site design. The instructional module consists of up to three pages of Web-based content relating to statistics. It will take approximately 20-30 minutes for you to complete these items.

You should not participate in the research study if you are not currently enrolled at UK or at least 18 years old.

This study is confidential. After completing the study, you will be asked to indicate your first and last name, course title and section number in order to receive credit for participation. This information will be collected to a separate "participation database." There will be no way to enter this database without first completing the study. The participation data cannot be connected to the response data. No other personally identifying information will be gathered.

The items you will be asked to complete for the research involve no more risk of harm that you would experience in everyday life.

If you decide at any time you do not want to finish the study, you may stop whenever you want to by closing your web browser.

You can contact the principal investigator, Jim Gleason, at any time about any questions you may have about this study by calling 859-333-1133. You can also contact the Office of Research Integrity at the University of Kentucky at 859-257-9428 or 1-866-400-9428 if you have any questions about your rights as a volunteer in the research.

By clicking on the "Next Page" button on this welcome screen, you are indicating that you have read this information and that you agree to participate in the research study. If you do not want to be in the study, simply exit the Web site.

Please click "Next Page" if you want to participate in the research.

Survey Powered By Qualtrics

NEXT PAGE

Consent to Participate in a Research Study of Outcome Interactivity Theory

You are being invited to take part in a research study being done by Jim Gleason, a doctoral student in the Department of Communication at the University of Kentucky. He is being guided in the research by his faculty advisor, Derek R. Lane, Ph.D. You are invited because you are a student at the University of Kentucky (UK) who is currently enrolled in an undergraduate communication class.

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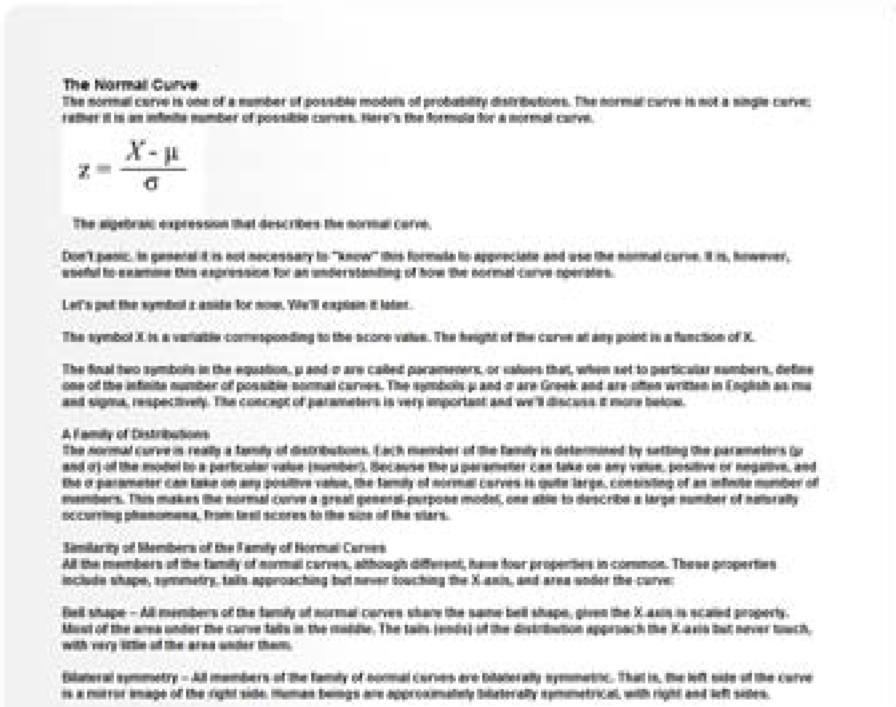
By clicking on ”next page” on this welcome screen of the Web site, you are indicating that you have read this information and that you agree to participate in the research study. If you do not want to be in the study, simply exit the Web site.

Please click “next page” if you want to participate in the research.

Appendix 4: Lesson Content

Comparison Group Lesson Content

Figure A4.1: Sample Web page of Comparison Group Lesson Content



The Normal Curve
The normal curve is one of a number of possible models of probability distributions. The normal curve is not a single curve; rather it is an infinite number of possible curves. Here's the formula for a normal curve.

$$z = \frac{X - \mu}{\sigma}$$

The algebraic expression that describes the normal curve.

Don't panic. In general it is not necessary to "know" this formula to appreciate and use the normal curve. It is, however, useful to examine this expression for an understanding of how the normal curve operates.

Let's put the symbol z aside for now. We'll explain it later.

The symbol X is a variable corresponding to the score value. The height of the curve at any point is a function of X.

The final two symbols in the equation, μ and σ are called parameters, or values that, when set to particular numbers, define one of the infinite number of possible normal curves. The symbols μ and σ are Greek and are often written in English as mu and sigma, respectively. The concept of parameters is very important and we'll discuss it more below.

A Family of Distributions
The normal curve is really a family of distributions. Each member of the family is determined by setting the parameters (μ and σ) of the model to a particular value (number). Because the μ parameter can take on any value, positive or negative, and the σ parameter can take on any positive value, the family of normal curves is quite large, consisting of an infinite number of members. This makes the normal curve a great general-purpose model, one able to describe a large number of naturally occurring phenomena, from test scores to the size of the stars.

Similarity of Members of the Family of Normal Curves
All the members of the family of normal curves, although different, have four properties in common. These properties include shape, symmetry, tails approaching but never touching the X-axis, and area under the curve:

Bell shape – All members of the family of normal curves share the same bell shape, given the X-axis is scaled properly. Most of the area under the curve falls in the middle. The tails (ends) of the distribution approach the X-axis but never touch, with very little of the area under them.

Bilateral symmetry – All members of the family of normal curves are bilaterally symmetric. That is, the left side of the curve is a mirror image of the right side. Human beings are approximately bilaterally symmetrical, with right and left sides.

Welcome and Introduction

A foundation of Communication as a discipline is the presumption that there is a considerable body of scholarly knowledge and hard science underlying it. Key among these is a familiarity with the subject of Statistics.

During the course of this activity, you'll start by taking a brief pre-test. Next, you'll be introduced to the Normal Curve, an important tool in the measurement of probability distributions and a key part of statistical analysis. After the third page of the lesson, you'll be asked to take a brief post-test and a survey about your experience in participating in the lesson online.

Thanks again for contributing to this important research.

The Normal Curve

The normal curve is one of a number of possible models of probability distributions. The normal curve is not a single curve; rather it is an infinite number of possible curves. Here's the formula for a normal curve.

$$z = \frac{X - \mu}{\sigma}$$

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Let's put the symbol **z** aside for now. We'll explain it later.

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The final two symbols in the equation, **μ** and **σ** are called ***parameters***, or values that, when set to particular numbers, define one of the infinite number of possible normal curves. The symbols **μ** and **σ** are Greek and are often written in English as mu and sigma, respectively. The concept of parameters is very important and we'll discuss it more below.

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All the members of the family of normal curves, although different, have four properties in common. These properties include shape, symmetry, tails approaching but never touching the X-axis, and area under the curve:

Bell shape – All members of the family of normal curves share the same bell shape, given the X-axis is scaled properly. Most of the area under the curve falls in the middle. The tails (ends) of the distribution approach the X-axis but never touch, with very little of the area under them.

Bilateral symmetry – All members of the family of normal curves are bilaterally symmetric. That is, the left side of the curve is a mirror image of the right side. Human beings are approximately bilaterally symmetrical, with right and left sides.

Tails never touch X-axis – All members of the family of normal curves have tails that approach but never touch the X-axis. The implication of this property is that no matter how far you travel along the number line, in either the positive or negative direction, there will still be some area under any normal curve. Thus, in order to draw the entire normal curve you must have an infinitely long line. However, because most of the area under any normal curve falls within a limited range of the number line, only that part of the line segment is drawn for a particular normal curve.

Area under curve totals 1.00 – All members of the family of normal curves have a total area of one (1.00) under the curve, as do all probability models or models of frequency distributions. This property, in addition to the property of symmetry, implies that the area in each half of the distribution is .50 or one half.

Area Under a Curve

In statistics, the area under a curve represents theoretical relative frequency or probability. It permits the statistician to make decisions about the world based on a belief about what the world looks like rather than the limited information available in a sample of scores. For example, the statistician would advise the shoe store owner to purchase shoes to stock his or her shelves based on the area under a normal curve model of the world rather than the proportion of individuals in the sample who wore a particular size shoe.

Drawing a Normal Curve

The standard procedure for drawing a ***normal curve*** is to draw a bell-shaped curve and an X-axis. A tick is placed on the X-axis corresponding to the highest point (middle) of the curve. Three ticks are then placed to both the right and left of the middle point. These ticks are equally spaced and include all but a very small portion under the curve.

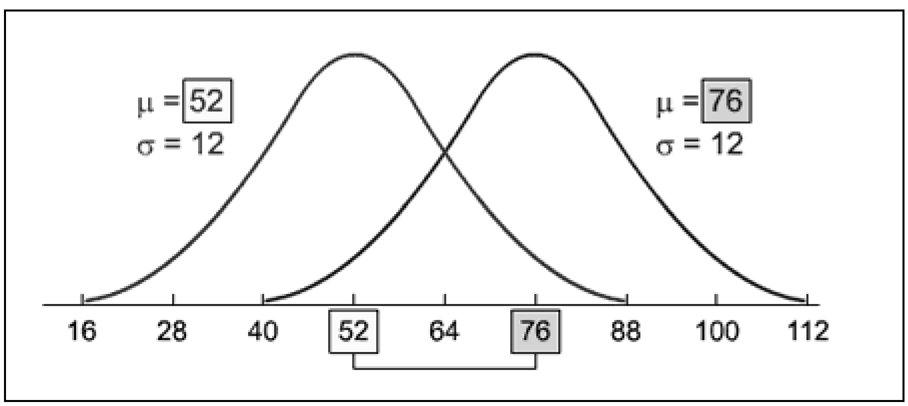
The middle tick is labeled with the value of **mu (μ)**. (It represents the **mean**, which explains why it's in the middle.) Sequential ticks to the right are labeled by adding the value of **sigma (σ)**. Ticks to the left are labeled by subtracting the value of **sigma (σ)** from **μ** for the three values. (Each sigma represents one **standard deviation** from the mean.)

Differences in Members of the Family of Normal Curves

Differences in members of the family of normal curves are a direct result of differences in values for these parameters. The two parameters, μ and σ, each change the shape of the distribution in a different manner.

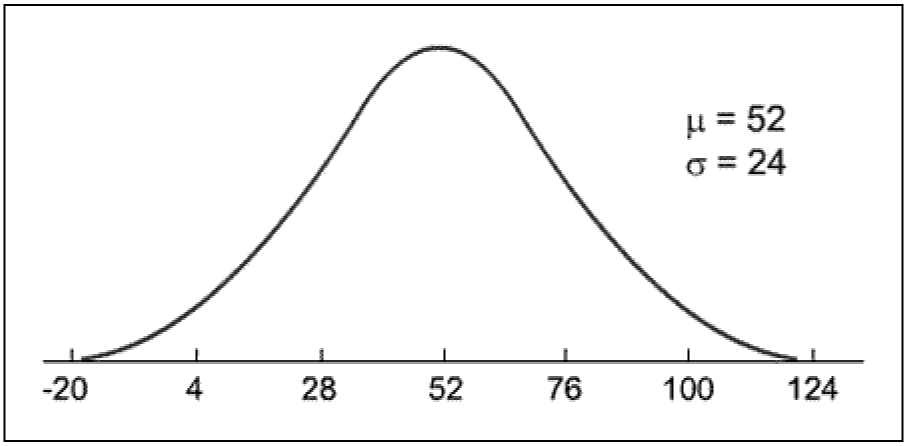
The first, μ, determines where the midpoint (mean) of the distribution falls. Changes in μ, without changes in σ, result in moving the distribution to the right or left, depending upon whether the new value of μ is larger or smaller than the previous value, but does not change the shape of the distribution. The following figure shows how a change in μ affects the normal curve.

Comparing normal curves with a constant value of sigma = 12 and differing values of mu.



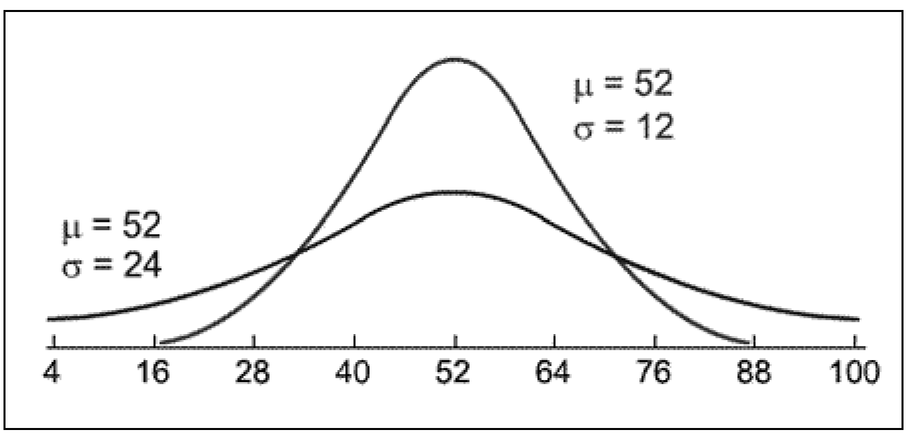
Changes in the value of **σ**, on the other hand, alter the shape of the distribution without affecting the midpoint, because **σ** affects the spread or the dispersion of scores. The larger the value of **σ**, the more dispersed the scores; the smaller the value, the less dispersed. Perhaps the easiest way to understand how **σ** affects the distribution is graphically. The following figure illustrates the effect of increasing the value of **σ**:

A normal curve with mu = 52 and sigma = 24.



Since this distribution was drawn according to the procedure described earlier, it appears similar to the previous normal curve, except for the values on the X-axis. This procedure effectively changes the scale and hides the real effect of changes in **σ**. Suppose the second distribution was drawn on a rubber sheet instead of a sheet of paper and stretched to twice its original length in order to make the two scales similar. Drawing the two distributions on the same scale results in the following graphic:

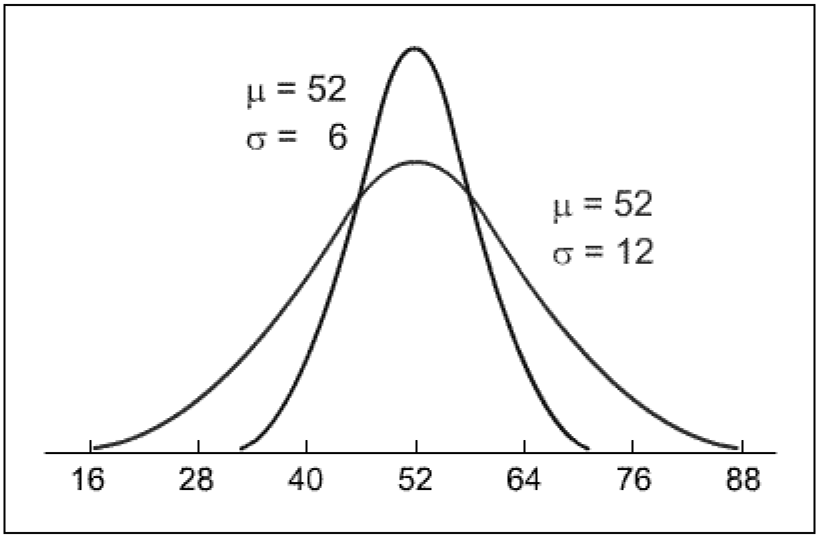
Comparing two normal curves with similar values for mu and different values for sigma.



Note that the shape of the second distribution has changed dramatically, being much flatter than the original distribution. It must not be as high as the original distribution because the total area under the curve must be constant, that is, 1.00. The second curve is still a normal curve; it is simply drawn on a different scale on the X-axis.

A different effect on the distribution may be observed if the size of **σ** is decreased.

Comparing two normal curves with different values of sigma.



Note that the distribution is much higher in order to maintain the constant area of 1.00, and the scores are much more closely clustered around the value of **σ**, or the midpoint, than before.

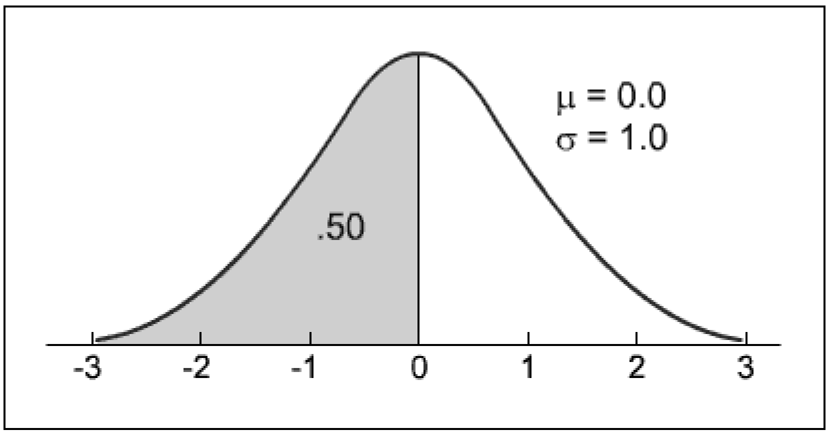
The Standard Normal Curve

The standard normal curve is a member of the family of normal curves with m = 0.0 and s = 1.0. The value of 0.0 was selected because the normal curve is symmetrical around m and the number system is symmetrical around 0.0. The value of 1.0 for s is simply a unit value. The X-axis on a standard normal curve is often relabeled and called ***z-scores***.

There are three areas on a standard normal curve that all introductory statistics students should know:

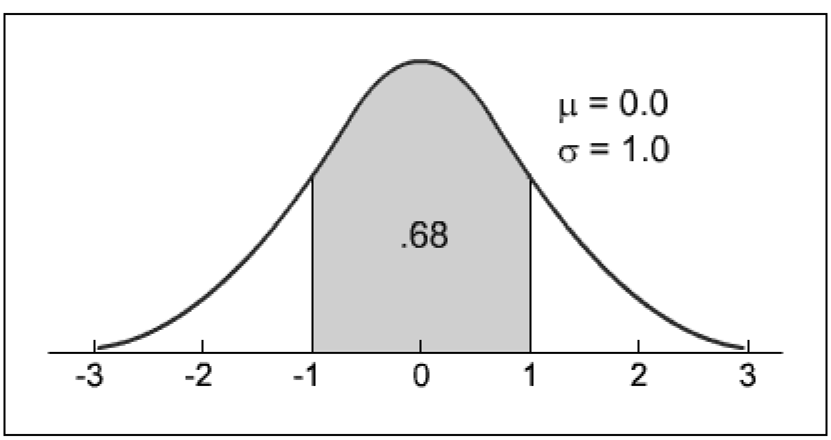
The area below 0.0 is .50 or 50%. This is because the standard normal curve is symmetrical like all normal curves. This result generalizes to all normal curves in that the total area below (to the left of) the value of mu is .50 in any member of the family of normal curves.

Half the area falls below the value of 0 on a standard normal curve.



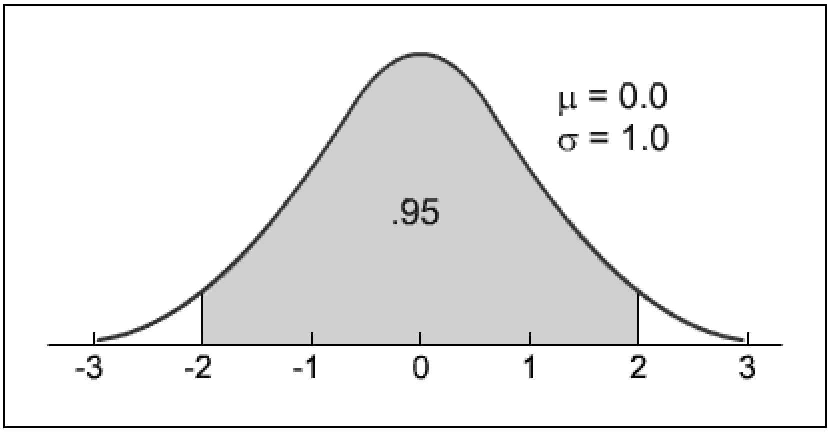
The area between z-scores of -1.00 and +1.00 is .68 or 68%. The total area between plus and minus one sigma unit on any member of the family of normal curves is also .68.

The area under a standard normal curve between plus and minus one sigma unit is .68.



The area between z-scores of -2.00 and +2.00 is .95 or 95%. This area (.95) also generalizes to plus and minus two sigma units on any normal curve.

The area under a normal curve between plus and minus two sigma units is .95.



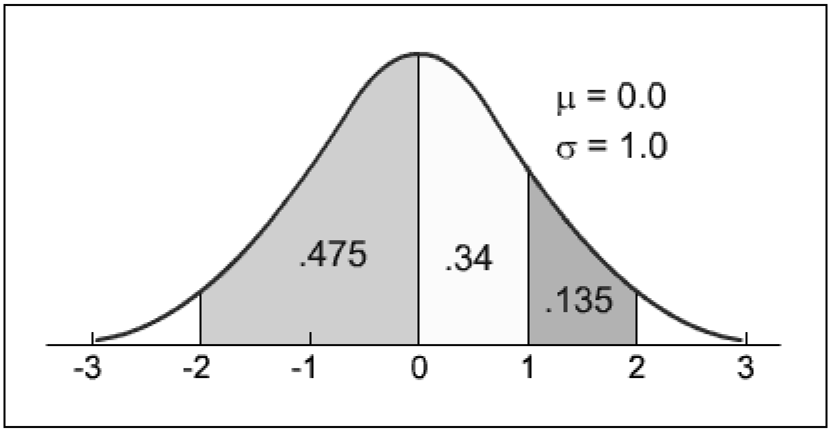
Knowing these areas allows computation of additional areas. For example, the area between a z-score of 0.0 and 1.0 may be found by taking 1/2 the area between z-scores of -1.0 and 1.0, because the distribution is symmetrical between those two points. The answer in this case is .34 or 34%. A similar logic and answer is found for the area between 0.0 and -1.0 because the standard normal distribution is symmetrical around the value of 0.0.

The area below a z-score of 1.0 may be computed by adding .34 and .50 to get .84. The area above a z-score of 1.0 may now be computed by subtracting the area just obtained from the total area under the distribution (1.00), giving a result of 1.00-.84 or .16 (16%).

The area between -2.0 and -1.0 requires additional computation. First, the area between 0.0 and -2.0 is 1/2 of .95 or .475. Because the .475 includes too much area, the area between 0.0 and -1.0 (.34) must be subtracted in order to obtain the desired result.

The correct answer is .475-.34 or .135. The following figure illustrates the areas just discussed.

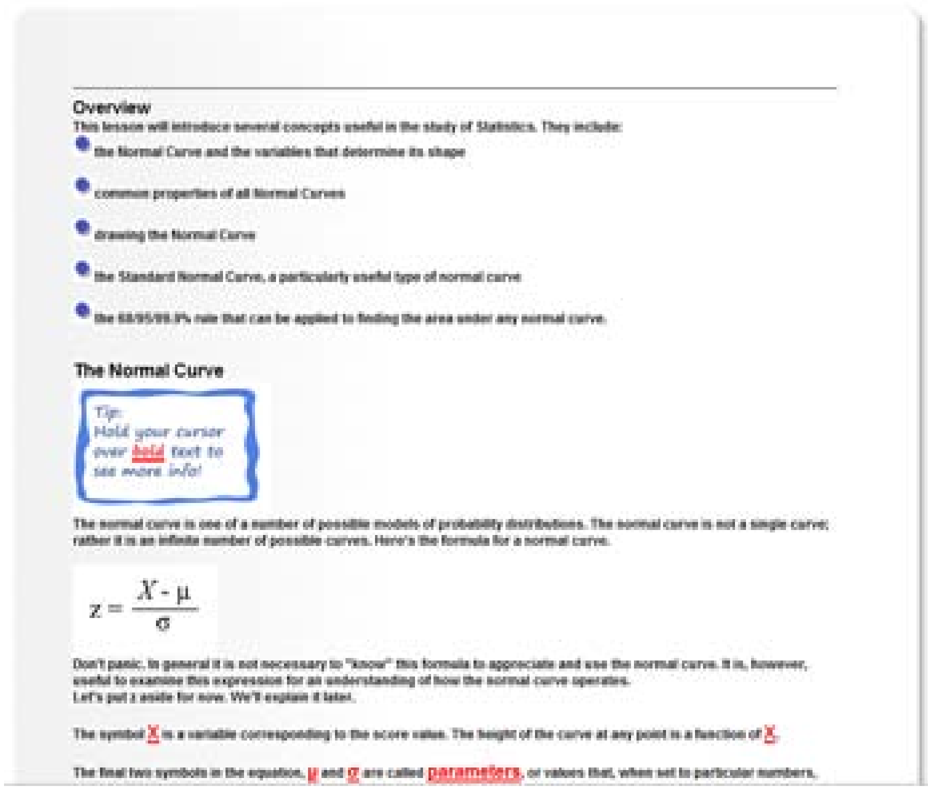
Area under various portions of a standard normal curve.



Using a similar kind of logic to find the area between z-scores of .5 and 1.0 will result in an incorrect answer because the curve is not symmetrical around .5. The correct answer must be something less than .17, because the desired area is on the smaller side of the total divided area.

Treatment Group Lesson Content

Figure A4.2: Sample Web page of Treatment Group Lesson Content



Welcome and Introduction

A foundation of Communication as a discipline is the presumption that there is a considerable body of scholarly knowledge and hard science underlying it. Key among these is a familiarity with the subject of Statistics.

During the course of this activity, you'll start by taking a brief pre-test. Next, you'll be introduced to the Normal Curve, an important tool in the measurement of probability distributions and a key part of statistical analysis. After the third page of the lesson, you'll be asked to take a brief post-test and a survey about your experience in participating in the lesson online.

Thanks again for contributing to this important research.

The Normal Curve

The normal curve is one of a number of possible models of probability distributions. The normal curve is not a single curve; rather it is an infinite number of possible curves. Here's the formula for a normal curve.

$$z = \frac{X - \mu}{\sigma}$$

Don't panic. In general it is not necessary to "know" this formula to appreciate and use the normal curve. It is, however, useful to examine this expression for an understanding of how the normal curve operates.

Let's put the symbol **z** aside for now. We'll explain it later.

The symbol **X** is a variable corresponding to the score value. The height of the curve at any point is a function of **X**.

The final two symbols in the equation, **μ** and **σ** are called ***parameters***, or values that, when set to particular numbers, define one of the infinite number of possible normal curves. The symbols **μ** and **σ** are Greek and are often written in English as mu and sigma, respectively. The concept of parameters is very important and we'll discuss it more below.

A Family of Distributions

The normal curve is really a family of distributions. Each member of the family is determined by setting the parameters (μ and σ) of the model to a particular value (number). Because the μ parameter can take on any value, positive or negative, and the σ parameter can take on any positive value, the family of normal curves is quite large, consisting of an infinite number of members. This makes the normal curve a great general-purpose model, one able to describe a large number of naturally occurring phenomena, from test scores to the size of the stars.

Similarity of Members of the Family of Normal Curves

All the members of the family of normal curves, although different, have four properties in common. These properties include shape, symmetry, tails approaching but never touching the X-axis, and area under the curve:

Bell shape **–** All members of the family of normal curves share the same bell shape, given the X-axis is scaled properly. Most of the area under the curve falls in the middle. The tails (ends) of the distribution approach the **X-axis** but never touch, with very little of the area under them.

Bilateral symmetry **–** All members of the family of normal curves are bilaterally symmetric. That is, the left side of the curve is a mirror image of the right side. Human beings are approximately bilaterally symmetrical, with right and left sides.

Tails never touch X-axis **–** All members of the family of normal curves have tails that approach but never touch the X-axis. The implication of this property is that no matter how far you travel along the number line, in either the positive or negative direction, there will still be some area under any normal curve. Thus, in order to draw the entire normal curve you must have an infinitely long line. However, because most of the area under any normal curve falls within a limited range of the number line, only that part of the line segment is drawn for a particular normal curve.

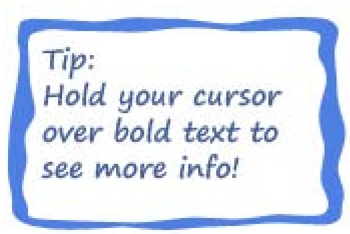
Area under curve totals 1.00 **–** All members of the family of normal curves have a total area of one (**1.00**) under the curve, as do all probability models or models of frequency distributions. This property, in addition to the property of symmetry, implies that the area in each half of the distribution is .50 or one half.

Area Under a Curve

In statistics, the ***area under a curve*** represents theoretical relative frequency or probability. It permits the statistician to make decisions about the world based on a belief about what the world looks like rather than the limited information available in a sample of scores. For example, the statistician would advise the shoe store owner to purchase shoes to stock his or her shelves based on the area under a normal curve model of the world rather than the proportion of individuals in the sample who wore a particular size shoe.

Drawing a Normal Curve

The standard procedure for drawing a ***normal curve*** is to draw a bell-shaped curve and an X-axis. A tick is placed on the X-axis corresponding to the highest point (middle) of the curve. Three ticks are then placed to both the right and left of the middle point. These ticks are equally spaced and include all but a very small portion under the curve.



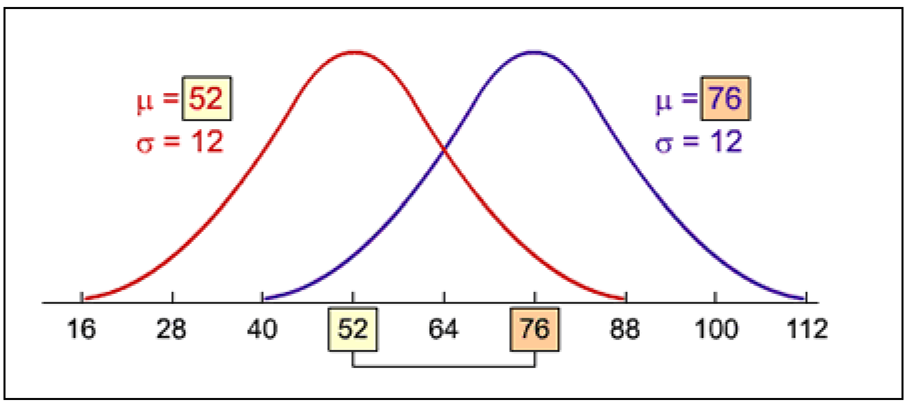
The middle tick is labeled with the value of **mu (μ)**. (It represents the **mean**, and it's in the middle because of the bilateral symmetry of a normal curve.) Sequential ticks to the right are labeled by adding the value of **sigma (σ)**. Ticks to the left are labeled by subtracting the value of sigma (σ) from μ for the three values. (Each sigma represents one **standard deviation** from the mean.)

Differences in Members of the Family of Normal Curves

Differences in members of the family of normal curves are a direct result of differences in values for these parameters. The two parameters, μ and σ, each change the shape of the distribution in a different manner.

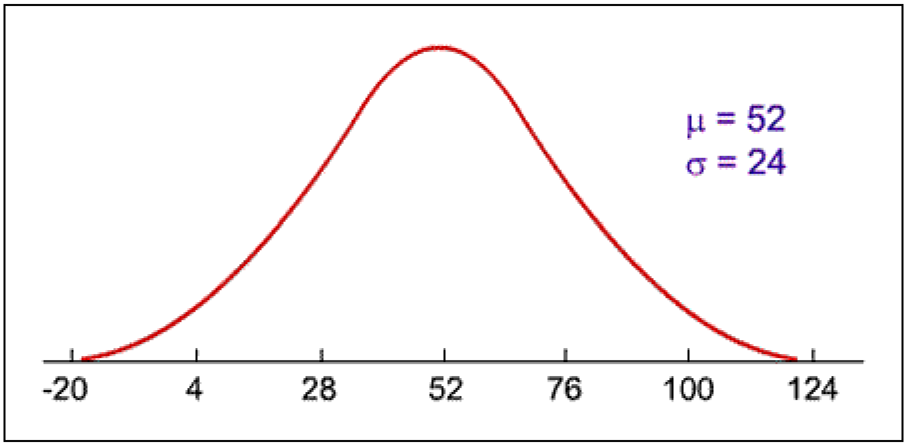
The first, μ, determines where the midpoint (mean) of the distribution falls. Changes in μ, without changes in σ, result in moving the distribution to the right or left, depending upon whether the new value of μ is larger or smaller than the previous value, but does not change the shape of the distribution. The following figure shows how a change in μ affects the normal curve.

Comparing normal curves with a constant value of sigma = 12
and differing values of mu.



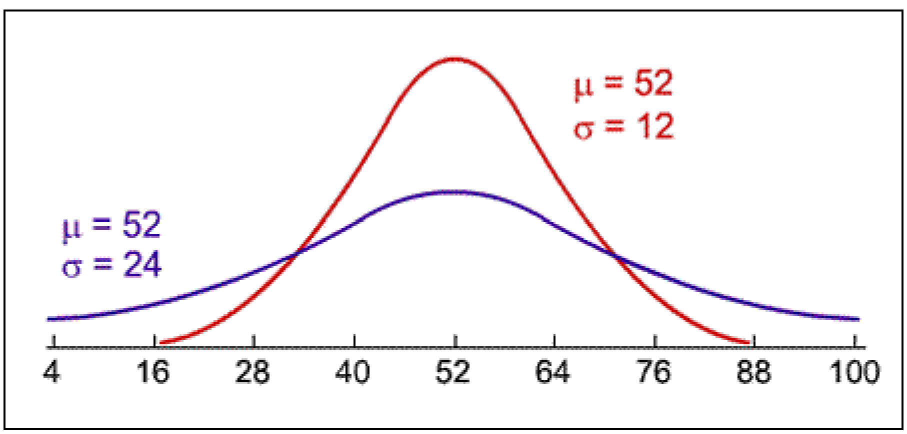
Changes in the value of σ, on the other hand, alter the shape of the distribution without affecting the midpoint, because σ affects the spread or the dispersion of scores. The larger the value of **σ**, the more dispersed the scores; the smaller the value, the less dispersed. Perhaps the easiest way to understand how σ affects the distribution is graphically. The following figure illustrates the effect of increasing the value of σ:

A normal curve with mu = 52 and sigma = 24.



Since this distribution was drawn according to the procedure described earlier, it appears similar to the previous normal curve, except for the values on the X-axis. This procedure effectively changes the scale and hides the real effect of changes in **σ**. Suppose the second distribution was drawn on a rubber sheet instead of a sheet of paper and stretched to twice its original length in order to make the two scales similar. Drawing the two distributions on the same scale results in the following graphic:

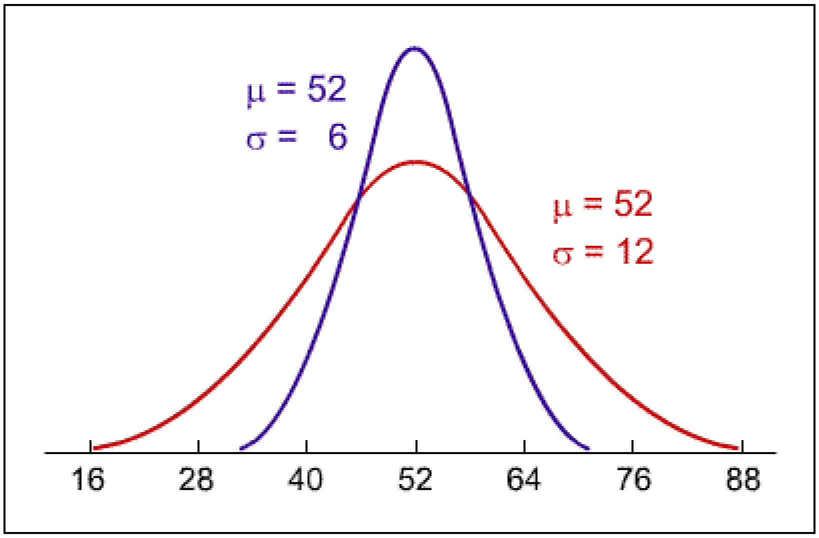
Comparing two normal curves with similar values for mu and different values for sigma.



Note that the shape of the second distribution has changed dramatically, being much flatter than the original distribution. It must not be as high as the original distribution because the total area under the curve must be constant, that is, 1.00. The second curve is still a normal curve; it is simply drawn on a different scale on the X-axis.

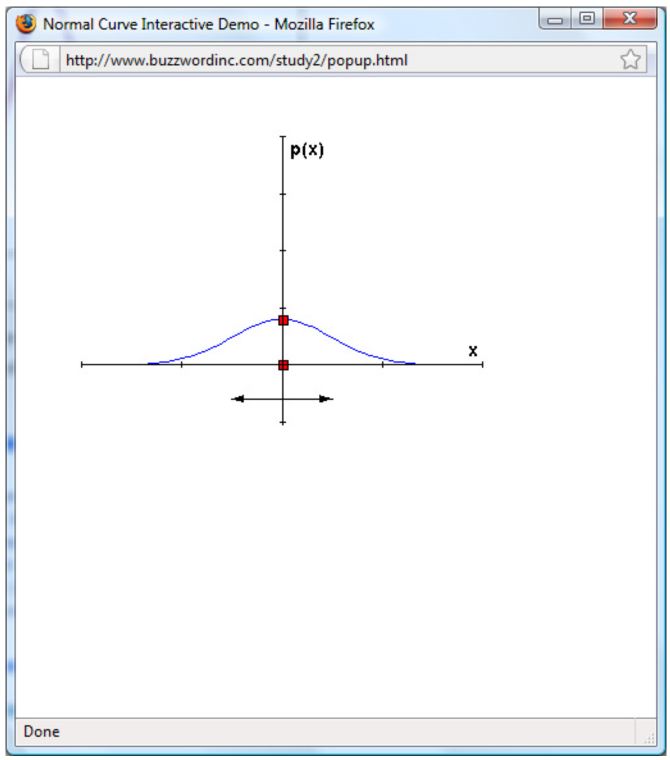
A different effect on the distribution may be observed if the size of σ is decreased.

Comparing two normal curves with different values of sigma.



Note that the distribution is much higher in order to maintain the constant area of 1.00, and the scores are much more closely clustered around the value of σ, or the midpoint, than before.

Tip:
In the demo below, you can explore what happens to the Normal distribution when its peak value is increased or decreased, and when its mean is moved. You will note that to preserve the area under the curve, the peak gets narrower if it gets taller, and fatter if it gets shorter. The line segment underneath the graph represents the standard deviation of the distribution.



The Standard Normal Curve

Tip:
Hold your cursor over bold text to see more info!

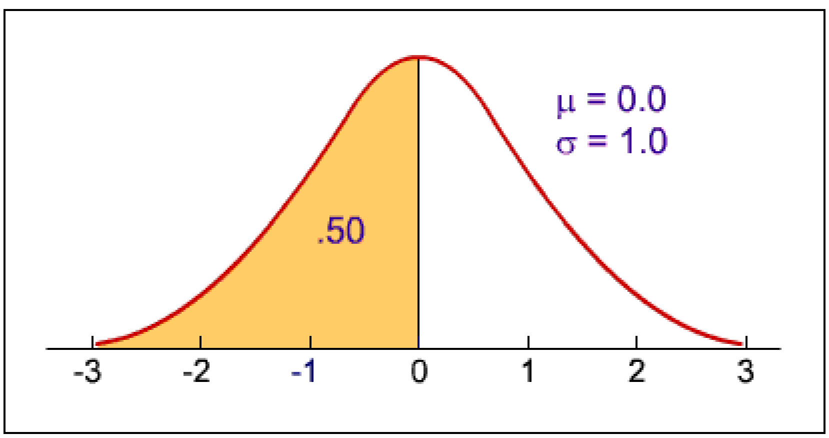
The **standard normal curve** is a member of the family of normal curves with m = 0.0 and s = 1.0. The value of 0.0 was selected because the normal curve is symmetrical around m and the number system is symmetrical around 0.0. The value of 1.0 for s is simply a unit value. The X-axis on a standard normal curve is often relabeled and called ***z-scores***.

There are three areas on a standard normal curve that all introductory statistics students should know:

The area below 0.0 is .50 or 50%.

This is because the standard normal curve is symmetrical like all normal curves. This result generalizes to all normal curves in that the total area below (to the left of) the value of mu is .50 in any member of the family of normal curves.

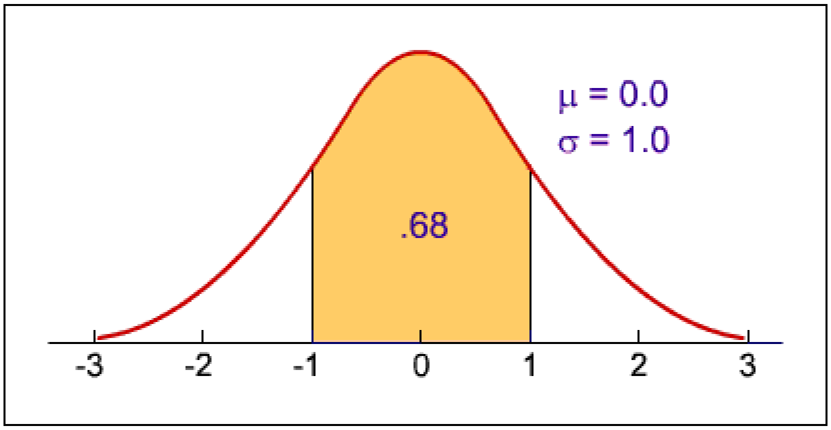
Half the area falls below the value of 0 on a standard normal curve.



The area between z-scores of -1.00 and +1.00 is .68 or 68%.

The total area between plus and minus one sigma unit on any member of the family of normal curves is also .68.

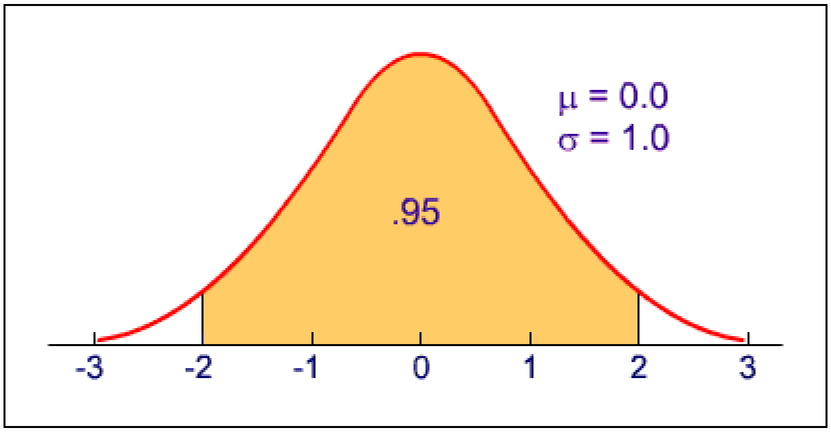
The area under a standard normal curve between plus and minus one sigma unit is .68.



The area between z-scores of -2.00 and +2.00 is .95 or 95%.

This area (.95) also generalizes to plus and minus two sigma units on any normal curve.

The area under a normal curve between plus and minus two sigma units is .95.

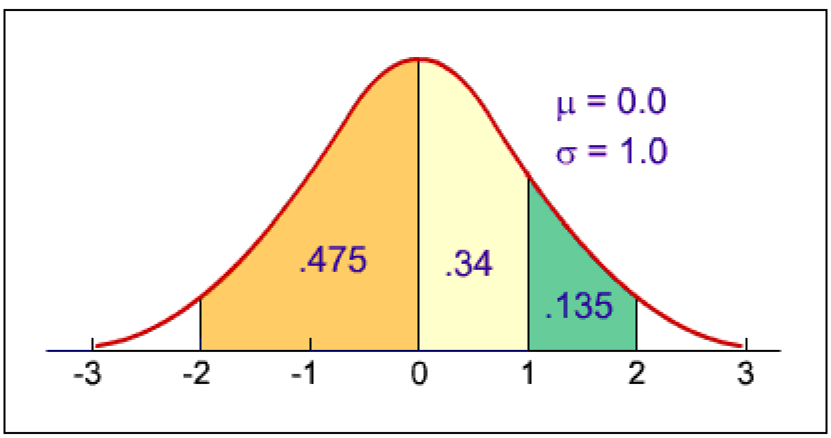


Knowing these areas allows computation of additional areas. For example, the area between a z-score of 0.0 and 1.0 may be found by taking 1/2 the area between z-scores of -1.0 and 1.0, because the distribution is symmetrical between those two points. The answer in this case is .34 or 34%. A similar logic and answer is found for the area between 0.0 and -1.0 because the standard normal distribution is symmetrical around the value of 0.0.

The area below a z-score of 1.0 may be computed by adding .34 and .50 to get .84. The area above a z-score of 1.0 may now be computed by subtracting the area just obtained from the total area under the distribution (1.00), giving a result of 1.00-.84 or .16 (16%).

The area between -2.0 and -1.0 requires additional computation. First, the area between 0.0 and -2.0 is 1/2 of .95 or .475. Because the .475 includes too much area, the area between 0.0 and -1.0 (.34) must be subtracted in order to obtain the desired result. The correct answer is .475-.34 or .135. The following figure illustrates the areas just discussed.

Area under various portions of a standard normal curve.



Using a similar kind of logic to find the area between z-scores of .5 and 1.0 will result in an incorrect answer because the curve is not symmetrical around .5. The correct answer must be something less than .17, because the desired area is on the smaller side of the total divided area.

Appendix 5: Pre-test and Post-test Assessment Questions

1. Parameters in the Normal Curve model are symbolized with
    a. Greek letters.
    b. numbers.
    c. letters late in the alphabet.
    d. letters early in the alphabet.
    e. Latin letters.
2. The "X" in the algebraic expression for the normal curve
    a. represents a score value.
    b. is the height of the curve at any point.
    c. serves no function within the algebraic expression.
    d. represents a parameter in the equation.
    e. is always a constant value.
3. Which of the following statements is NOT a property of a normal curve?
    a. All members have a bell shape.
    b. All curves have bilateral symmetry.
    c. Curves can have one tail or two.
    d. The tails never touch the X-axis.
    e. The area under the curve always totals 1.00.
4. When drawing a normal curve, the tick on the X-axis corresponding to middle of the distribution is labeled with:
    a. sigma.
    b. mu minus sigma.
    c. 100
    d. mu.
    e. pi.
5. On a standard normal distribution, sigma must always be:
    a. 1.0
    b. 0.0
    c. < 0.0
    d. A whole number
    e. Can be any value.
6. On a standard normal distribution, the mean must always be:
    a. 1.0
    b. 0.0
    c. < 0.0
    d. A whole number
    e. Can be any value.

7. The area between z-scores of -1.00 and +1.00 equals:
    a. 99%
    b. 95%
    c. 68%
    d. 50%
    e. 200%
8. The total area under a standard normal curve is:
    a. Dependent on the number of samples measured.
    b. Always between -1.0 and 1.0.
    c. Always equal to 1.0.
    d. Dependent on the value of X.
    e. Dependent on the value of mu.
9. The area between z-scores of -2.00 and +2.00 equals:
    a. 99%
    b. 95%
    c. 68%
    d. 50%
    e. 200%
10. If your study uses a sample of n=200, the number of subjects in the area with a z-score less than +1.00 equals:
    a. 100
    b. 168
    c. 84
    d. 50
    e. 176

Appendix 6: Demographic Measures

1. Gender ( ) Female
   ( ) Male

2. What is your approximate age?
   ( ) Younger then 18
   ( ) 18 - 19
   ( ) 20 - 21
   ( ) 22 -24
   ( ) 25 - 29
   ( ) 30 and over

3. Race (Check all that apply):
   ( ) American Indian or Alaska Native
   ( ) African-American
   ( ) Asian or Pacific Islander
   ( ) Caucasian
   ( ) Hispanic
   ( ) Other _________________

4. Academic standing:
   ( ) Freshman
   ( ) Sophomore
   ( ) Junior
   ( ) Senior
   ( ) Greduate

5. Major (Which college best matches your eventual major?):
   ( ) College of Agriculture
   ( ) College of Arts & Sciences
   ( ) College of Business & Economics
   ( ) College of Communication & Information Studies
   ( ) College of Education
   ( ) College of Engineering
   ( ) College of Fine Arts
   ( ) College of Health Services
   ( ) College of Nursing
   ( ) College of Social Work
   ( ) Other ________________

6. How long have you been using the Internet (including using e-mail, texting, ftp, etc.)?
   ( ) less than 6 months
   ( ) 6 to 12 months
   ( ) 1 to 3 years
   ( ) 4 to six years
   ( ) 7 or more years

7. What is your personal comfort level with math or statistics coursework?
   ( ) Very Uncomfortable
   ( ) Uncomfortable
   ( ) Neither Comfortable nor Uncomfortable
   ( ) Comfortable
   ( ) Very Comfortable

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