USING DIFFUSION OF INNOVATIONS TO EXPLORE DIGITAL GAMING IN UNDERGRADUATE LIBRARY INSTRUCTION

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Digital games and simulations are receiving considerable notice within the library and information science (LIS) community. This study adds to the depth of knowledge in this area by providing research on the likelihood a hypothetical digital game delivery method for library instruction achieves sufficient adoption to justify its development. Furthermore, this knowledge will assist decision making processes for individuals debating the current or potential role of digital gaming at their institutions.

In this mixed methods study, over 300 undergraduates were surveyed about their technology preferences, including digital gaming, for delivery of two forms of academic library instruction. The two forms of library instruction were (a) providing users with spatial information on physical library layout, and (b) educating users on information literacy topics and skills. Observational data was collected during the survey sessions, occurring at face-to-face library instruction sessions. Self-selected survey participants were also interviewed to further probe their survey responses.

Rogers' diffusion of innovations was the theoretical foundation to this research. The primary innovation of study was the digital game delivery method. Detailed analysis of the survey-based data set included three nonparametric scaling methods: 1) rank-sum scaling; 2) circular triad analysis; and 3) multidimensional preference mapping. Content analysis of the observations and semi-structured interviews also occurred.

Major outcomes were 1) the digital game delivery method achieved mediocre preference across both questions; 2) the audiovisual delivery method received the

highest overall preference ranking; and 3) overall preference for the audio-only delivery method was remarkably low. The most important theme across the observational data was the participants' waning attention during the face-to-face library instruction sessions. The most important outcome from the semi-structured interviews was interviewees' stated appreciation for useful technologies. Over 95% of participants were so-called digital natives, that is, born post-1980. Rogers' assertion that age plays a minor role in predicting technology adoption appears warranted, since the more innovative digital game delivery method achieved mediocre overall preference.

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INTRODUCTION

This chapter introduces the research topic, offering a brief background to frame the general problem of study. It next addresses the purpose and significance of the research, along with the major research question and sub-questions. The chapter concludes with an overview of the major elements of inquiry, followed by assumptions and limitations to the study.

Background

For centuries human beings have embraced games for learning and instruction (Dempsey, Lucassen, Haynes, & Casey, 1998). To varying degrees, games appeal to certain neurophysiological, sociocognitive, and cultural variables in every human being – perhaps the evolutionary predisposition for competitive interaction is the most basic example. Gaming entered the domain of computer science in the mid-20th century, via the pioneering work of individuals such as C. Shannon (1950) and Turing (1950). Today digital gaming is a key aspect of the technology landscape; its historical development and current prominence reflect a wider, digital evolution (Gibson, Aldrich, & Prensky, 2007). Users play digital games in living rooms, classrooms, coffee shops, and libraries, via wrist watches, mobile phones, personal computers, and advanced haptic interfaces.

Digital games – video, computer, and online - include rules, goals and objectives, outcomes and feedback, conflict or competition, interaction, and representation or story (Prensky, 2006). At their simplest, digital games allow the user to interact with the system and/or other users via an audiovisual interface displaying feedback reflecting his

or her choices within the game environment. The three-dimensional (3-D) immersive graphical user interface (GUI) is the direct manipulation interface adopted in most current digital games (M. J. Robertson & Jones, 2009). The three dimensions of human visual perception are height, width, and depth (Marr, 1982). It is notable that we do not objectively process all three dimensions. Rather we internally construct and subsequently project them onto our eyes' retinas. The retina is a two-dimensional (2-D) plane. Marr refers to this phenomenon as the 2 ½-D sketch. The 3-D immersive GUI situates the user in a 3-D digital environment, via an avatar (i.e., virtual-self), wherein movement within the environment provides the user sense of physical motion and temporal progress. Appendix A includes a 3-D immersive GUI example. To operate, digital games require a platform, or some hardware and low-level software. At present different platforms (e.g., PC, Xbox 360, PSP, etc.) facilitate digital game play.

In 2007 total sales in digital gaming resulted in $18.85 billion dollars profit in the U.S. (Bangeman, 2008), with 267.9 million digital games sold (Entertainment Software Association, 2008). Entertainment Software Association (ESA) President Michael D. Gallagher states, "On average, an astonishing 9 games were sold every second of every day of the year [2007]" (cited in Bangeman, 2008). Moreover, research indicates that over half of all adults in the U.S. play digital games, with one in five doing so almost every day (Associated Press, 2008), while 51% of K-12 students express interest in educational gaming (Stansbury, 2008). Consequently, digital games and simulations are receiving considerable notice within the library and information science (LIS) community (Abram & Luther, 2004; Branston, 2006; Hinton, 2006; Levine, 2007; Lipshultz, 2009; Myers, 2008; Nicholson, 2008; Peters, 2007).

LIS practitioners and researchers address digital games in a variety of ways, ranging from collection development to library instruction. For example, representing the American Library Association (ALA), Boss (2005) proposes a series of questions libraries should ask when considering whether to add digital games to their collections. Perhaps most important, Boss asks, “Are games and game playing consistent with the goals of libraries,” (p. 2). Additionally, Uzwyshyn (2005) suggests that future systems may present information via interfaces similar to the 3-D immersive GUI. There are also various approaches to utilizing digital gaming in library instruction, ranging from educational games that incorporate information literacy (Cybrarian, 2007; Pearson Education, 2008; Schmidel & Wojcik, 2008) to presenting an online digital library and its services via a game-like interface (Bronack, Riedl, & Tashner, 2006; Infoisland.org, 2008; Puterbaugh, n.a.). Utilizing digital game technology in library instruction may ultimately prove to be an engaging and motivating delivery method, particularly for so-called *digital natives* (i.e., millennials, neomillennials, N-gen users) (Prensky, 2006), that is, users born post-1980.

Research indicates younger users adopt some technological innovations at faster rates than users over 30 (i.e., digital immigrants) (Forrester Research, 2006; Pew Internet and American Life Project, 2009). Online media, mobile digital devices, social computing, and home networking are technologies that digital natives lead adoption among all consumers. Abram and Luther (2004) suggest the early adoption of instant messaging (IM) by younger users’ exemplifies innovativeness. Sikba and Barton (2006) list innovativeness as a major characteristic of digital natives, stating, “This group is

constantly trying to push the technology to its next level and figure out how to create a better world."

Problem Statement

At present the majority of LIS-generated literature on digital gaming is not derived from peer-reviewed research conducted by LIS community members (M. J. Robertson, in press). This deficiency in substantive LIS-based scholarly research may contribute to a complicated decision making process for library administrators, instructional personnel, and others debating the current or potential role of digital gaming at their institutions. Therefore prospective research providing insight on the likelihood a hypothetical innovation (e.g., digital game for library instruction) may or may not achieve sufficient adoption to justify its development is useful to decision makers (Rogers, 2003). The 2007 Online Computer Library Center (OCLC) *Sharing, Privacy and Trust in Our Networked World* report exemplifies prospective research in library technology planning (cited in British Library, 2008, p. 16).

While there is emerging LIS discourse concerning digital gaming in a variety of areas, including those related to library instruction (see Chapter 2), there is little discussion of whether or not the most important human component in the equation – the user – perceives the idea of digital gaming in library instruction as useful. If he or she does not, why invest precious resources to develop and deploy such systems? Van Eck (2007) suggests effective digital games designed for instructional purposes are complex and thus resource intensive, requiring significant planning and effort.

Therefore, this mixed methods quasi-case study provides a refined understanding for the LIS community of the technology preferences of undergraduate library users, specifically as they relate to digital gaming in library instruction. What is more, by carefully researching user preferences this study provides the LIS community with a better sense of the instructional technologies that the users in this research prefer their institution develop and deploy.

Purpose of the Study

This study explored undergraduates' perceptions of digital gaming in library instruction. More specifically, the purpose of this concurrent mixed methods quasi-case study was to examine an emerging research area by joining nonparametric survey data with open-ended interview and unobtrusive observational data. Expanding upon previous research (M. J. Robertson & Jones, 2009), 343 undergraduate library users at the University of North Texas (UNT) were surveyed about their technology preferences, including digital gaming, for delivery of two forms of academic library instruction. The two forms of library instruction were (a) providing users with spatial information on physical library layout, and (b) educating users on information literacy topics and skills.

Observational data was also collected during the survey sessions, which occurred at the beginning of select face-to-face bibliographic instruction sessions held at UNT Willis Library throughout the fall 2008 semester and led by instructional librarians from UNT Libraries Research and Instructional Services Department. Then based upon the survey findings and other factors, self-selected survey participants were interviewed to probe their survey responses in more depth.

The theoretical foundation of this research is Rogers' (2003) diffusion of innovations (DOI). DOI provides researchers direction in understanding changes in human behavior, particularly by way of its descriptive capacity. Rogers defines diffusion as the process "by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) over *time* (4) among the members of a *social system*," (p. 11). In this research, the primary innovation of study was the *idea* of the digital game delivery method. Ultimately all data was interpreted through a DOI lens. More in-depth review of DOI concepts located in Chapter 2, with further discussion in Chapter 5 and Chapter 6.

Research Question and Sub-Questions

This section presents the research question, followed by subsections addressing the four research sub-questions. In this research, technology refers to any number of physical or digital objects, tools, and/or systems used by human beings to achieve a specific goal or series of goals. A delivery method is analogous to a communication medium or information presentation format; conceptually, it is an approach to communicating specific information in an instructional context. Thus a technology-based delivery method is a physical or digital object or system applied in user instruction. With that understanding, the primary question driving this research was:

> Do undergraduates prefer a digital game system over other technology-based delivery methods to engage in library instruction?

Research Sub-Question 1

Do undergraduates prefer a paper-based document over other technology-based delivery methods to engage in library instruction? Libraries use paper-based documents to inform and instruct users of collections, programs, and services. Paper-based documents may focus on specific aspects of information literacy instruction or library orientation. Examples of paper-based documents utilized for library instruction are those provided by the Christchurch City Libraries (2008) of Christchurch, New Zealand.

Research Sub-Question 2

Do undergraduates prefer a 2-D webpage over other technology-based delivery methods to engage in library instruction? Webpage design historically follows a 2-D layout of text and often images (Shneiderman & Plaisant, 2005). Two dimensions of human visual perception are height and width (Marr, 1982). An example of a 2-D webpage in a library instructional context is the UNT Libraries (2008) Locations and Maps webpage.

Research Sub-Question 3

Do undergraduates prefer an audio-only presentation over other technology-based delivery methods to engage in library instruction? An audio-only presentation provides information solely in audio format. A popular example for library instructional purposes is the podcast. Libraries use the podcast – a digital audio file syndicated directly to the user via the Internet – to inform of various types of programs and services

(Library Success, 2006). An example of an audio-only presentation for library instructional purposes is the Ohio University (2008) Alden Library podcast tour.

Research Sub-Question 4

Do undergraduates prefer an audiovisual presentation over other technology-based delivery methods to engage in library instruction? The audiovisual presentation informs the user via a combination of both audio and video formats (Merriam-Webster Online, 2009). An example of an audiovisual presentation for library instructional purposes is the Brown University (2008) library video tutorial, addressing topics such as finding resources and utilizing interlibrary loan.

Relevance and Value of the Study

The purpose of this section is to provide rationale for conducting prospective research, and ultimately why the research outcomes are important. To begin with, from a scholarly perspective, this research is significant in that it contributes to emerging discourse on digital gaming in the LIS community (see Chapter 2). This research also adds to the inversely large body of literature on academic library instruction (see Chapter 2). Interdisciplinary researchers concerned with younger users and instructional technology adoption may also find it useful (see Chapter 2).

Discussing library technology planning, Stephens (2004) suggests users are technology consumers with evolving expectations for library services. User perceptions influence user expectations (Rogers, 2003). Therefore understanding how users perceive the applicability of particular technologies in task-oriented contexts is important

to both LIS researchers and practitioners. Such knowledge aids decision makers in preparing a more accurate view of user expectations and may help with the development of current and future academic library instruction programs and services. As such the Teaching, Learning, and Technology standing committee of the ALA Library Instruction Round Table should find this research informative. This research may also influence various administrative and operational concerns of a library system and/or organization, such as funding and even collection development.

Furthermore, in a direct practice-based sense, the results of this research provide decision makers at UNT Libraries with empirically-based perspective on the preferences and expectations of the participants for technology-based library instruction. Hopefully this perspective encourages those decision makers to create and implement instructional programs and services that motivate and engage their undergraduate users. This research also has potential in other types of libraries, like school media, as well as instructional scenarios and environments not directly associated with libraries, such as human resources training and biomedical instruction.

Elements of Inquiry

This section discusses the major elements of inquiry in this research, followed by a subsection concerning assumptions and limitations. In formal, peer-reviewed research three elements must be considered: 1) the knowledge claims informing the study, 2) the strategies of inquiry informing the procedures in the study, and 3) the data collection and analysis methods used in the study (Creswell, 2003).

First, the knowledge claims in this research are best described as a synthesis of socially constructed and pragmatic. Creswell (2003) suggests that knowledge claims are assumptions about how knowledge is generated. Socially constructed knowledge claims are developed on the assumption that users construct subjective meanings of their external worlds, by way of human interaction within a social group or groups. J. G. Jones and Bronack (2006) state, “Social constructivists view learning… as a contiguous process that exists each time people willfully interact with each other in the world around them,” (p. 93). Congruent with this stance, Bates (2006) claims that because of the complex nature of information (i.e., cognitive, physical, social, etc.) “people create subjective constructions of their experiences,” (p. 1035), while Steinkuehler (2005a) and Gee (2003) discuss this viewpoint in the confluence of digital gaming and literacy.

Additionally, the pragmatic (non-positivistic) (Creswell, 2003) nature to this research suggests that knowledge is “validated by its usefulness,” (Sternberg, 2006, p. 535). Creswell comments that for the pragmatist, “Instead of methods being important, the problem is most important, and researchers use all approaches to understand the problem,” (p. 11). Used in basic and applied research, pragmatism maintains a rich history within the education (Bredo, 1994; J Dewey, 1897) and LIS communities (Kuhlthau, 2006; D. Shannon, 2002), and allows for freedom of choice in data collection and analysis.

Second, this research used a transformative strategy of inquiry; a distinct type of mixed methods research (Creswell, 2003). Mixed methods research incorporates the collection and analysis of both quantitative (i.e., numeric) and qualitative (i.e., text and/or images) data (Fidel, 2008). As a result, this transformative strategy allowed me

to minimize or neutralize biases associated with a particular data collection and analysis method (e.g., survey) by way of the biases associated with other methods (e.g., semi-structured interviews and unobtrusive observations), resulting in the desirable triangulation of research efforts.

Transformative strategies often have value-based, emancipatory, or action-oriented themes underlying their development. While an action-oriented or applied aspect was present in this research (e.g., providing UNT Libraries decision makers with findings reflecting the technology preferences of participants that can in turn be used to develop and implement instructional programs and services), the primary focus was less on any one of the aforementioned three items than on basic exploration of a to-date unaddressed area of the burgeoning digital gaming discourse within the LIS community.

Therefore in this research, the two most important aspects of the transformative strategy were the adoption of a theoretical lens and the data collection and analysis processes. For example, this research relied upon DOI to provide an interpretive framework to make sense of the data and discuss the outcomes of analysis. Transformative strategy also allows for a concurrent approach to the data collection process, evident in the following third and final element of inquiry.

Third, this research utilized a pilot-tested survey instrument administered to a participant sample of 343 undergraduate library users, followed by semi-structured interviews with select survey participants. Unobtrusive observations ran concurrent with survey administration. Analytic techniques included rank-sum scaling, circular triad analysis, and multidimensional preference mapping, as well as content analysis of

interview and observational data. More detailed discussion of the research methodology occurs in Chapter 3 (data collection) and Chapter 4 (data analysis).

Assumptions and Limitations of the Study

Research design was influenced by certain personal assumptions. The following is based upon tacit knowledge and personal experiences gleaned throughout previous research utilizing a similar strategy of inquiry (see Chapter 2, Pilot Study section):

- As a researcher, I can explicate participants' perceptions by way of my own insight and interpretations of the data.
- The participants can provide reasonably accurate and detailed accounts of their perceptions with regard to the study.
- The protection of privacy for each participant, via the promise of secrecy, supports unrestrained communications of perceptions without fear of reprisal from outside sources.

Resting upon a social constructivist/pragmatist foundation, this research was by nature non-positivistic. In other words, as the research proceeded and patterns emerged, outcomes were neither predicted nor hypothesized (J. G. Jones, 2001). Nonetheless, the provision of certain information here should benefit the reader so that he or she may construct an accurate mental model of the research. Ultimately, it is the responsibility of the reader to determine the transferability and applicability of their context to this research.

Perhaps most important, the incoming familiarity of the participant with digital gaming, based upon his or her unique memories of objects and experiences, was both an assumption and limitation. It was assumed that each participant has some familiarity with the concept of the digital game. In turn the level of familiarity influenced, or inversely limited, his or her survey responses. It was also assumed that bibliographic instruction sessions, like those surveyed in this study, are a good idea for younger users. As such, determining the appropriateness and effectiveness of such instruction for younger users was never a goal of this research.

General assumptions and limitations related to the three major methods in the research – survey, unobtrusive observations, and semi-structured interviews – discussed in Chapter 3, while specific procedural items worthy of initial highlight discussed here. For example, I assumed that the study participants would take no more than 10 minutes to complete the online survey. As previously described in the Research Question and Sub-Questions section, this research was limited to five technology-based delivery methods. Additional delivery methods, like face-to-face instruction, were not measured, nor were combinations of any of the five technology-based delivery methods directly measured. Insight on face-to-face instruction was however inadvertently gleaned via the semi-structured interviews.

Moreover there were no working examples of the five technology-based delivery methods within the survey; there were however contemporary visual examples of each. This limitation required the participant to draw upon his or her socially constructed knowledge about the nature of the digital game in library instruction idea. That is, one

participant may recall a historically dated example of a digital game, while another may think of a more recent instance, while yet another, perhaps only the given example.

Additionally, it is noteworthy that this research did not directly measure over a period of time the diffusion of the digital game for library instruction idea within the sample. Instead it used the extensive body of knowledge stretching back over 50 years that DOI offers, as a theoretical lens to interpret and make sense of the multiple forms of data acquired. Ultimately this study, from a diffusion standpoint, constitutes prospective research and development (R&D) within the library community for digital gaming in library instruction. It did not directly measure the four main elements of DOI outlined in Chapter 2. As such it is unconventional diffusion research.

Premature closure of the study was also a limitation. However the following factors helped to minimize such risk: (a) My intimate involvement with the study over a period of time is accounted for in the Person as Instrument Statement (see Appendix C), (b) a detailed reflexive journal maintained throughout the inquiry should have aided to provide a basis for trustworthiness of findings, and (c) consultations with knowledgeable mentors and peers were done throughout the study as an additional means for establishing trustworthiness. Each of these factors were used to minimize threats to credibility outlined by the assumptions and limitations of the study and to persuade the reader as to the trustworthiness of my findings (Lincoln & Guba, 1985).

CHAPTER 2

REVIEW OF RELATED LITERATURE AND THEORY

This chapter presents an interpretative summary of existing knowledge in the fields directly relevant to this study. It first introduces digital gaming literature derived from the library and information science (LIS) community, including sections focusing on collection development, marketing, and library instruction. The chapter follows with an overview of cognitive aspects to digital game use, as well as a summary of library-related digital game literature on systems design. It then introduces writings on the so-called digital native, followed by an overview of the pilot study, the antecedent to this research. Methodological background literature follows, including an overview of diffusion of innovations (DOI) and its use in LIS research. Since these are generally independent yet related topics, some will only be summarized with regard to the study in question. As such, the topics are put forward so that the reader may better understand the selected research domains, and then synthesize the findings discovered and communicated in the study's results.

Digital Gaming in Library and Information Science Literature

While LIS-generated literature on digital gaming continues to steadily accumulate, much of it to date, in an applied sense, lacks empirical backing derived from LIS-based research (M. J. Robertson, in press). This deficiency may contribute to a complicated decision making process for library administrators and instructional

personnel debating the role of digital gaming at their institutions. Fortunately some individuals within the LIS community are currently working to fill this gap in research.

Nicholson (2008) is exploring ways that libraries can effectively utilize gaming, digital and non-digital, to support their institutional goals. His census of public, academic, and school media libraries reveals that 69% circulate no games of any type, while 9% offer PC-based games, and 3% console games (e.g., Xbox 360, PlayStation 3). Nicholson (2009) is also director of the Library Game Lab of Syracuse, a cooperative research effort between the Syracuse University School of Information Studies, the American Library Association (ALA), and the University of Illinois at Champaign-Urbana. The lab's core mission is to investigate the growing gaming in libraries phenomenon, by exploring gaming of all types, including card, board, and digital.

Urban (2007) emphasizes that the principles of information science provide an appropriate analytical framework for the investigation of information use inside digital game environments, particularly networked systems. Bell, Pope, and Peters (2007) also contribute to the digital gaming discussion from an informatics-based perspective. To provide an overview of the digital gaming discussion within the LIS community, the remainder of this section addresses three aspects of library programs and services wherein digital gaming is an important, growing topic of discussion: collection development, marketing, and library instruction.

Collection Development

As the following indicates, collection development and digital gaming historically overlap within LIS literature. Considering the profits mentioned in the Background section of Chapter 1, it is not surprising that the question of whether or not libraries should include digital games in their collections exists among some practitioners and researchers. Both Emmens (1982; 1984) and Poller (1988) provide some of the earliest discussion on collection development and digital games, while H. Wilson (2005) presents a more recent overview weighing the pros and cons of adding such media to collections.

Utilizing the popularity of digital games as an example, Sullivan (2005) suggests that changing user expectations are driven primarily by technology. Sullivan proposes that function, not format, should be the main goal of collection development. Wand, Harbur, and Scotti (2005) also address function versus format, and advocate academic libraries extending their collections to include digital games. Phillips and Spilver (2007) discuss adding digital games to school library collections and provide suggestions of various titles appropriate for such libraries. Oakley (2008) also shares the experiences of the Guilderland Public Library in New York at building a digital game collection.

Czarnecki (2007b) recommends various print media titles relevant to teenage digital game users, while Aronson (2007) discusses ways in which books enhance digital game play. Czarnecki (2007a) and Schwarzwalder (2007) also review major digital game console units and select digital game titles for school and public library practitioners. For more information on digital gaming and collection development see Huber (2008) and Kane, Soehner, and Wei (2007).

Marketing

Marketing is an important discussion topic here because it represents one application of digital gaming by libraries that is largely successful. For libraries of all types and sizes, community outreach is paramount. Communicating with both users and non-users about the resources, expertise, services, and programs the library offers is increasingly necessary in the networked information environment of today. For example, Neiburger (2007) and Neiburger and Gullett (2007) focus on public libraries in the US, and discuss how such institutions can market to current and future youth users. Neiburger suggests that libraries must evolve to meet the digital expectations of today's youth, and promotes digital gaming initiatives as a means for attracting such users. Helmrich and Neiburger (2005; 2007) also review a three year case study at the Ann Arbor District Library in Michigan, concluding that the institution's digital gaming initiative has drawn significant and growing numbers of users into the physical library facility. Providing an international perspective, Lewis (2005) describes using digital games to promote computing services to potential youth users of select UK libraries.

Sutton and Womack (2006) offer a practice-based glimpse into the positive impact promoting digital games present academic libraries, and suggest that gaming programs, such as hosting a game night for young adults, supports academic libraries in proving their relevance to digital natives and other user populations. Stephens (2006) observes that digital game programs held by public libraries offer their users an exciting programming option. He emphasizes that such programs encourage digital natives to perceive the library as a place of real, personal value. H. Wilson (2005) also suggests various methods for bringing games of all types, not just digital, to youth users. Like Stephens, H. Wilson asserts that libraries ignore both the needs and expectations of

large segments of youth users when those institutions do not embrace digital gaming. Oakley (2008) also states that digital game collections can be “a great way to attract young adults to the library,” (p. 30).

It is noteworthy that at the 2008 ALA TechSource Gaming, Learning, Libraries Symposium, Nicholson (personal communication, November 2, 2008) conveyed that his 2007 gaming census identified digital gaming initiatives as most effective at bringing users through libraries’ doors. In relation, Wayne (2008) suggests that integrating gaming into library services is a decision that should be made on an individual library by library basis. For more information on promoting library services through digital gaming, see Czarnecki (2007c), King (2007), Saxton (2007), Scordato (2008), Sullivan (2005), and Ward-Crixell (2007).

Library Instruction

Lipshultz (2009) writes, “Games can support our [libraries] shared mission of helping patrons become more informed participants in an information-based society,” (p. 41). In practice libraries do far more than provide access to information; they also act as both formal and informal educational agencies (Marchionini & Maurer, 1995). For example, UNT Libraries Research and Instructional Services Department (2009) provides library instruction for:

> …groups and involves in-depth instruction in and development of cognitive strategies for the effective use of the services, facilities, and resources available through the University of North Texas Libraries. In its most comprehensive form,

> library instruction includes the promotion of information literacy skills for lifelong learning.

Adapting previous definitions (Lorenzen, 2001; Reitz, 2007), for the purposes of this research, library instruction describes the collective educational efforts – formal (i.e., guided or directed within an established learning environment) and informal (i.e., self-guided or user-directed) (J. G. Jones, personal communication, May 16, 2008) – of an academic library. Libraries of all types and sizes are responsible for providing user instruction in areas such as bibliographic instruction, information literacy, and library orientation. Each of these areas shares the fundamental purpose of teaching the user to effectively use the library and its resources (Cleveland & Philbrick, 2009). The phrase library instruction is overarching, encompassing all types of user instruction.

At its core, the purpose of bibliographic instruction is to teach the user basic principles of information organization and retrieval (Cleveland & Philbrick, 2009). However, since the 1980's, the phrase has evolved to include additional aspects. Today, because of various socioeconomic and technology-related forces, bibliographic instruction may also include elements of library orientation and information literacy instruction. Reitz (2007) states:

> In academic libraries, bibliographic instruction is usually course-related or course-integrated. Libraries that have a computer-equipped instruction lab are in a position to include hands-on practice.… Instruction sessions are usually taught

by an instructional services librarian with specialized training and experience in pedagogical methods.

The Association of College and Research Libraries (ACRL) (2003) outlines the core competencies of information literacy as, “identifying an information need, accessing needed information, evaluating, managing, and applying information, and understanding the legal, social, and ethical aspects of information use.” For academic libraries, a primary component of their service missions is to educate users about information literacy concepts and skills. Such instruction often occurs either in a face-to-face setting or online and may include educating users in evaluating information resources, searching electronic bibliographic databases, and utilizing various services offered by the institution, such as interlibrary loan. Ultimately the goal of information literacy instruction is to encourage library users to be independent, cross-disciplinary researchers confident in their own abilities to locate and utilize valid information both in physical and digital formats (Association of College and Research Libraries, 2008). Information literacy instruction is closely related to bibliographic instruction and library orientation, and likewise falls under the larger banner of library instruction.

Another form of library instruction, library orientation focuses on spatial information on the physical facility (i.e., building layout), as well as user privileges, library services, policies and collections (Cleveland & Philbrick, 2009). Library orientation may also include aspects of bibliographic and/or information literacy instruction, and frequently occurs as guided or self-guided tours of physical facilities. Keefer (1993) suggests that academic library users under time constraints and other

stresses are more likely to have difficulty conducting independent research; often these users fail to see directional signs and other communication media providing spatial information on the facility. Eschedor Voelker (2006) reinforces this aspect of library orientation in her discussion of freshman users, information literacy instruction, and library anxiety. For many libraries, frequent means of communicating spatial information include pamphlets, strategically placed signs, and online guides via an institution's Web presence (M. J. Robertson & Jones, 2009). The 3-D immersive GUI allows users to process information via audio dialogue, text, and avatar movement. It also permits users to engage one another within an entirely neutral digital reality, an important benefit for freshmen sensitive to their own abilities to integrate into the physical library environment (Eschedor Voelker, 2006).

Libraries provide educational programs and services to their users via a range of technology-based delivery methods, stretching from simple pamphlets to extensive instructional websites. Computer-supported library instruction – ranging from spatial information on a physical facility to bibliographic or information literacy – is an area where digital gaming and LIS have historically merged. A significant early discussion of this relationship was in 1982 (Koelewyn & Corby) with the advent of the digital game Citation designed to teach young people basic information literacy skills. More recent, Branston (2007) presents an overview of digital game-based information literacy instruction, addressing topics such as user motivations, digital game design, and assessing learning outcomes. Prensky (2006) suggests that the appeal of utilizing digital games for non-traditional purposes (i.e., education) is that they require the user to focus on personal experiences to make complex decisions that determine progress

within the game environment, ultimately resulting in learning that is both unforced and meaningful. For additional, general information see the Gaming in Library Instruction (Association of College and Research Libraries, 2007) webpage.

Currently there are a variety of approaches to utilizing digital games for library instruction, ranging from the provision of online educational games that incorporate information literacy concepts (Cybrarian, 2007; Pearson Education, 2008; Schmidel & Wojcik, 2008) to presenting an entire digital library and its services via a 3-D immersive GUI. Select examples include Quarantined (Gallegos & Allgood, 2007) at Arizona State University Fletcher Library, and Within Range at Carnegie Mellon University Libraries (2007). Utilized to augment formal library instruction, Quarantined is an action-adventure game presented via a two-dimensional interface. In Within Range users classify various resources on a virtual shelf using the Library of Congress system.

Dawes and Dumbleton (2001) reveal that children under adult supervision playing SimCity (Electronic Arts, 2009) within a formal classroom environment subsequently utilized their physical library more proficiently to engage in learning activities. Focusing on various institutional experiences, Whelan (2005) considers the potential of digital games as an instructional delivery method, while Bloom (2008) reviews how the University of Southern California uses simulations and gaming in formal instruction. Additionally, Reutter (2006) discusses possible ethical implications on younger library users that emerging multimedia technologies may present practitioners, including designers' propensity to incorporate cheat codes into many digital games. In relation to so-called cheat codes, Prensky suggests the terminology is misleading. He puts forward that game designers integrate such codes into their products primarily to

allow pre-release testing and evaluation to take place quickly and efficiently, not for the user experience.

Budd (2008) states, “The effective combination of materialist and constructivist elements of learning and knowledge may be the most profound challenge facing information literacy (and all teaching and learning),” (p. 324). It is therefore noteworthy that some researchers frame (Gonzalez & Blanco, 2008; Mayo, 2007; Prensky, 2001) digital games and game-like learning environments (Akilli, 2007) as motivating, engaging, and potentially effective instructional delivery methods, describing them as experiential exercises (Turkle, 1984) wherein users develop various metacognitive skills (i.e., learn how to learn) (Gredler, 1996). Rieber (1996) observes that digital games motivate users to take personal responsibility for learning, while Cole (1996) suggests that long-term interaction with a digital game effects student learning in a positive manner (cited in Subrahmanyam, Greenfield, Kraut, & Gross, 2001, p. 16). Becker (2007) suggests that digital games are motivating and engaging because their designers, often unintentionally, draw upon effective approaches to learning, teaching users to play in both fun and natural ways. See Akilli (2007) for more information on the effects of digital games and simulations on learning processes and outcomes.

Becker (2007) writes, “Books, film, television, and indeed every other medium that came before them have been used… as media for the delivery of instruction,” (p. 21). Digital games are more likely to be effective instructional media when users can relatively easily achieve a specified goal or goals. Users enjoy playing when they perceive in-game tasks to be fair, and risk-reward failure as evident but not too high. Users also enjoy digital games that contain sufficient positive and negative feedback,

allowing them to gauge their progress toward the specified goal or goals. Finally, engaging and motivating digital games must include the element of chance that "in turn encourages people to keep trying or to try again," (Becker, 2007, p. 25).

Wong (2007) et al. assert that further empirical research is needed to confirm the claim that digital games have significant value as instructional media. Likewise, Akilli (2007) suggests that while games are used in some modern educational environments, their overall effectiveness is questionable because of a lack of rigorous scientific evaluation. Gredler (1996) provides historical precedence for Akilli's stance, pointing out the need for well-designed evaluations of games and simulations as instructional delivery methods. For additional information on digital gaming and its relationship to learning technologies see Kirriemuir (2002).

Cognitive Aspects of Digital Game Use

This section addresses items of interest related to both user cognition and digital gaming. The first subsection reviews major theoretical approaches to cognition in game studies, cognitive psychology, educational technology, and other disciplines. The second subsection discusses research derived from fields such as information visualization and cognitive neuroscience. Its focus is largely on cognitive processes involved in digital game use.

Major Theoretical Approaches

Although this research utilizes DOI as a theoretical lens, it is helpful to review other frameworks used to explore digital gaming in order to better appreciate the potential some individuals claim it offers user instruction. Furthermore, since digital gaming researchers come from many disciplines, a variety of theories are evident in the literature. For example, notable explanatory theories reflecting a sociocognitive approach to research include communities of practice (Lave & Wenger, 1991), situated cognition (Gee, 2003), and distributed cognition (Steinkuehler, 2005a). These theoretical perspectives synthesize to varying degrees internal human factors with external variables like social interaction and physical space, to address user behavior. Many of the current theoretical approaches, such as communities of practice and situated cognition regard learning as a primary activity of human information processing - these theoretical approaches reflect to varying degrees historically significant literature by Dewey (1897; 1933), Kelly (1963) and Vygotsky (1978). In relation to the previous statement, it is also noteworthy that some LIS researchers frame information seeking behavior as first and foremost, an exercise in learning (Pettigrew & McKechnie, 2001).

Foundational to this discussion, social cognitive theory (Bandura, 1986) focuses on observational modeling and learning. Incorporating aspects of both behaviorism and cognitivism, social cognitive theory includes three core premises: 1) triadic reciprocal causation; 2) multiple levels of goals; and 3) the role of self-efficacy in identity construction (Miwa, 2005). Additionally, participatory culture theory (Jenkins, 2006) is an important contributor to current theoretical approaches in digital gaming research. Jenkins suggests that a participatory culture is one in which expression, engagement,

mentorship, and sense-making are encouraged. Communities of practice theory also focuses on social participation, identifying learning as an organized collective activity distributed across (dis)organized settings (Davies, 2005).

Closely related to communities of practice theory is situated cognition. Situated cognition researchers claim that human learning involves both internal and external processes, and emphasize the sociocultural and material aspects of the user's external environment. Similarly, Steinkuehler proposes a theory of distributed cognition. She suggests that digital games, particularly massively multiplayer online role playing games (MMORPG), offer an excellent context for studying human thinking because they often require users enlist collective intelligence (Levy, 1999) through various formal and informal social interactions. Additionally, Steinkuehler (2005b) explores the sociocognitive effects MMORPGs have on the learning activities of younger users.

Cognitive Processes and Digital Game Use

A fundamental goal of information visualization research is to design and develop digital systems that better facilitate human beings' primary means of perception – vision (Hearst, 2000). Similarly, research indicates digital games can affect the cognitive development of users' in areas ranging from visuospatial skills to problem solving (Akilli, 2007). As such, select research drawn from information visualization, as well as instructional media and cognitive neuroscience, reveals much about the captivating appeal of digital games.

Research suggests that digital animation may support users' abilities to simplify structure during learning activities (Sperling, Seyedmonir, Aleksic, & Meadows, 2003).

This assertion is congruent with discussion on visual analytics and rich interaction environments (J. Johnson, 2006), and runs parallel with research indicating increased dopamine levels in digital game users during user-system interaction periods (Koepp et al., 1998). Dopamine is a neurotransmitter involved in various forms of learning and decision making (Shohamy, 2008).

Visual perception is the most productive and efficient perceptual resource available to users (Sternberg, 2006). Perception is the operationalized group of nested cognitive processes – attention, consciousness, and memory – from which users make sense of their external worlds. In relation to visual perception, attentional processing that occurs without conscious awareness is preattentive (C. Healey, 2007). Via low-level parallel abilities, preattentive processing takes less than 250 milliseconds to occur (C. G. Healey, Booth, & Enns, 1996). Greenfield, deWinstanley, Kilpatrick, and Kaye (1994) suggest that users' visual attention increases in tandem with their in-game skills. Similarly, in 2006, Green and Bavelier published research indicating that action digital games may enhance the visuospatial attentional capabilities of their users. See de Castell and Jenson (2006) for additional research on user attentional resources during interaction with a digital game designed to support learning activities.

Information visualization research may elucidate previous findings from other fields that relate to the strengths and limitations of various information presentation formats. For example, consumer research indicates that information presentation formats effect users' learning and decision processes (Bettman & Kakkar, 1977; Biehal & Chakravarti, 1982). Image-based communication media (i.e., information presentation formats and/or delivery methods) incorporate both attentive and preattentive perception.

Multiple visual properties associate with preattention, including height, width, and depth – the necessary components of three-dimensionality (3-D) (Ware, 2004). Three-dimensionality plays a major role in making digital game users feel immersed within the game environment (see Systems Design, Physical Library Metaphor).

Language is an orderly system of sounds and frequently symbols allowing for communication between users (Eysenck, 2006). In relation to language, reading is a sequential processing, conscious attentive task (Hearst, 2000). In contrast to images, text presents certain characteristics that contribute to increased cognitive workload in users, such as being difficult to internally visualize, as well as subjectively ambiguous. On the other hand certain characteristics of text, such as its high redundancy, easily facilitate information retrieval. Ultimately, while text does aid in constructing mental models, it inherently lacks the detail and precision of visual imagery.

In relation to digital games, Abram and Luther (2004) state, “Many of us in the information profession are great text-based learners. For most of the rest of the world, reading is not a primary learning behavior.” Relative to the previous assertion, Uzwyshyn (2005) challenges those within the LIS community who do not consider digital games as serious examples of information systems to rethink their viewpoints. Also, interesting discussions on information retrieval systems with relevance to the 3-D immersive GUI approach – for example, providing the user context to content versus focus on content – exist across disciplinary lines (C. Chen, 2000; C. Chen, Czerwinski, & Macredie, 2000; C. J. Chen, Toh, & Fauzy, 2004; Deligiannidis & Jacob, 2005; Ford, 2000; Marchionini & Komlodi, 1998). Further discussion relevant to digital gaming located in Marr (1982) and Snowdon, Churchill and Frecon (2004).

Systems Design

This section discusses various approaches to incorporating digital gaming technologies into information systems. The basic question these approaches present is to what extent the integration of a 3-D immersive GUI is desirable and/or effective in an information system? Two general approaches are evident in the following literature: 1) modeling physical libraries within digital game environments, and 2) creating digital systems utilizing select design aspects of digital games.

Physical Library Metaphor

Examples of libraries and other types of information centers (Barcelo, Forte, & Sanders, 2000; Barton, 2005; Corcoran, Demaine, Picard, Dicaire, & Taylor, 2002; Lepouras & Vassilakis, 2005) modeling physical structures, to varying degrees of exactness, exist throughout LIS-related literature. Most focus on modeling new virtual environments designed around a generic physical library metaphor. A historically significant example is the Digital Rare Book System, which allowed the user to view an entire collection within the 3-D digital library space, as well as view scanned images of select rare books and other historic items preserved by the University of North Carolina Library System (Yumetech, 2003). Some researchers suggest that digital libraries utilizing the 3-D immersive GUI approach look engaging, but generally hinder information retrieval (Shneiderman & Plaisant, 2005).

More recent examples of platform-dependent digital library systems utilizing the 3-D immersive GUI design approach include the Appalachian State Educational Technology Zone (Bronack et al., 2006; n.a., 2006; Prestridge, Dunn, & Lang, 2006),

the Warner Library Virtual Bibliographic Instruction ChatWorld (D. T. Hawkins & Brynko, 2006; Puterbaugh, n.a.), and the Alliance Virtual Library (Infoisland.org, 2008; Talis Information Ltd, 2006) within Second Life (Linden Research, 2008). Each provides users with fully immersive game-like information spaces, with the means to conduct a variety of learning activities related to library educational efforts. Moreover, each example is part of a larger multi-user virtual environment (MUVE), a persistent networked digital space wherein multiple users engage and interact with one another. As such they provide their users with chat areas and audio communication, as well as development capabilities to create digital objects, environments, and customizable avatars (Bronack et al., 2006).

The Alliance Virtual Library within Second Life (Linden Research, 2008), an ongoing project co-sponsored by the Alliance Library System and the Online Programming for All Libraries initiative, is receiving considerable attention within the LIS community (Czarnecki & Gullett, 2007; Infoisland.org, 2008; Talis Information Ltd, 2006). Levine (2006) introduces Second Life to LIS practitioners and researchers, and discusses ways in which library services may be implemented within Second Life. Fetscherin and Latteman (2007) provide a synopsis of their research on user acceptance of Second Life, including discussion of user demographics as well as psychological determinants (F.D. Davis, 1989) like perceived ease-of-use. Haycock and Kemp (2008) discuss using Second Life at the San Jose State University School of Library and Information Science for course delivery and identify adoption as a potential area for future research. Students in the computer science department of the Swiss Federal Institute of Technology Zurich also employ a Second Life-based environment to

"visualize an automated library that uses Radio Frequency Identification (RFID) technology," (n.a., 2008b). For additional discussion on Second Life and libraries, see Erdman (2007), Grassian and Trueman (2007), D. Hawkins, Dempsey, Hane, Hoffman, and Kaser (2007), and Swanson (2007).

From a sociocognitive perspective, proponents of the physical library metaphor approach suggest the visual navigation features presented within the 3-D immersive GUI supply spatial context that when coupled with connection to the institution's Web presence provides a potent interface for the more visually inclined users. J. G. Jones and Bronack (2006) refer to this ability as *cognitive scaffolding*. J. G. Jones, Warren, and Robertson (2009) suggest that cognitive scaffolding stimulates accelerated communicative exchanges between users, ultimately resulting in the generation of high quality rapport (i.e., communicative trust). Similarly, Shneiderman and Plaisant (2005) state that this design approach, "may prove to be successful because of the increasingly rich social context based on spatial cognition – that is, users may come to appreciate the importance of the setting and value participants who choose to stand close to them," (p. 243). Consider that in physical reality, users employ various voluntary and involuntary body movements – facial expressions, hand signals, posture, and so on – to communicate. Digital games allow users to process audio dialogue, textual information, and avatar movements. Furthermore, the 3-D immersive GUI approach allows users to engage one another within an entirely neutral digital reality – an important benefit for users sensitive to their own abilities to integrate into the physical library environment (Eschedor Voelker, 2006; Peters & Bell, 2007). For additional perspectives on this design approach see Created Realities Group (2007), Croquet

Consortium (2007; Lombardi & McCahill, 2004), Karaseitanidis et al. (2006), and Snowdon, Churchill, and Frecon (2004).

Select Design Aspects of Digital Gaming

Literature describing designs adopting the second basic approach – incorporating select aspects of digital gaming – also exists. There are a variety of commercial applications, including information retrieval systems, file management systems, and desktops, that deliberate or not incorporate aspects of digital gaming, primarily three-dimensionality, in their user interface designs (3DNA, 2008; Heiss, 2004; Kaneva, 2008; KartOO Technologies, 2008a, 2008b; Microsoft, 2007; SpaceTime, 2008; Upper Bounds Interactive Inc., 2008; Vivaty, 2009). A notable contribution from the LIS community, Hearst and Karadi (1997) discuss the development of a user interface for information retrieval incorporating 3-D objects and structures. They report that for category-based searching the interface proved generally successful. It is noteworthy that Driver et al. (2008) predicts a major evolution in Web-based interfaces by 2015, from the current text-oriented and graphically interactive approach to 3-D immersive, interactive environments. Naone (2008) also reports about a 3-D immersive Web and presents several innovative approaches to expanding avatar use. Cockburn (2004) and G. Robertson et al. (1998) also discuss design elements related to digital games, outside of traditional game environments.

Digital Natives

Born post-1980, the so-called digital native (i.e., millennial, neomillennial, N-gen) knows only a world interlaced with digital technologies and services, and as the following literature suggests, is distinctive in both computing abilities and technology expectations. Sweeny (2005) states, “they [digital natives] make up the demographic tsunami that will permanently and irreversibly change the library and information landscape,” (p. 165). Research indicates younger users adopt some emerging technologies at faster rates than other user groups (Forrester Research, 2006; Pew Internet and American Life Project, 2009). They lead adoption among all consumers in areas like online media, mobile digital devices, social computing, and home networking, as well as play digital games more frequently than they watch TV. Abram and Luther (2004) use digital natives’ early adoption of instant messaging (IM) software to exemplify younger users’ propensity for innovativeness. Sikba and Barton (2006) also include innovativeness as a major characteristic of digital natives. However, Skiba and Barton warn, “Action and what the technology enables them [digital natives] to do is more important than the particular technology.”

Digital natives are accustomed to rapid visual stimuli, like one might encounter during the introduction for MTV News, as well as multitasking (i.e., parallel processing) via multiple digital devices simultaneously (Oblinger & Oblinger, 2005a). As a result researchers in cognitive neuroscience are exploring the possibility that such experiences are altering younger users neurobiological structures and process (Ritter, 2008). Dede (2002, 2005) and Gee (2003) propose digital natives maintain a unique learning style fixed in ubiquitous immersion of digital devices, content, and services.

Rise (2006) suggests that digital natives present an entirely new set of service expectations driven by their inherent attraction toward digital technologies.

Abram and Luther (2004) contend that digital natives differ from previous user groups in nine fundamental ways: indifference towards information format, nomadic digital interaction, propensity for multitasking, experiential learning strategies and styles, collaborative interaction, integrated content, principled values, increased need for adaptive technologies, and direct style of communication. Kennedy, Judd, Churchward, Gray, & Krause (2008) review their study in Australia of over 1,000 incoming undergraduates and suggest that although digital natives are more often than not technology literate their related expectations are quite diverse. Robbins (2007) contemplates the cultural underpinnings of the immigrant-native nomenclature, countering “there is more to these technology-adoption shifts than an age group growing up with access to computers.”

Let the Games Begin (2003), a report from the Pew Internet and American Life Project, focuses on college students use of digital gaming technologies, and the “impact of that use on their everyday life,” (p. 4). The report reveals that one out of five participants felt that networked, multiplayer digital games helped them develop real-world relationships, ultimately suggesting that for some users digital games are a social activity. Schmidt (2005) also explores the Pew Internet and American Life Project, addressing key points to make the case for designing library services around the needs of the youth population. A more recent Pew Internet and American Life Project (2008) report details the gaming behaviors and perceptions of digital natives as they relate to their civic activities, including civic commitment and participation.

Squire and Steinkuehler (2005) assert digital natives may expect game-like experiences throughout all digital interactions; therefore, the LIS community cannot afford to ignore the potential digital gaming presents both research and practice. Expanding upon Steinkuehler's (2005a) use of Oldenburg's (1999) *Third Place*, Hinton (2006) proposes digital natives define themselves within a so-called *game layer*, or in broader terms, a digital reality. He suggests the need to design systems both literally and metaphorically, based upon the fundamental observation of a digital game as a goal-driven system of human behavior. Reminiscent of the participatory nature of the Web 2.0 movement (O'Reilly, 2005), Hinton states that digital systems and services successfully designed within the game layer provide "emergent spaces where user activity and interaction create meaning and relevance."

McDonald and Thomas (2006) suggest there are disconnects between many libraries and digital natives' technology expectations, stating, "Finding the right way to achieve balance between traditional library values and the expectations and habits of coming generations will determine whether libraries remain relevant in the social, educational, and personal contexts of the Information Age." See Robinson (2008) for additional discussion of digital natives and academic library services. From an applied standpoint, the 2008 *Horizon Report* from the New Media Consortium and the EDUCAUSE Learning Initiative identifies and describes six emerging technological innovations and practices prospectively relevant to digital natives' learning strategies and styles. Van Eck (2007) suggests that while digital natives may learn differently from other user groups, that is insufficient justification for designing and developing high-end digital game-based learning systems, considering the extensive resources required.

Based on extensive longitudinal research, Yee (2005a, 2005b) investigates both the individual and group-oriented discourse motivations of MMORPG users, many of which fall within the digital native age bracket. For example, the mean age of participants in the 2004 iteration of Yee's research was 25.6 years old. MMORPGs are digital games concurrently shared and played across the Internet by millions of users worldwide; examples include Lineage, Everquest, and World of Warcraft. Addressing information behavior and sociocultural considerations, Adams (2005) discusses the development and preservation of user groups within the MMORPG City of Heroes. For more information on social aspects of digital gaming see Williams (2003, 2006).

S. Johnson (2005) examines various aspects of digital media in relation to emerging user populations, and presents a counter to digital gaming opponents who contend that such technologies' negatives outweigh any positive benefits they may offer users. S. Johnson believes that digital natives learn more 21st century skills from "cognitively-demanding leisure activities" such as digital games than more structured, formal learning environments dependent upon high-stakes testing and content-oriented curriculum (cited in Galarneau & Zibit, 2007). Furthermore, up until the late 1990s, research on digital gaming often focused on negative perceptions (Walsh, 2008) like violence (M. D. Griffiths, 2002) and addiction (Chang, 2003). Reflecting on such research, Squire (2003) suggests that none has established a direct, causal relationship between digital game use and violent behavior. For more information related to digital game use and negative perceptions see Anderson (2008), Herold (2005), G. Jones (2002) and Kutner and Olson (2008).

Pilot Study

A pilot study (see Appendix B) was conducted in the fall of 2006 and formed the foundation for this study. As such it also provides accuracy to this larger study. In the pilot study M. J. Robertson and Jones (2009) explored academic library users' perceptions of digital gaming, compared to other technology-based delivery methods, in two types of library instruction. The two types of library instruction were (a) formal information literacy instruction and (b) informal library orientation related to a physical library facility.

The study began with a paper-based survey administered to 42 participants. Upon completion of the data collection process, three separate scaling methods were applied to the data set. Analysis showed an overall preference for the 2-D webpage approach, as well as notable enthusiasm for the 3-D immersive GUI in both types of library instruction. Analysis also showed an overall lack of preference toward the audio-only presentation and mediocre preference for the audiovisual presentation.

In the pilot study, the 2-D webpage received the highest preference ranking across both questions. Furthermore, the significant lack of interest in audio-only is a bit startling considering the enthusiasm by many LIS practitioners for podcasting in an educational capacity. In addition, the study showed noteworthy preference for application of a 3-D immersive GUI in library instruction, particularly library orientation involving the communication of spatial information concerning a physical facility. Also, considering the results of all three analytic methods for information literacy instruction, the same chance may exist for the 3-D immersive GUI.

Methodological Background

Mixed methods research, the collection of both quantitative (i.e., numeric) and qualitative (i.e., text or image) data in a single study, is relatively young in the social sciences (Fidel, 2008). However a steadily accumulating body of literature is available for mixed methods LIS researchers. Tashakkori and Teddlie (1998) review the evolution of the approach, starting with the multitrait-multimethod matrix of Campbell and Fiske (1959). Jick (1979) addresses triangulating multiple forms of data, while Creswell (2003) outlines motivations, rationales, and procedures in mixed methods research.

LIS literature maintains various examples of mixed methods research. McKechnie, Baker, Greenwood, & Julien (2002) report on a study wherein 15% of the 180 LIS research articles analyzed show use of both qualitative and quantitative methods. Fidel (2008) provides a more recent review, addressing the state of mixed methods LIS research, types of mixing, triangulation, and interpretation. Fidel also points out major discrepancies in key mixed methods terms, both inside and outside the LIS community. Sonnenwald and Iivonen (1999) offer a framework for selecting multiple methods in human information behavior research.

Using mixed methods, Kwon (2008) investigates the relationships between critical thinking styles and library anxiety during the library use processes of 137 undergraduates. Kwon suggests the findings have implications related to affective information behavior and information literacy. Bishop et al. (2000) also discuss mixed methods research related to digital library use, while P. Williams and Gunter (2006) mix transaction log analysis with qualitative analyses to explore use of a health information

system. The following two subsections provide background information related to the survey instrument used in this research.

Data Collection

As previously discussed, perception is the operationalized group of nested cognitive processes – attention, consciousness, and memory – from which users make sense of their external worlds (Sternberg, 2006). The survey design used in this research is firmly rooted in psychophysics, that is, the measuring of users' perceptions of physical properties of environmental stimuli (Stevens, 1975). Perceptual data contribute to research on similarity and dissimilarity of stimuli as well as the estimation of perceptual magnitude between stimuli (Stevens, 1956; Tversky, 1977). Today individuals in both academic and practice-based contexts utilize such methods to simplify data sets into underlying psychological constructs representing participants' perceptions of physical objects and/or alternative representations of physical objects. Eisenberg (1986), Rorissa (2005), and Rorvig (1985) also utilize psychophysical methods in LIS research.

Presenting the sensory continuum concept, Thurstone (1927) suggests that preference choices by a participant may vary under indistinguishable conditions. Thus when quantitatively evaluating object sets on an object by object basis with subjective criteria (e.g., bitterness, loudness, sweetness, etc.), imprecise results frequently occur. Pairwise (paired) comparisons allow researchers to avoid this issue (Dunn-Rankin, Knezek, Wallace, & Zhang, 2004). The survey instrument in this research follows a generally accepted format for acquiring data via responses to pairwise comparisons, a

measurement method utilized in experimental cognitive psychology, communication studies, zoology, public health, human-computer interaction and various other disciplines. Grasshoff, Grossmann, Holling, and Schwabe (2003) write, “In a paired comparison task objects are presented in pairs and the respondent has to trade off one alternative against the other,” (p. 373). In other words, the pairwise comparison method requires a participant to vote on objects presented in pairs relative to a given question or scenario. By counting the votes for each pair, the researcher is able to derive a preference ranking of the objects relative to the given question or scenario.

Pairwise comparisons are a common voting method, as in the soft drink taste test for example. In such a test, the participant is first presented with two cups, one marked A the other B, with each containing a particular soft drink, the specific brand of which he or she does not know. The administrator informs the participant to take a sip from each of the two cups. Next, the administrator asks the participant, “Which soft drink do you prefer, A or B?” The participant then indicates to the administrator or records in some fashion his or her preference. In short, pairwise comparisons solicit votes of preference by participants. The soft drink taste test example presents participants with only one pairwise comparison, whereas the survey instrument used in this research presents participants with a series or group of comparisons for the respective questions.

While mixed methods generally suggest the collection of both quantitative and qualitative data (Creswell, 2003), variations to this characteristic are possible. As is the case with this research, both unobtrusive observations and semi-structured interviews directly reflect a qualitative approach, while the survey collects ordinal type data. Ordinal type data is assumption free and therefore does not allow for generalizations

(Vaughan, 2005), however it is numeric and thus quantitative (Fidel, 2008). So in a sense while numeric data is collected via the survey, the major results that data helped to generate ultimately take on a more qualitative tone. Fidel (1993) suggests that qualitative research is best for exploring user behavior since it "aims at understanding people from their own point of view" (p. 222).

Moreover, compared to quantitative wherein statistical significance and generalizability are major indicators of credibility and significance of research, Creswell (2003) suggests generalizability plays "a minor role in qualitative inquiry" (p. 195). Creswell's statement aligns with both the social constructivist and pragmatic approaches to knowledge claims discussed in Chapter 1. Rossman and Rallis (1998) also write that qualitative research, such as unobtrusive observations, occur in natural settings, like homes, offices, or classrooms. Such settings allow the researcher to make information rich observations detailing participants' real world experiences. Additionally, this research reflects the general qualitative characteristic of being both interactive and reflexive, as evidenced by the semi-structured interviews discussed later.

Data Analysis

Rank-sum scaling is a common method of tallying participants' votes of preference given to scalable objects (e.g., technology-based delivery methods) when those objects are arranged in all possible pairs, allowing votes of preference to be mapped on a linear scale of zero to 100 (Dunn-Rankin et al., 2004). In short, rank-sum scaling is a reworking of two-way variance analysis by ranks, and as a result, is nonparametric (i.e., assumption or distribution free) because the data is two-way.

Like rank-sum scaling, circular triad analysis tallies votes of preference, yet goes a step further by identifying any inconsistencies among participant responses. Circular triads form whenever a participant selects intransitive (i.e., inconsistent) pairwise choices. For example, a participant selects A > B, B > C, and C > A. The previous example is a circular triad, indicating a nonlinear ordering in the preference pattern. In short, circular triad analysis aids in confirming the rank-sum scaling results as well as evaluating the overall quality of the data collection instrument for purposes of current and future research by providing an intransitivity index of complete paired comparisons.

Factor analysis is, “A statistical method for separating a construct… into a number of hypothetical factors or abilities that… form the basis of individual differences in test performance,” (Sternberg, 2006, p. 533). Based upon the matrix theorem of Eckhart and Young (1936), multidimensional preference mapping, or geometric factor analysis, is applied to the data set to situate the objects and participants in the same analytic, psychological space. The primary motivation for using this method is to provide a visualization of specific subgroups of participants with specific objects. The various distances between subgroups and objects within the visual space represent participants’ perceptions of (dis)similarity between points.

From a methodological perspective, it is noteworthy that the scaling methods utilized in this research allow one to quantify user preferences toward an object, concept, and so on. For example, Participant A *likes* audiovisual *more* than audio-only and paper-based media. As previously discussed, such data are of the ordinal type. Ordinal data require nonparametric analysis; however, parametric methods are traditionally preferred in LIS research (Vaughan, 2005). Parametric methods allow one

to generalize findings to a larger population, whereas nonparametric methods are more or less assumption free and therefore do not allow for generalizations.

Theoretical Background

Introduced in Chapter 1, this research uses diffusion of innovations (DOI) (Rogers, 2003) as a theoretical framework. The remainder of this section includes an overview of DOI, as well as discussion of perceived attributes, the innovation-development process, and adopter categories. This section ends by reviewing LIS-based DOI literature.

Diffusion of Innovations

Rogers (2003) writes, “Getting a new idea adopted, even when it has obvious advantages, is difficult,” (p. 1). DOI posits that users adopt innovations (e.g., emerging technologies, ideas, roles, etc.) at different rates over periods of time, and offers a broad conceptual framework for exploring technology adoption (Dillon & Morris, 1996). Rogers (2003) states *diffusion* is the process “by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) over *time* (4) among the members of a *social system*,” (p. 11). Brown (EDUCAUSE Learning Initiative, 2008b) emphasizes innovation is synonymous with change and contends it is incremental, disruptive, small or large scale, and based upon either a current or emerging paradigm.

Dillon and Morris (1996) state technology acceptance “revolves around the issue of whether IT [Information Technology] is actually accepted by its intended users,” (p. 3). For example, Hollifield and Donnermeyer (2003) use DOI to explore factors

influencing early IT adoption in rural communities, while B. Chen and Raible (2008) address the adoption of wikis in an instructional context. Considering the potential complexity of measuring and exploring human interactions with IT, published acceptance research is extensive in both size and scope (F.D. Davis, 1989; Fred D. Davis, Bagozzi, & Warshaw, 1989; Fishbein & Ajzen, 1975; Mathieson, 1991; Mathieson, Peacock, & Chin, 2001; Venkatesh, Morris, Davis, & Davis, 2003). A comprehensive review of such research is beyond the needs of this dissertation.

From the onset it is necessary to reflect upon the concept of innovativeness. Innovativeness is the most widely understood concept in diffusion research (Rogers, 2003). Rogers defines innovativeness as, “the degree to which an individual (or other unit of adoption) is relatively earlier in adopting new ideas than other members of a system,” (p. 267). Innovativeness reflects behavioral change in a user, and is the “bottom-line behavior in the diffusion process,” (p. 268). So-called digital natives maintain characteristics (e.g., early adoption of some emerging technologies) reflecting a higher propensity for innovativeness than other users (e.g., digital immigrants, like their parents and instructors) (Skiba & Barton, 2006).

Before moving on to select concepts it is only fair to mention the four major historical criticisms of DOI. First is the pro-innovation bias, that is, the feeling by a researcher that an innovation should be rapidly diffused and adopted by all members of a social system. Second is the individual-blame bias or the tendency by a researcher to place responsibility on an individual rather than the system wherein that individual is a member. Third is the problem of recall, that is, participants’ self-reporting on the amount of time taken for innovation adoption. Finally is the issue of equality. Rogers (2003)

states, “socioeconomic gaps among the members of a social system are often widened as a result of the spread of new ideas,” (p. 135).

Considering these criticisms, Clarke (2009) argues that DOI best serves as a means for description. This suggestion accurately reflects the application of DOI in this research. Clarke also proposes that DOI lacks in explanatory power, in predicting outcomes, and may in guiding decision makers on how to accelerate adoption rates, primarily because of its historical and cultural development paths. Rogers (2003) aligns somewhat with Clarke suggesting that criticisms such as the pro-innovation bias may be overcome by exploring the diffusion process either prospectively or during its lifecycle, and not retrospectively as is historically common. By doing so researchers are more likely to investigate unsuccessful cases of innovation diffusion, an area that Rogers asserts is sorely lacking in the diffusion literature.

Four Components of Diffusion

Rogers (2003) writes that the four core elements to diffusion research are (a) the innovation, (b) the communication channel, (c) time, and (d) a social system. Rogers defines innovation as, “an idea, practice, or object that is perceived as new by an individual or other unit of adoption,” (p. 12). Most diffusion research focuses on technological innovations; however, an innovation can be a single idea or even an ideological movement (e.g., diffusion of Jeffersonian democracy in the Middle East post 2001). In this research the digital game for library instruction idea is the primary innovation of study.

Rogers (2003) states, “A communication channel is the means by which messages get from one individual to another,” (p. 18). In this research communication channels are not formally measured or observed, however it is possible to consider both the survey instrument and semi-structured interviews, discussed in Chapter 3, as communication channels (albeit unconventional). Communication channels are important because most users do not evaluate an innovation based upon rigorously tested scientific research, but through the subjective messages of their peers.

As for the third element, Rogers (2003) suggests time is frequently overlooked in the behavioral and social sciences; as such, it benefits diffusion research. Time is not formally measured in this research because there is no longitudinal checking and rechecking of participants’ preference votes. However the concept of time is relevant to research indicating that digital natives adopt some technological innovations faster than users over the age of 30 (Forrester Research, 2006; Pew Internet and American Life Project, 2009), thus relating to adopter categories and rate of adoption. Rate of adoption is the relative speed that a social system (i.e., user group) adopts an innovation.

The social system is a “set of interrelated units that are engaged in joint problem solving to accomplish a common goal,” (Rogers, 2003, p. 23). The sample in this research represents a social system on the macro level, while the individual library instruction sessions represent micro level systems. Social systems contain norms, that is, established behavioral patterns followed by system members. The degree to which an innovation adheres to or inversely challenges social norms, ultimately affects its level of adoption. Chapter 5 addresses this final point in greater detail.

The Innovation-Development Process

The innovation-development process is important to this discussion. The innovation-development period best describes where this research fits into the broader diffusion process. Rogers (2003) describes the innovation-development process as "all the decisions, activities, and their impacts that occur from recognition of a need or a problem, through research, development, and commercialization of an innovation, through diffusion and adoption of the innovation by users, to its consequences," (p. 137). This research incorporates aspects of the first two steps in the process: recognizing a problem or need, and basic and applied research.

Recognizing a problem or need can occur because of many reasons. It may take place because someone identifies an emerging or future problem or issue. Or the stimulus to identify a problem or need may be an individual or system's social agenda. In the case of this research I identified a lack of discussion on the topic within the LIS community prompting a desire for incrementally more complex inquiries from the pilot study to this research. The second step in the innovation-development process is that of basic and/or applied research. Related to problem identification, Rogers writes that "Innovation-development occurs… when information is exchanged about needs and wants and possible technological solutions to them," (p. 144).

Rogers' (2003) discussion of these two steps can be a bit convoluted because the concept of R&D crosses over between the two steps. The second step takes new direction when Rogers discusses the role of the lead user in R&D, stating that "Sometimes the initial impetus for an innovation comes from a lead user," (p. 144). Lead users are individuals with needs for innovations that are generally ahead of the general

public and as a result often develop their own prototypes. Lead users often convince major companies to produce and market their prototypes. Examples of lead users in the digital gaming in library instruction area discussed previously in this chapter (see Library Instruction and Systems Design sections). It is noteworthy that an important concept related to the lead user is reinvention. Reinvention is “the degree to which an innovation is changed or modified by a [lead] user in the process of adoption and implementation,” (p. 17). Additional discussions related to lead users and reinvention included in the DOI in Library and Information Science subsection, as well as Chapter 5.

Perceived Attributes

Perceived attributes are variables that help to determine users’ rate of innovation adoption (Wonglimpiyarat & Yuberk, 2005). Rogers (2003) states that, “characteristics of innovations, as perceived by individuals, help to explain their different rates of adoption,” (p. 15). He continues, “The individual’s perceptions of the attributes of an innovation, not the attributes as classified objectively by experts or change agents, affect its rate of adoption,” (p. 223). The five general perceived attributes or characteristics of innovations are (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability. Relative advantage and compatibility are the most important factors in determining the rate of innovation diffusion.

Relative advantage is “the degree to which an innovation is perceived as better than the idea it supersedes,” (Rogers, 2003, p. 15). Rogers argues that perceived advantage trumps objective advantage (e.g., 3-D immersive GUI may offer users more accurate representation of physical library facility than paper-based document), and that

advantages may be measured economically, socially, by level of convenience and/or satisfaction with use. Compatibility is “the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters,” (p. 15). Values, experiences, and needs within a social system dictate whether or not an innovation is deemed compatible and thus ultimately help to influence the rate of diffusion. This assertion draws directly from the previous discussion on norms in a social system.

Expanding upon Rogers’ (2003) perceived attributes, Moore and Benbasat (1991) develop an evaluative research instrument to explore users’ perceptions of technology innovations. With regard to use, they identify the most important perceived attributes of an innovation as: voluntariness of use, degree to which use enhances one’s perception of self within a social system, relative advantage, ease of use, compatibility, trialability, demonstrability, and visibility.

Adopter Categories

Innovativeness is the decisive factor for adopter categorization. Adopter categories (i.e., who adopts innovations) are “concepts based on observations of reality that are designed to make comparisons possible,” (Rogers, 2003, p. 282). The five adopter categories are (a) innovator, (b) early adopter, (c) early majority, (d) late majority, and (e) laggard. These categories range in innovativeness from most innovative at innovator to least innovative at laggard. Adopter categorization is not a goal of this research; however, adopter categories do influence methodological and interpretative aspects discussed in subsequent chapters.

Characteristics of adopter categories are generally described as falling under either socioeconomic, personality values, or communication behavior. In short, age does not play a major role in defining earlier versus later adopters in a social system. However, earlier adopters are more likely to have more formal education, higher social status, and greater degrees of upward social mobility than later adopters. Thus earlier adopters frequently have greater socioeconomic standing than do later adopters.

With regard to personality values, earlier adopters are less dogmatic, maintain a greater ability to deal with abstractions and change, and generally have favorable attitudes towards science and technology. Earlier adopters also have a greater ability to cope with risk and manage uncertainty. As for communication behavior, earlier adopters have more highly interconnected communication channels, greater exposure to mass media, actively engage in information seeking more so than later adopters, and generally maintain greater knowledge of innovations. Some of these generalizations inform the development of interview questions (see Chapter 3).

Diffusion of Innovations in Library and Information Science

Innovation is an important topic of discussion within the LIS community. Neelameghan (2008) states that "library and information professionals must research and innovate to continue to be considered useful information service providers to the community of information seekers and users," (p. 255). LIS literature referencing DOI is significant in size and scope. The remainder of this chapter provides a general overview of LIS-based DOI resources. This section does not however address the growing LIS

research area of computerization movements that frequently includes DOI discussion. For information related to computerization movements see Elliott and Kraemer (2008).

In November 1986 (J. Griffiths) the U.S. Department of Education released a historically significant report entitled, *Diffusion of Innovations in Library and Information Science*. The report explores four aspects of innovation diffusion in library services, including "when and why innovation occurs in the library and information field," as well as "what options and recommendations are needed to develop a plan for diffusion networks for library innovation," (p. 1). The report contains many findings and recommendations relevant to current discussion of innovation in libraries. For example, it identifies historical, organizational, social/psychological, and political factors as having potential to inhibit adoption of an innovation.

A decade later Dillon and Morris (1996) provide the LIS community in-depth discussion of DOI in their *Annual Review of Information Science and Technology* chapter entitled "User Acceptance of Information Technology: Theories and Models." Dillon and Morris suggest that the "principal theoretical perspective on technology acceptance is innovation diffusion theory, which has been applied at both individual… and organizational… levels of analysis," (p. 6). Dillon and Morris analyze various literature related to IT acceptance and review at length adopter categories, as well as other diffusion concepts such as perceived attributes.

Wainwright and Waring (2007) put forward a modified DOI framework for exploring IT innovations in healthcare settings. Similarly, Rogers and Scott (1997) use DOI to examine the effectiveness of outreach efforts by the National Network of Libraries of Medicine on Pacific Northwest Native American users, while Minishi-

Majanja and Kiplang'at (2005) make use of the descriptive power of DOI in a meta-analysis of two studies of IT adoption within the LIS field on the African continent. Minishi-Majanja and Kiplang'at show great detail in reviewing major DOI topics, from conceptual to procedural. Likewise, with an eye on the U.S. archival community Yakel and Kim (2005) use DOI to describe the diffusion and adoption of Encoded Archival Description (EAD). They describe overall EAD adoption as slow and identify compatibility as a critical factor inhibiting its acceptance. Bishop et al. (2000) review research related to the innovation-development process of a digital library at the University of Illinois, and address the role of infrastructure in systems design.

White (2001) focuses on the adoption of digital reference services in academic libraries. White categorizes academic libraries by way of adopter types and addresses additional factors such as change agents and reinvention. Starkweather and Wallin (1999) discuss qualitative research on faculty attitudes toward library technologies implemented in an academic library setting. Starkweather and Wallin use adopter categories to probe faculty technology experiences, how faculty adapt to technological changes, and faculty perceptions of the increasingly digital academic library. Pungitore (1995) explores how top-down innovations diffuse among public librarians, while Abram (2007) discusses possible barriers to innovation in libraries and provides LIS practitioners several suggestions for managing diffusion in their institutions. For additional discussion see Almobarraz (2007), Buddy (2006), Jeyaraj and Sabherwal (2008), Knuth (1997), Nov and Ye (2008), Owens (2002), Rijnsoever and Castaldi (2009), Rutherford (2008), Sun and Zhang (2008), and Wang and Swanson (2007).

Summary

This chapter first introduced literature derived from the LIS community relevant to digital gaming in undergraduate library instruction. It followed with an overview of cognitive aspects to digital game use, as well as a summary of LIS-related digital game literature on systems design. The chapter then introduced writings on the so-called digital native, followed by an overview of the pilot study, the basis of this research. Methodological background literature ensued, including an overview of DOI.

CHAPTER 3

METHODOLOGY

This chapter first provides background information on the methodology utilized in this research. It follows with an overview of the electronic survey instrument. Next the chapter addresses the unobtrusive observation and semi-structured interview methods, concluding with a short discussion concerning research validity.

Background

In response to the current need for scholarly research on digital gaming from within the library and information science (LIS) community, I explored user preferences related to five technology-based methods currently utilized by academic libraries to deliver two forms of library instruction. Face-to-face was not included because it is not a technology-based delivery method. The five technology-based delivery methods (i.e., scalable objects, psychological stimuli) were:

- Paper-based document (Object 1, shown in Appendix A)
- 2-D webpage (Object 2, shown in Appendix A)
- 3-D immersive GUI (Object 3, shown in Appendix A)
- Audio-only presentation (Object 4, shown in Appendix A)
- Audiovisual presentation (Object 5, shown in Appendix A)

This prospective research employed concurrent mixed methods, specifically nonparametric scaling, unobtrusive observations, and semi-structured interviews. These methods allowed for the triangulation of research efforts, ultimately helping to richly describe a multi-dimensional picture resulting from multiple forms of data. The University of North Texas (UNT) Institutional Review Board (IRB) approved this research for a one year period (Application Number 08-162) on May 14, 2008 (see Appendix D). Primary data collection occurred via a pilot-tested (M. J. Robertson & Jones, 2009) (see Appendix B), electronic survey instrument administered to 343 undergraduate library users at UNT throughout the fall 2008 semester. The sample size ensures that for research purposes, the five delivery methods can be differentiated and are well above the threshold for object scalability (Dunn-Rankin, Knezek, Wallace, & Zhang, 2004).

Administration of the survey instrument occurred during the first 10 minutes of prearranged face-to-face library instruction sessions for select undergraduate courses (e.g., ENGL 1320: College Writing II). UNT Libraries staff conducted the sessions at the Willis Library Learning Center throughout the fall 2008 semester. Unobtrusive observation of the survey participants also occurred throughout 11 survey sessions. UNT Libraries Research and Instructional Services librarian Annie Downey was my primary contact for the purposes of this research. She is responsible for developing, coordinating, and conducting the aforementioned library instruction sessions, and allowed me to administer the survey instrument, as well as conduct unobtrusive observations throughout the entirety of each session. In addition to the survey and observations, eight semi-structured follow-up interviews were conducted with subjects

who agreed to participate. The interview questions were based upon emergent elements from the survey and observational findings, as well as Rogers' (2003) adopter categories.

It is notable that I overestimated the participant sample during my proposal. According to Annie Downey (personal communication, March 25, 2009) the proposed sample size (i.e., 1,400) was accurate; however, it was ultimately unobtainable. The course with the historically largest number of pre-arranged fall sessions (i.e., COMM 1010) underwent considerable overhaul during summer 2008 migrating to an online format. The department was not notified until after the semester began, by students of the course, that their instructor no longer required them to take part in library instruction sessions. Instead students were given the option of taking part in the sessions for extra credit, which in turn led to small participant numbers.

Survey Instrument

The online format of the survey instrument (see Appendix A) was practical and efficient for the research setting, that is, the UNT Willis Library Learning Center containing over 20 networked, personal computers. Upon arrival at the survey session, the student encountered a sign projected on the large overhead screen at the front of the room soliciting their participation. The instructional librarian was responsible for placing the sign on the overhead screen prior to the session. The participants would logon to the survey via the Web-based URL provided on the aforementioned sign. The survey instrument could only be accessed by students with a current and valid university electronic student ID. This assured that only UNT students could participate in

the survey. Collection of the student ID also prevented any participants from submitting more than one set of survey responses. After login, participants had to agree to an informed consent notice (see Appendix A). Participants were subsequently redirected to a series of webpages containing instructions and steps necessary to complete the survey process (see Appendix A). These webpages contained contemporary visual examples of the scalable objects in order to guide participants should confusion related to the five technology-based delivery methods arise. After the participant finished reviewing these webpages he or she took the survey consisting of 13 questions divided into two sections (see Appendix A).

The electronic component to the survey was helpful because of the quick turnaround it provided, as well as the ability to automate the data archival process. Such advantages aside, certain general limitations to this method must be acknowledged. For example, the data from closed survey questions can be superficial, while there is no opportunity for the participant to expand upon unclear responses (Osborne & Nakamura, 2000). In this research, both limitations were addressed by way of triangulation with semi-structured interview and unobtrusive observational data. Interviewees were asked about the ease of use of the survey and provided the opportunity to ask questions or have aspects of the survey clarified by the interviewer.

Section I of the survey presented 11 questions soliciting descriptive information such as age, gender, and number of hours per week spent studying and playing digital games. Section I also queried participants on their use of mobile digital devices and membership in social networking sites. Utilizing the same list of scalable objects (i.e., five technology-based delivery methods), Section II contained two questions including

10 pairwise comparisons each. The first question (Q1) in Section II asked, “Which method would you rather use for acquiring information on the physical layout of the library?” The second question (Q2) asked, “Which method would you rather use for receiving information literacy instruction?”

Unobtrusive Observations

Because the pre-arranged face-to-face library instruction sessions contained largely younger users engaged in library computing activities, the sessions were deemed in and of themselves sufficiently interesting for study. As a result, unobtrusive observations provided an additional data collection method, offering firsthand examination of the participants. Unobtrusive observations occur when the participants do not realize they are being observed, as was the case during the face-to-face library instruction sessions. During unobtrusive observations the researcher takes field notes on the “behavior and activities of individuals at the research site,” (Creswell, 2003, p. 185).

Unobtrusive observations occurred throughout the entirety of select library instruction sessions, wherein administration of the survey instrument occurred during the first 10 minutes. Eleven of these library instruction sessions resulted in unobtrusive observational data. Library instruction sessions lasted approximately 45 minutes, and included aspects of library orientation, bibliographic instruction, and information literacy instruction. Additionally, each session was taught by an instructional librarian or librarians from UNT Libraries Research and Instructional Services Department, with content individualized according to the needs of the specific course.

Field notes followed a standard observational protocol for recording information (Creswell, 2003). This protocol starts with a sheet of paper divided into two columns. The top of the sheet lists the time and date, as well as course name and number. The course name and number reflect the course pre-assigned to the specific library instruction session. The left column is labeled Descriptive Notes and portrays aspects of the participants' behavior and research setting. The right column is labeled Reflective Notes, and includes personal thoughts.

Semi-Structured Interviews

Semi-structured follow-up interviews of eight participants occurred throughout the fall 2008 semester. Forming a purposeful sample of potentially information rich cases, participants self-selected via the survey instrument to be contacted for an interview. Once interviewees were contacted via email, time and interview medium (i.e., telephone or email) was determined and confirmed. While this method provides the interviewee an opportunity to share background information not obtainable via the survey or unobtrusive observations, it does maintain various limitations.

Interview data represents the interviewees' perceptions (i.e., views and/or opinions) articulated unequally across participants (Creswell, 2003). Furthermore the interviewer's presence may factor into or bias participant responses, although Shuy (2002) suggests that interviewer presence is less a factor in telephone and email formats than in the face-to-face format. Shuy also implies that while often more cost effective than face-to-face, telephone and email interviews may result in less thoughtful responses. He states, "In face-to-face interaction there are many visual signs to

encourage respondents to elaborate, clarify, or amend what they say," (p. 543). Ultimately the decision to conduct interviews via telephone and/or email was a result of careful consideration, relative to the overall research strategy and purpose.

Guided by ten broad questions or topics derived from the survey and observations, as well as characteristics of Rogers' (2003) adopter categories (e.g., see *frequently* questions listed below), the semi-structured interviews allowed for informal, two-way discussion between the interviewer and participant. Relationships between interviewee responses, identified by the interviewer during the session, also informed the development of questions not prepared in advance. Semi-structured interview questions used in this research include the following examples:

- What does information literacy mean to you?
- How do you feel about the role and relevance of the library in your education?
- Do you think using a video game to learn about the library is innovative?
- How *frequently* do you read the news?
- How *frequently* do you travel?

Interview sessions occurred via telephone and/or email, with telephone being the preferred medium since it better allows for informal, two-way discussion. Telephone interviews recorded via a digital audio recording device that stores the verbal exchanges as MPEG-1 Audio Layer 3 (MP3) files.

Once all interview sessions were completed analysis of the resulting data set occurred, with a focus on describing, relating, and comparing the communication content. Analysis began with organizing, preparing, and reading the interview data, followed by detailed analysis to identify and describe recurrent themes or statements. Recurrent items across multiple interviews were synthesized and interpreted, with those deemed particularly noteworthy highlighted in following chapters.

Validity

When revealing scholarly research, validity must be established for the reader to determine the findings' credibility or authenticity. Moreover, validity procedures in mixed methods research should address all phases of the study (Creswell, 2003). As such I utilized a strategy of triangulation, in both data collection and analysis, as a means for establishing overall research validity.

In the case of data collection I employed three distinct methods: pilot-tested online survey (see Chapter 2, Pilot Study section), unobtrusive observations, and semi-structured interviews. Employing all three methods negated biases associated with one method by way of biases associated with another method.

As for data analysis, the use of three distinct approaches to address the survey data allowed for the desirable triangulation of efforts. Detailed analysis of the survey-based data set included three nonparametric scaling methods: 1) rank-sum scaling of the objects; 2) circular triad analysis to identify inconsistencies; and 3) multidimensional preference mapping to graphically superimpose the affinity of specific participants with specific objects.

Summary

This chapter detailed the mixed methodology used in this study on digital gaming in undergraduate library instruction. Study participants were derived from the overall UNT undergraduate population. Data collection occurred via a pilot-tested survey (see Chapter 2, Pilot Study section) utilizing pairwise comparisons to illicit participant responses. Unobtrusive observations were conducted in 11 survey sessions. Eight semi-structured interviews also occurred. The chapter closed by looking at select items related to research validity.

CHAPTER 4

DATA ANALYSIS

First this chapter presents an overview of demographic findings. It then addresses the data analysis related to the survey findings. Items related to analysis of the unobtrusive observations and the semi-structured interviews follow. This chapter concludes by responding to the research question and sub-questions.

Demographics

The overall University of North Texas (UNT) (2009) undergraduate student population during the fall 2008 semester was 27,779, with 54.45% (n=15,127) female and 45.55% (n=12,652) male. The sample size for this research was 343 participants, well above the threshold for object scalability (Dunn-Rankin et al., 2004). Ultimately the number of participants was lowered to 312 once initial analyses of the survey data identified 31 of the 343 sample as incomplete surveys (n=28), extreme outliers (n=1), or graduate students (n=2). To be an extreme outlier, a participant's survey responses had to include five or more circular triads on a Section II question (see Circular Triads section).

Of the 312 participants 44% (n=137) were male while 56% (n=175) were female. As Figure 1 indicates, 50% (n=156) of the 312 participants were 18 to 19 years old, while 49% (n=151) were in their twenties. Therefore 99% of participants fall within the so-called digital native age bracket, born post-1980. By comparison, the average age of undergraduates at the university during the same time period was 22.4 years (University

of North Texas, 2009). After consulting with committee members, questions regarding race or ethnicity were not included in the survey.

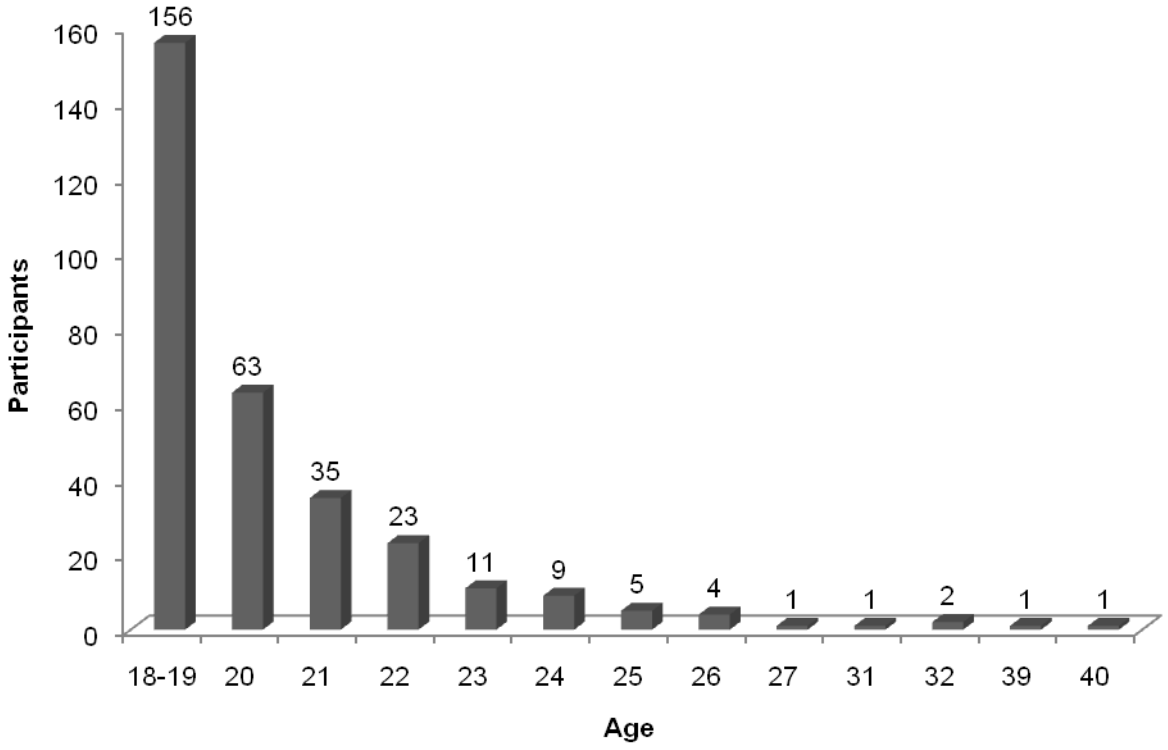


Figure 1. Participant age.

Participants were surveyed on the number of hours they study per week, with 58% (n=182) at seven or less hours and 32% (n=101) at eight to 11 hours. Participants were also surveyed on the number of mobile digital devices they use, with 67% (n=209) at one to two devices and 30% at three to four devices. As for the number of social networking sites participants reported membership in, 79% (n=245) listed one to two and 14% (n=42) listed three to four. Fifty-five percent (n=172) reported using assistive technology for instructional purposes.

Participants were also surveyed in three digital game-related areas. First they were surveyed on the number of hours per week they spend engaged in digital gaming (see Table 1). Forty-five percent (n=140) selected zero hours per week, with 18% (n=56) listing one hour per week and 17% (n=54) listing two to three hours per week. Interestingly there is a trend between the number of hours per week engaged in digital gaming and gender. For example, 7% (n=22) spend eight to 15 hours per week gaming with 16 of the 22 participants being male, while 2% (n=5) at 16-31 hours and 1% (n=3) at 32 plus hours contain only male participants. Chapter 5 also addresses trends derived from descriptive analysis.

Table 1

Hours per Week Digital Gaming

Hours per Week	**Participants**	**Percentage**
None	140	45%
1 Hour	56	18%
2-3 Hours	54	17%
4-7 Hours	32	10%
8-15 Hours	22	7%
16-31 Hours	5	2%
32 or More Hours	3	1%

Additionally, participants were surveyed on the number of digital games they currently play, with 42% (n=130) listing one to two and 36% (n=111) listing zero or none. Of the 111 participants listing zero or none, 103 also reported zero hours per week engaged in digital gaming. Finally, participants were surveyed on when in their lives they first played a digital game. Elementary school received the highest tally at 78% (n=243), followed by junior high or high school at 13% (n=41). Five percent (n=14) responded they have never played any digital game.

Pairwise Comparisons

Detailed analysis of Section II of the survey instrument included three nonparametric scaling methods: 1) rank-sum scaling of the objects; 2) circular triad analysis to identify inconsistencies; and 3) multidimensional preference mapping to graphically superimpose the affinity of specific participants with specific objects. Ultimately, applying these three related yet distinct methods allowed for the desirable triangulation of analytic efforts.

Rank-Sum Scaling

Analysis of Q1 (Library Layout) indicated that audiovisual (Object 5) and 2-D webpage (Object 2) grouped together somewhat closely, with the remaining three objects spread out across the unidimensional scale (see Figure 2). As Table 2 shows, rank totals across the 312 participants' choices resulted in 628 for audio-only (Object 4), 840 for paper-based (Object 1), 951 for 3-D immersive GUI (Object 3), 1,088 for 2-D webpage (Object 2), and 1,173 for audiovisual (Object 5). Table 3 shows that rank-sum

differences among the five objects range from 85 (the difference between Objects 2 and 5) to 545 (the difference between Objects 4 and 5). All of the rank-sum differences are beyond the critical value of 33 to reach significance at the $p < .001$ level. As shown in Table 2, rank totals were converted to scale scores on a zero to 100 scale and are graphically displayed in Figure 2.

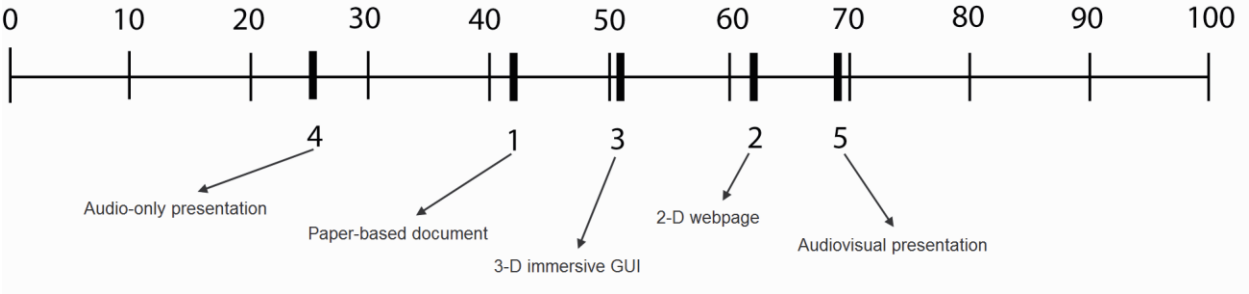


Figure 2. Unidimensional scale for Q1.

Table 2

Rank Totals and Scale Scores for Q1

Object	Rank Total	Scale Score
Min	312	0
1	840	42
2	1088	62
3	951	51
4	628	25
5	1173	69
Max	1560	100

Table 3

Rank-Sum Differences for Q1

	5	**2**	**3**	**1**	**4**
5	0				
2	85	0			
3	222	137	0		
1	333	248	111	0	
4	545	460	323	212	0

Analysis of Q2 (Information Literacy) showed that audiovisual (Object 5) and 2-D webpage (Object 2) grouped closely together at first and second places respectively, with 3-D immersive GUI (Object 3) relegated to fourth place (see Figure 3). Table 4 indicates that rank totals across the 312 participants' responses resulted in 697 for audio-only (Object 4), 861 for 3-D immersive GUI (Object 3), 944 for paper-based (Object 1), 1,067 for 2-D webpage (Object 2), and 1,111 for audiovisual (Object 5). Table 5 shows that rank-sum differences among the five objects range from 44 (the difference between Objects 2 and 5) to 414 (the difference between Objects 4 and 5). All of the rank-sum differences are beyond the critical value of 33 to reach significance at the $p < .001$ level. As shown in Table 4 rank totals were converted to scale scores on a zero to 100 scale and are graphically displayed in Figure 3.

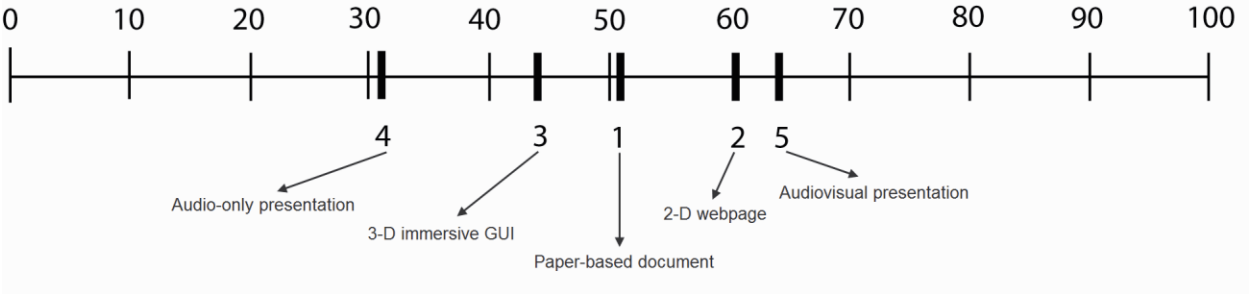


Figure 3. Unidimensional scale for Q2.

Table 4

Rank Totals and Scale Scores for Q2

Object	Rank Total	Scale Score
Min	312	0
1	944	51
2	1067	60
3	861	44
4	697	31
5	1111	64
Max	1560	100

Table 5

Rank-Sum Differences for Q2

	5	**2**	**1**	**3**	**4**
5	0				
2	44	0			
1	167	123	0		
3	250	206	83	0	
4	414	370	247	164	0

Circular Triads

The second analytic method focused on identifying any circular triads. Circular triads form whenever a participant selects intransitive (i.e., inconsistent) pairwise choices. For example, a participant selects A > B, B > C, and C > A. The previous example is a circular triad, indicating a nonlinear ordering in the preference pattern. By identifying an object or objects that caused several participants to be inconsistent and/or locate a particular participant responsible for a large number of circular triads, I was better able to determine both object scalability and individual participant consistency. In one case the method identified a participant responsible for five circular triads on Q1 (Library Layout). As a result this participant was deemed an extreme outlier and was subsequently dropped from the data set. Ultimately, circular triad analysis aided in confirming the rank-sum scaling results as well as assessing the overall quality of the data collection instrument.

For Q1 (Library Layout), 245 of the participants were consistent in their choices, whereas 67 responded with circularity. Table 6 shows a summary of circular triad analysis, including an itemization of objects by the number of circular triads associated with each. Note that the scale values provided mirror those derived from the rank-sum scaling analysis in the previous section. The 2-D webpage (Object 2) produced the most circular triads at 72, whereas audiovisual (Object 5) generated the fewest at 61.

Table 6

Summary of Circular Triad Analysis for Q1

Object	**# CT's In**	**# Votes**	**Scaled**
1	62	528	42.31
2	72	776	62.18
3	70	639	51.20
4	64	316	25.32
5	61	861	68.99

Table 7 provides a general summary of circular triad analysis for Q2 (Information Literacy). Paper-based document (Object 1) triggered the most circular triads at 85, whereas audiovisual (Object 5) initiated the fewest with 76. Two-hundred and forty three of the participants were consistent in their choices, while 69 demonstrated circularity.

Table 7

Summary of Circular Triad Analysis for Q2

Object	# CT's In	# Votes	Scaled
1	85	632	50.64
2	82	755	60.50
3	79	549	43.99
4	77	385	30.85
5	76	799	64.02

Multidimensional Preference Mapping

Multidimensional preference mapping (MDPREF) situates objects and participants in the same analytic, psychological space. The primary motivation for utilizing this method is to provide a visualization of specific subgroups of participants with specific objects. The various distances between subgroups and objects represent participants' perceptions of (dis)similarity between points. As the remainder of this section details, MDPREF analysis indicates that for both questions, each of the five objects maintain different levels of distinctness among one another and/or participant subgroups. It is noteworthy that the statistical package used in this research has a 100 participant limit per MDPREF analysis (Dunn-Rankin et al., 2004). Therefore Q1 (Library Layout) and Q2 (Information Literacy) were each divided into three groups of 100 participants (e.g., Q1.1, Q1.2, Q1.3) plus one group of 12 participants (e.g., Q1.4).

MDPREF analysis of Q1 (Library Layout) indicated a consistent participant-object disbursement pattern across Figure 4 (Q1.1), Figure 5 (Q1.2), Figure 6 (Q1.3), and Figure 7 (Q1.4). For example, in each figure paper-based (Object 1), 2-D webpage (Object 2), and audio-only (Object 4) collocate on the left side of the y-axis, with audiovisual (Object 5) and 3-D immersive GUI (Object 3) on the right side of the y-axis. This specifies some level of significant difference between the former objects and the latter. Additionally, because each of the three former objects is located within the left side plots, some level of alignment is also present among these objects. The most interesting observation is that 3-D immersive GUI (Object 3), as opposed to audiovisual (Object 5), lies within the lower right-hand plot of the graph; this space also includes the majority of participants. This observation discussed further in Chapter 5.

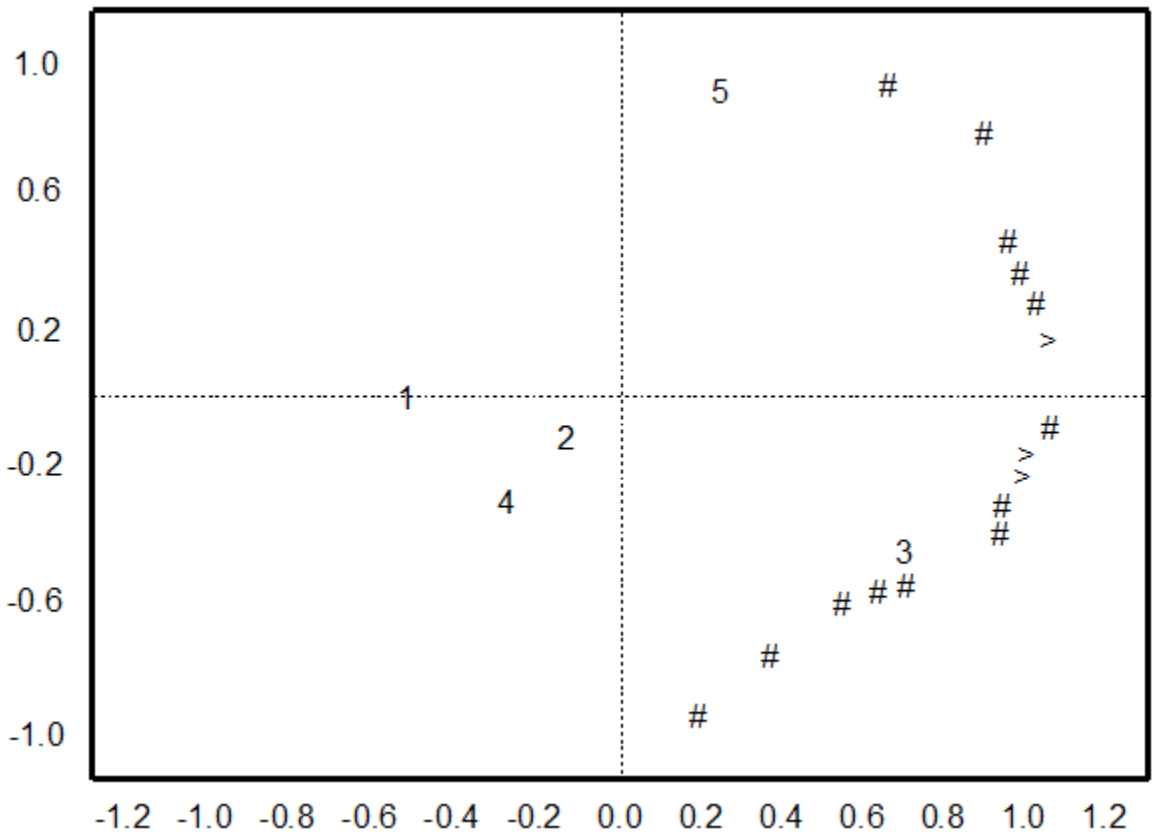


Figure 4. MDPREF analysis for Q1.1.

Note: Multiple points identified as # / first 5 points are objects, others are participants.

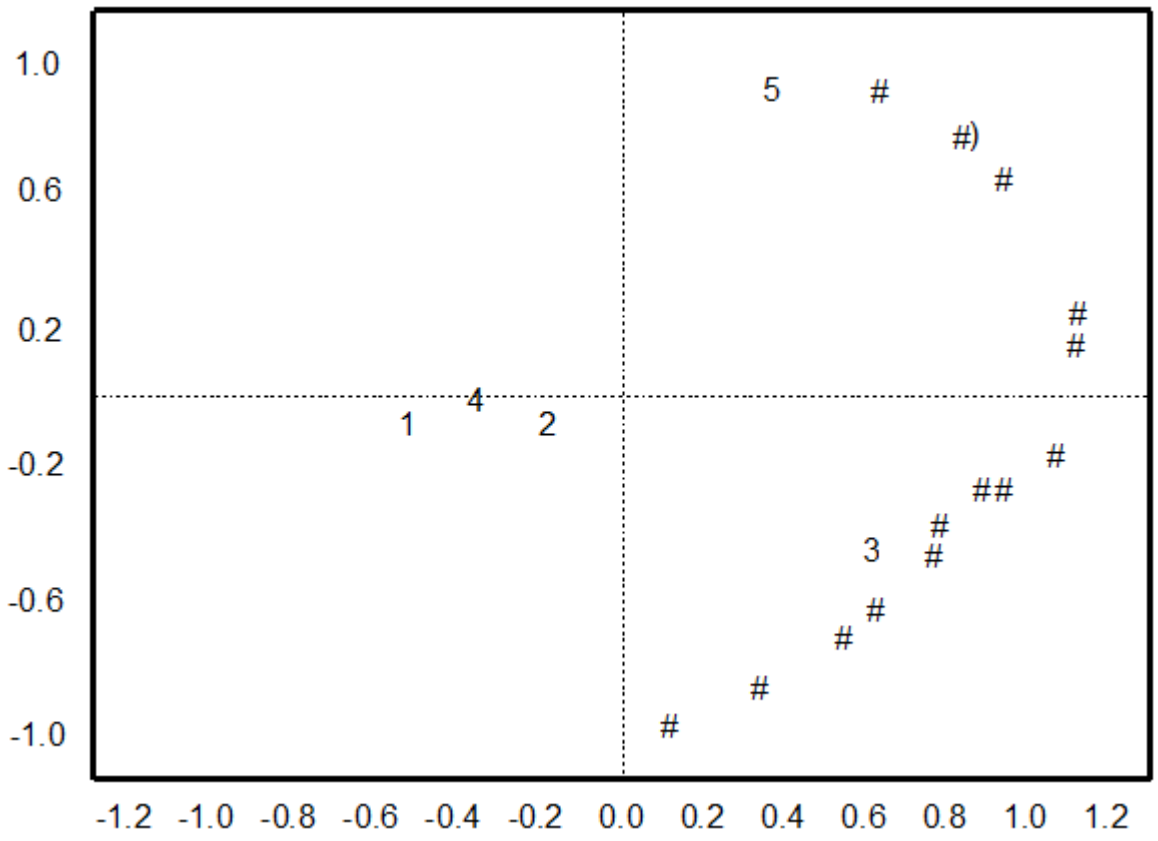


Figure 5. MDPREF analysis for Q1.2.

Note: Multiple points identified as # / first 5 points are objects, others are participants.

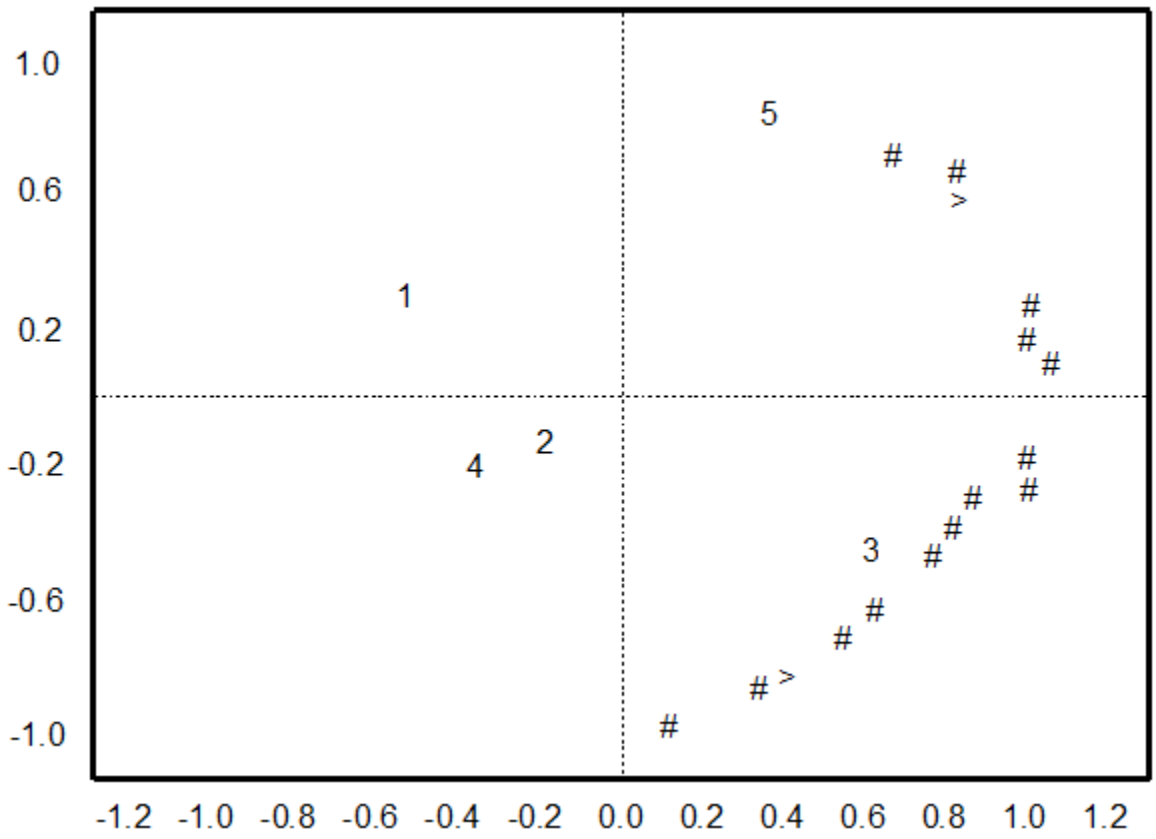


Figure 6. MDPREF analysis for Q1.3.

Note: Multiple points identified as # / first 5 points are objects, others are participants.

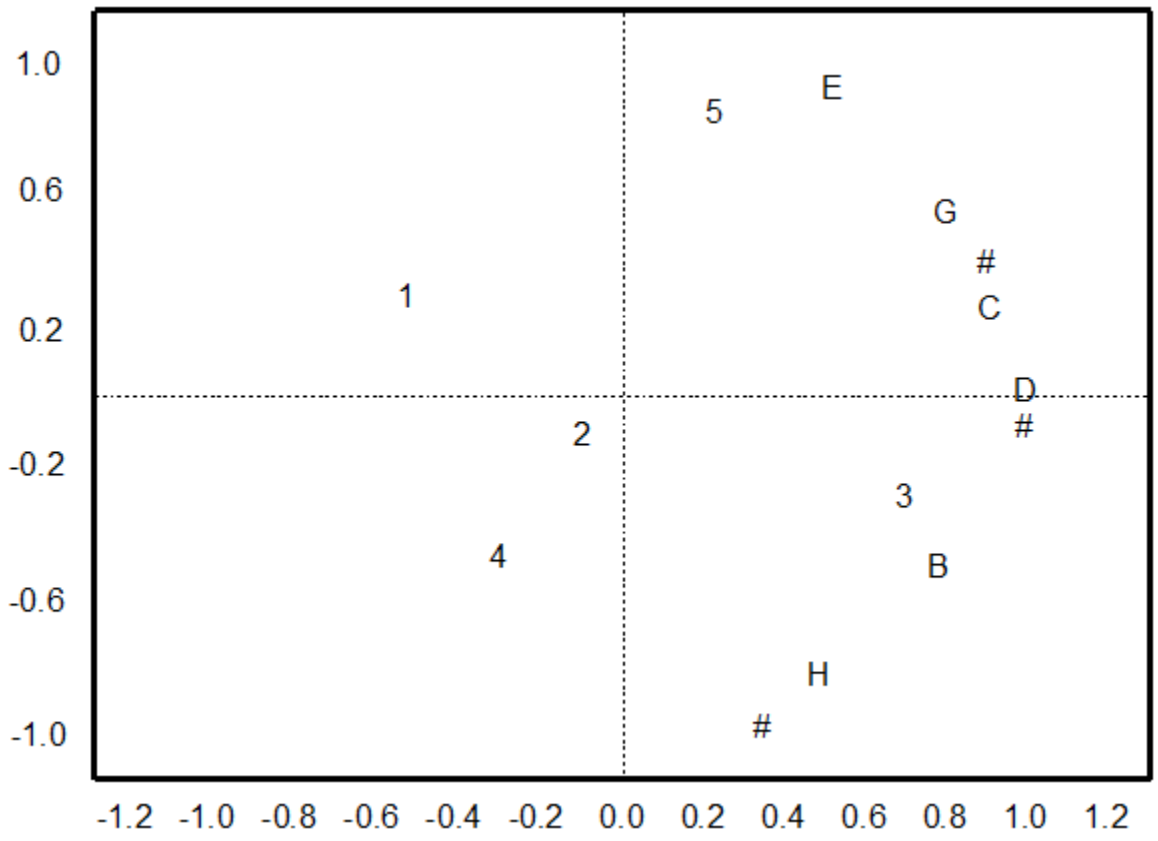


Figure 7. MDPREF analysis for Q1.4.
Note: Multiple points identified as # / first 5 points are objects, others are participants.

Figure 8 (Q2.1), Figure 9 (Q2.2), Figure 10 (Q2.3), and Figure 11 (Q2.4) show that for Q2 (Information Literacy), paper-based (Object 1), 2-D webpage (Object 2), and audio-only (Object 4) collocate on the left side of the y-axis, with audiovisual (Object 5) and 3-D immersive GUI (Object 3) on the right side of the y-axis. Moreover, plot points loosely mirror Q1 (Library Layout) results, indicating an affinity for particular technology-based delivery methods across both questions. Furthermore, it is noteworthy that participants align closest with 3-D immersive GUI (Object 3), as they did with Q1 (Library Layout).

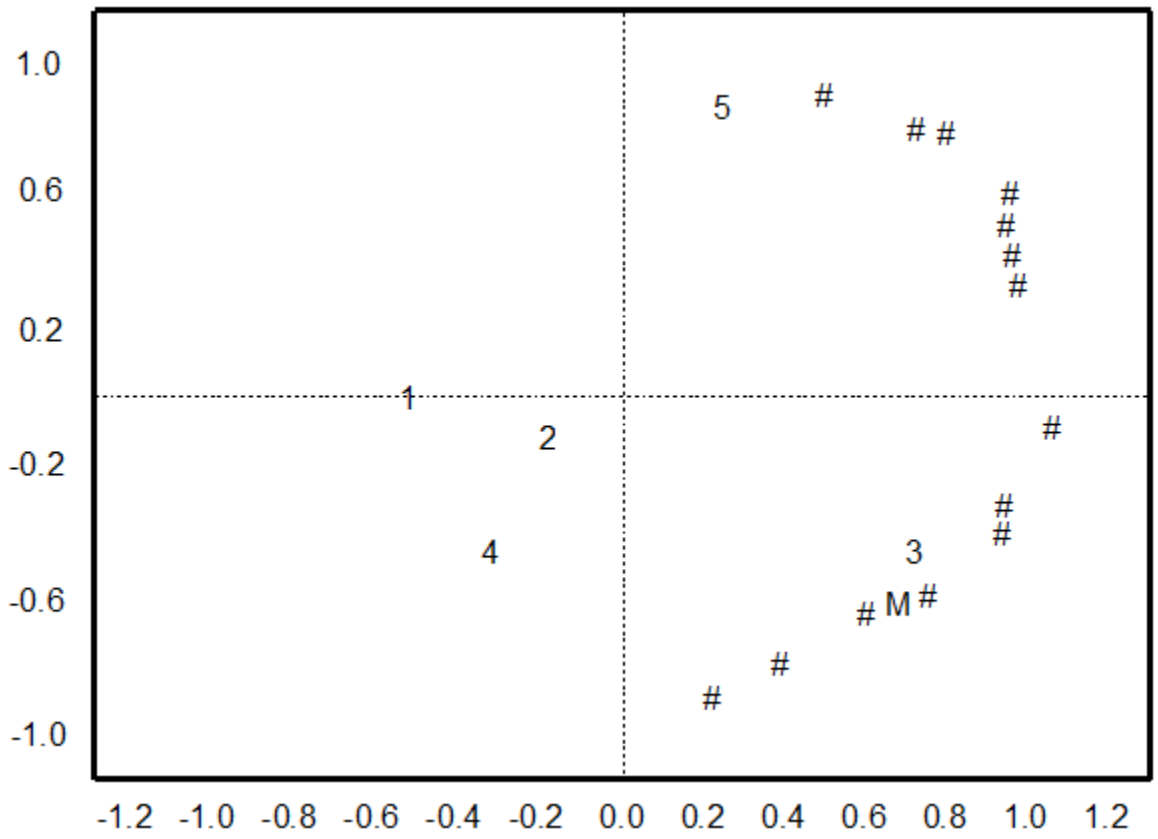


Figure 8. MDPREF analysis for Q2.1.

Note: Multiple points identified as # / first 5 points are objects, others are participants.

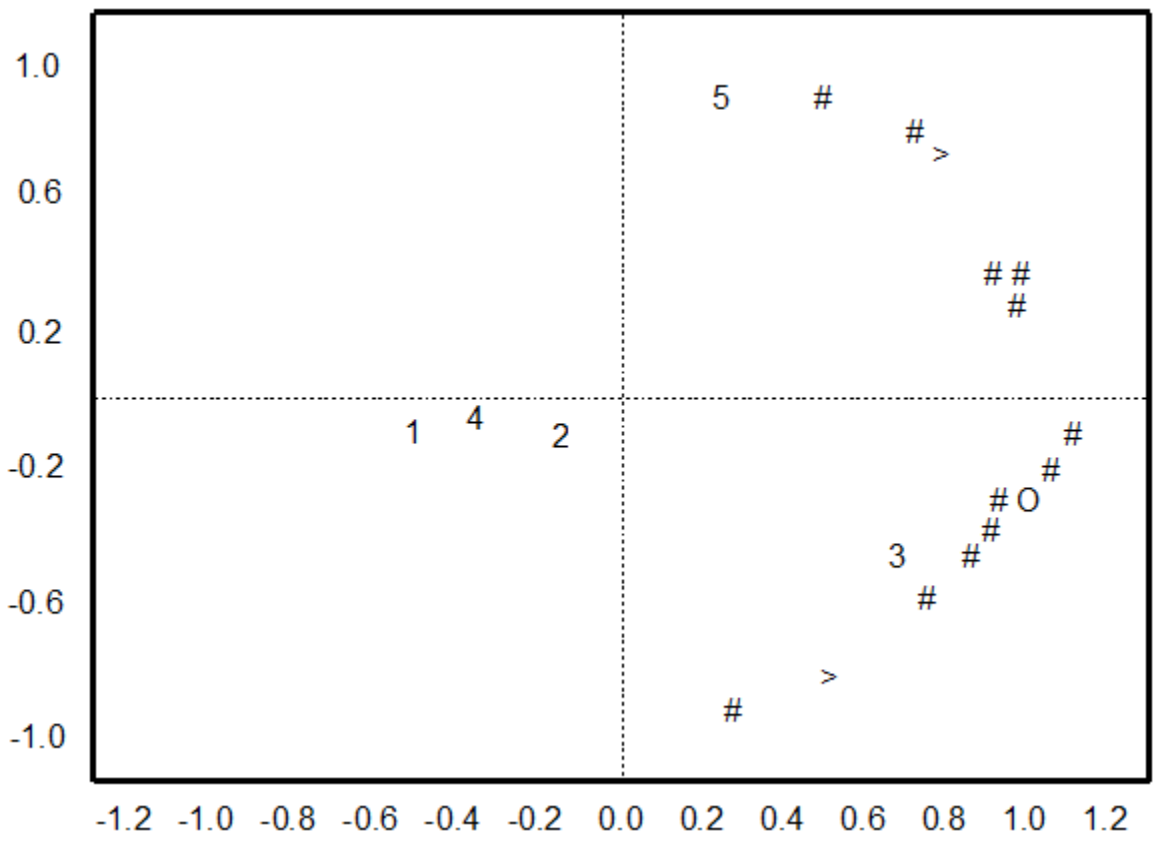


Figure 9. MDPREF analysis for Q2.2.

Note: Multiple points identified as # / first 5 points are objects, others are participants.

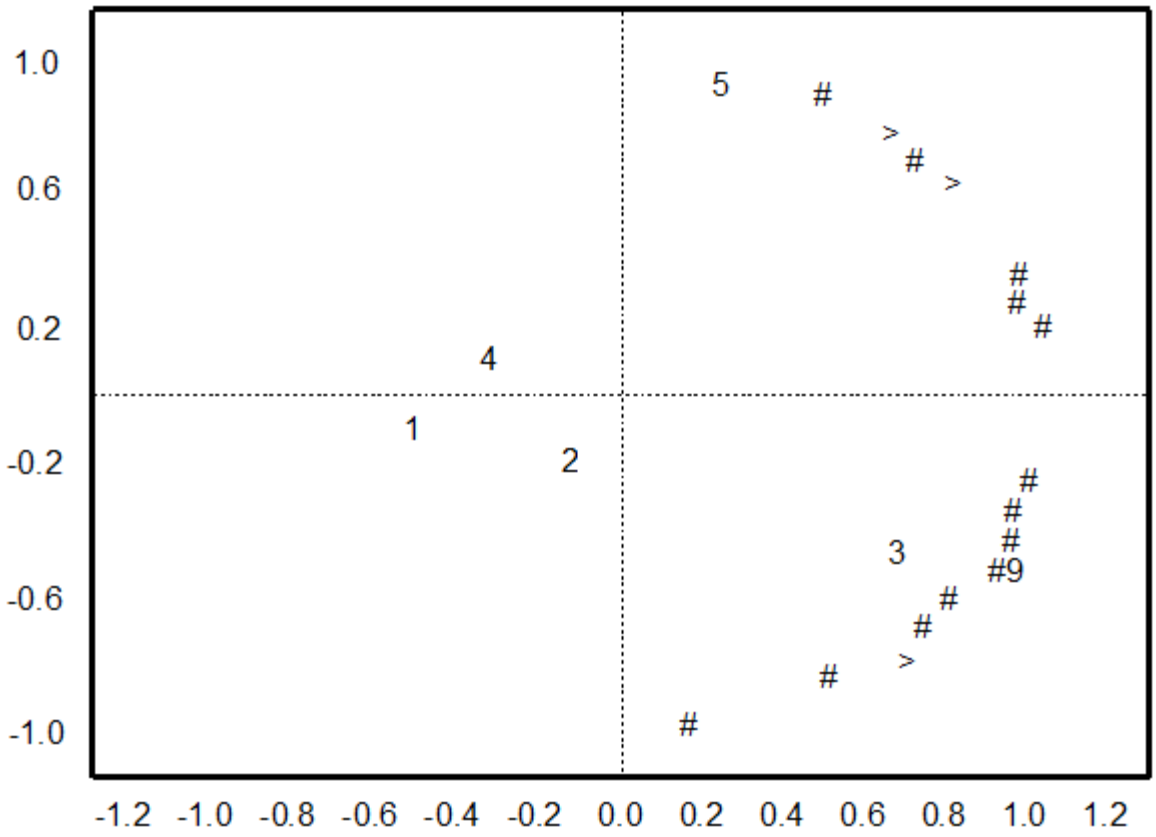


Figure 10. MDPREF analysis for Q2.3.

Note: Multiple points identified as # / first 5 points are objects, others are participants.

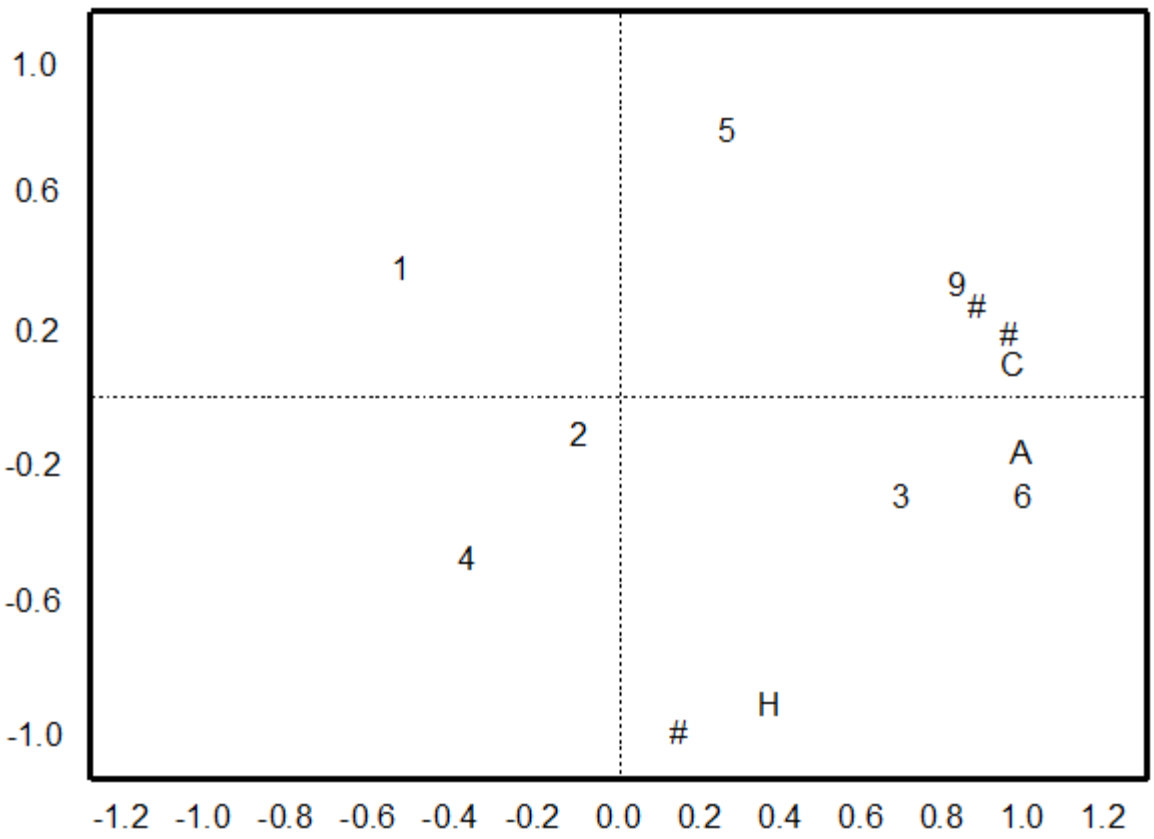


Figure 11. MDPREF analysis for Q2.4.

Note: Multiple points identified as # / first 5 points are objects, others are participants.

Unobtrusive Observations

Unobtrusive observations provided an additional data collection method, offering firsthand examination of the participants engaged in library instruction computing activities. Analysis was an ongoing, reflective process (Creswell, 2003). Formally, it began by organizing, preparing, and reviewing the data set. Detailed reflection followed, focusing on dividing the data set into chunks that in turn were used to generate themes. Recurrent themes were then identified and interpreted for discussion. Ultimately, data analysis from 11 unobtrusive observations resulted in three recurrent themes worthy of discussion here due to their overall importance to the study. Chapter 5 includes further discussion of these themes, as well as additional observational items.

First, participants appeared to be generally at ease interacting with Web-based content. This was evident in multiple documentations of participants using online social networking sites and other Web-based content and services while attending the library instruction sessions. Such use often times occurred from the start of the session all the way through to its conclusion. By and large, Web-based interactions did not relate directly to the formal library instruction sessions. However on a few instances participants were observed informally exploring the UNT Libraries Electronic Resources, independent of the instructional librarian's guidance. Overall, such interactions occupied the attention of the participants, not the face-to-face interaction of the sessions.

Second, multitasking behavior was frequently observed. Many participants appeared comfortable multitasking by way of various digital technologies (e.g., desktop computer, mobile digital device, etc.). Numerous instances are recorded of a participant or participants concurrently texting via a mobile digital device as well as communicating

via an online instant messaging (IM) service, while surfing the Web, all the while holding a conversation with his or her neighbor on an adjacent terminal or even row.

Third, the most consistent theme across the observational data was the participants' waning attention during the face-to-face library instruction sessions. The data reflects a consistent struggle by the instructional librarians for the participants' attention. In virtually every session it was apparent that the longer participants were physically present the more their attention diminished. The first two recurrent themes served in large part to exemplify this final theme as well.

Additional notable observational items include the following. The lab was often uncomfortably warm when populated because of the multiple active computing terminals. Furthermore, the vast majority of participants finished the survey in less than 10 minutes and appeared to have no problems understanding the survey instructions since only two participant questions related to the survey were documented out of all of the sessions. Participants were also frequently provided paper-based instructional material by the instructional librarian to augment the sessions.

Semi-Structured Interviews

One hundred and three (n=103) participants self-selected to participate in semi-structured follow-up interviews, with eight (n=8) interviews conducted and transcribed. The oldest interviewees were 22; overall, five were male, and three were female. Most of the self-selected participants seemed to either ignore the initial contact email or may not have received the email or follow-ups because of technical issues on their end. Like the unobtrusive observations, analysis was an ongoing, reflective process (Creswell,

2003). Analysis began by organizing, preparing, and reviewing the data set, followed by dividing it into chunks that in turn were used to generate themes. Recurrent themes were then identified and interpreted for discussion here. Ultimately, data analysis resulted in three major themes worthy of introduction here due to their overall importance to the study. Chapter 5 includes further discussion of these major recurrent themes, as well as additional interview items relevant to the study.

First, interviewees expressed frequent, often daily, use of the Web for information access and retrieval. Google (2009) and Yahoo (2009) were regularly cited as initial access points. Various reasons for Web use were listed, ranging from scanning the daily news to locating information on emerging technologies. Some interviewees commented that they use the Web to locate authoritative research for educational purposes. These views reinforce the unobtrusive observational data reflecting the relative ease with which many participants interacted with Web-based content.

Second, interviewees expressed a range of views related to the role and relevance of the physical library to their overall educational experience. Some interviewees perceived the physical library to be more or less obsolete, while others stated an appreciation for the facility as a place to study and prepare for educational tasks and other responsibilities. Several interviewees commented that electronic library services were preferred over their physical analogues due to their speed and efficiency.

Third, a major recurrent theme across the interview data was interviewees' stated appreciation for technologies they perceive as useful. The five technology-based delivery methods were frequently discussed in terms of their perceived usefulness, relative to one another. Likewise, the relevance of the physical library was also

addressed by way of its perceived usefulness, compared to electronic resources and other information access points.

Additional items of interest derived from the interview data, discussed in Chapter 5, include the following. Interviewees addressed innovation characteristics including compatibility with social norms, complexity, observability, and trialability. Interviewees also discussed their perceptions of the current state of digital gaming. Preference for visual over auditory information was a notable talking point, as well as comments concerning preference for experiential or active learning exercises. Interview statements also addressed adopter characteristics related to ability to deal with abstractions, as well as cope with risk and/or uncertainty.

Research Question and Sub-Questions

Via the survey instrument, expression of preference occurred by selecting one option (e.g., audiovisual presentation) over all other options (e.g., 2-D webpage, paper-based document, 3-D immersive GUI, audio-only presentation). Ultimately multiple participants' preferences were grouped together to ascertain rank totals (i.e., preference rankings). Moreover, the observational and interview data served in large part to reinforce the survey findings. Therefore, considering the results of the data analysis, it is possible to provide answers to the research question and sub-questions introduced in Chapter 1. Further discussion of the following responses is included in Chapter 5. To review, the primary question driving this research was:

Do undergraduates prefer a digital game system over other technology-based delivery methods to engage in library instruction?

Because the 3-D immersive GUI ranked third for Q1 (Library Layout) and fourth for Q2 (Information Literacy), on the whole this undergraduate sample *did not* prefer the idea of a digital game system over other technology-based delivery methods to engage in library instruction. Of course individual orders of preference varied by participant, as was the case for all research questions.

This research also sought to answer four sub-questions. The first sub-question was: Do undergraduates prefer a paper-based document over other technology-based delivery methods to engage in library instruction? In short answer, the undergraduates in this sample *did not* prefer the idea of a paper-based document over other technology-based delivery methods. Evidence for this interpretation includes collective preference rankings of fourth for Q1 (Library Layout) and third for Q2 (Information Literacy).

The second research sub-question was: Do undergraduates prefer a 2-D webpage over other technology-based delivery methods to engage in library instruction? While notable enthusiasm was evident, this undergraduate sample *did not* prefer the idea of a 2-D webpage over the other technology-based delivery methods. Evidence includes collective preference rankings of second place for 2-D webpage on both Q1 (Library Layout) and Q2 (Information Literacy).

The third research sub-question was: Do undergraduates prefer an audio-only presentation over other technology-based delivery methods to engage in library instruction? In this study audio-only achieved rank totals of fifth (i.e., last) on both Q1

(Library Layout) and Q2 (Information Literacy). Therefore this undergraduate sample *did not* prefer the idea of an audio-only presentation over other technology-based delivery methods for library instruction.

The final research sub-question was: Do undergraduates prefer an audiovisual presentation over other technology-based delivery methods to engage in library instruction? Of the five technology-based delivery methods, this undergraduate sample *preferred* audiovisual over all other given options. Audiovisual achieved a preference ranking of first on both Q1 (Library Layout) and Q2 (Information Literacy). However for Q2 (Information Literacy) 2-D webpage followed closely, only four points behind audiovisual on the unidimensional scale (see Figure 3 and Table 4).

Summary

This chapter first presented an overview of major observations and select trends in participant sample demographics. It then addressed three nonparametric scaling methods, the primary means of analysis, related to the electronic survey instrument. The three nonparametric scaling methods were rank-sum scaling, circular triad analysis, and multidimensional preference mapping. Detailed analysis of the unobtrusive observation and semi-structured interview data followed. The chapter closed by articulating responses to the research question and sub-questions.

CHAPTER 5

DISCUSSION

A letter to the editor of *School Library Journal* titled “The Gaming Bandwagon” begins, “Bandwagons can be dangerous things, especially when you jump on them without considering the destination,” (n.a., 2008a). Related to such concern, this mixed methods quasi-case study represents prospective research. As such, it provides new findings on the possible role or roles digital gaming may play in undergraduate library instruction, relative to participants’ perceptions of other technology-based delivery methods. This research is also strongly concerned with the digital native characterization as an appropriate representation of the study’s participants. Such concern aligns with the user-centered paradigm (Allen, 1996; Dervin, 1986).

With regard to diffusion of innovations (DOI), this research responds to Rogers’ (2003) call for “prospective studies of the innovation-development process,” (p. 163). Ultimately, introducing users to hypothetical innovations can support decision makers in library technology planning. Moreover, as a theoretical framework, various aspects of perceived attributes and adopter categories provide support to much of the discussion in this chapter.

The remainder of this chapter discusses the major findings of this study and then briefly compares those findings with the pilot study. The chapter continues with discussion about the digital native characterization. It then addresses practical points of interest relevant to the University of North Texas (UNT) Libraries Research and Instructional Services Department.

Major Findings

This section weaves major findings derived from the survey-based data set with data from the unobtrusive observations and semi-structured interviews. The major findings deemed most noteworthy are 1) the 3-D immersive GUI achieved mediocre preference across both questions; 2) the audiovisual delivery method received the highest overall preference ranking; and 3) overall preference for the audio-only delivery method was remarkably low. The most recurrent theme across the observational data was the participants' waning attention during the face-to-face library instruction sessions. Moreover, semi-structured interview data reflects complex and diverse perceptions concerning library technology; however, one consistent theme emerged across all, that is, interviewees' appreciation for technologies they perceive as useful.

Perceived Attributes

Some researchers suggest digital gaming may be a motivating and engaging instructional delivery method (see Chapter 2, Library Instruction subsection and Systems Design section). Various sociocognitive factors (see Chapter 2, Cognitive Aspects section and Systems Design section) appear to provide weight to the assumption. However in this prospective research it is the technology-based delivery methods that participants perceived to have the most relative advantage over other options and/or compatibility with their existing norms that received the higher preference rankings. Ultimately participants' perceptions of the digital gaming in library instruction idea were a major factor influencing their preference choices.

I initially expected the 3-D immersive GUI to receive greater overall preference than it did because 1) it is the most innovative of the five technology-based delivery methods; and 2) its' moderate overall preference ranking in the pilot study. Since so-called digital natives adopt many technological innovations at faster rates than other users (Forrester Research, 2006; Pew Internet and American Life Project, 2009), expecting a higher overall preference ranking seemed appropriate considering the demographic makeup of the sample. Regarding Q1 (Library Layout), my initial expectation was also related to the potential scope and fidelity of spatial information conveyed via a 3-D immersive GUI.

However, remember that perceived attributes trump objective attributes. For example, when one considers the importance that some interviewees placed on the physical library relative to their overall educational experience, it is less surprising that the more cognitively affording delivery method was trumped by the more easily accessible. One male interviewee referred to the physical library as "draconic" while another stated, "I don't so much go to the library for any educational purposes anymore. You can pretty much Google any kind of information you want these days." Likewise a female interviewee said, "I think we're [younger users] more likely if given the option between something online and having to go get it in person… going to automatically choose well online because it's easier and faster." Two participants also used the phrase "phase out the library" in their interviews.

Participants' perceptions of the relative advantage of the 3-D immersive GUI affected its preference ranking. Male and female interviewees used terms such as "silly" and "worse" to describe their comparative perception of the hypothetical innovation.

Such perceptions directly relate to perceived relative advantage. On the other hand, male interviewees stated it “would be better” than face-to-face instruction, and “Interaction and being able to engage in the activity… always helps in learning.” While the two previous statements reflect perceptions of relative advantage, the latter also speaks to the concept of cognitive scaffolding (see Chapter 2).

Interview data suggests that the 3-D immersive GUI innovation was incompatible with the norms of some participants. Consider that a male interviewee stated, “The idea had never even crossed my mind. I don't see how it can be done.” Related to social norms, reinvention also helps describe the mediocre preference ranking of the 3-D immersive GUI. For example, one female interviewee stated:

> …if you tried to use it [digital game] for a library I think people [younger users] would think that you were like trying too hard. You know what I mean? Like, it would be like, oh, they're bringing a video game out... I don't see it as like a useful application.

The statement, “if you tried to use it,” suggests that the hypothetical reinvention was incompatible with her perception of such technologies’ role. The same interviewee also commented, “I think that if you decided to teach someone… to learn to use the library, [with] a video game [younger users] would be just like no, I don’t get it.” Researchers (British Library, 2008) identify insufficiently planned library reinvention initiatives as potentially dangerous, stating “There is a big difference between ‘being where our users are’ and ‘being USEFUL to our users where they are,’” (p. 16). In short,

younger users may perceive reinvention initiatives, like digital games designed for information literacy instruction, as incompatible with their social norms.

Regarding complexity, observability, and trialability, a male interviewee stated, “I am definitely curious to see the product of this idea, but as to whether or not I would find it useful my hesitation leads me to believe I won't.” Ultimately, by not providing participants working examples of the five delivery methods via the survey instrument these three perceived attributes did not factor into their decision making. Although relative advantage and compatibility are the dominant perceived attributes one can only speculate on the effects of the other attributes had working examples been both available and accessible. My feeling is that it would have opened up many additional methodological and interpretative considerations related to the sensory continuum (Thurstone, 1927), as well as perceived ease-of-use (Fred D. Davis et al., 1989). Perceived ease-of-use is the “degree to which a person believes that use of the system will be free from effort,” (Dillon & Morris, 1996, p. 11).

Additional Thoughts

Interview statements reflect various levels of affinity for digital gaming. One female interviewee stated, “video games to our generation are mostly creative. People use video games for all kinds of things.” Likewise, a male interviewee said, “well it [digital game] might not be appealing to some, but for the most part it would be more interesting than listening to someone explaining [face-to-face library instruction] to you.” What is more, on Q1 (Library Layout), the 3-D immersive GUI scaled higher than an established delivery method (i.e., paper-based document), as well as a recent convert

from emerging to mainstream technology (i.e., audio-only presentation) on both Q1 (Library Layout) and Q2 (Information Literacy). All interviewees replied no when asked if, prior to the study, they had encountered the idea of using a digital game for library instruction.

Ultimately the most innovative of the five objects – the 3-D immersive GUI - ranked no higher than third in this study, while more established delivery methods, such as audiovisual and 2-D webpage, achieved higher rank totals. Speaking about the audiovisual presentation, a male interviewee stated, “They help grasp our attention more than certain books. Books can be very boring at times, but videos with special effects are a huge attention getter.” Additionally, another male interviewee indicated he preferred interacting with “visual” information, while yet another stated, “I think that watching a video to learn... is the best way to actually get the information the first time through.” Reminiscent of the information visualization discussion in Chapter 2, a male interviewee commented, “A book can describe a tribal dance, a video can show it.” Oblinger and Oblinger (2005b) suggest many younger users prefer image-based delivery methods over text-based, claiming that many “retain 10 percent of what they read but closer to 30 percent of what they see.”

Finally, considering the increase in LIS discourse concerning podcasting, the low overall preference ranking is interesting. Perhaps participants do not associate the audio-only delivery method with educational tasks. Related to the previous suggestion Kennedy et al. (2008) states, “the transfer from a social or entertainment technology… to a learning technology is neither automatic nor guaranteed.” This outcome reinforces the usefulness of prospective research for library technology planning. However,

interview data suggests that for some users, audio-only *is* desirable. For those users it has a relative advantage over the other four delivery methods. A male interviewee said, “That’s [podcast] very helpful, in terms of lectures,” while a female interviewee stated, “I think that it [podcasting] is VERY important and necessary, and unfortunately very under-used.” Interestingly, both interviewees reported using assistive technology for instructional purposes. Another male interviewee said, “It [podcasting] would help, especially if someone missed a class,” while a female interviewee commented, “I think something easy to listen to that is available online would be helpful.” Further discussion of podcasting and assistive technology in subsequent sections.

Brief Comparison with Pilot Study

Major findings from this research, in some cases align and in others counter those from the pilot study. In the pilot study 45% of participants were so-called digital natives, while the majority of participants (99%) in this study were also born post-1980. Comparatively the social systems surveyed in the pilot study consisted of mainly graduate students while those in this research were exclusively undergraduates. This difference suggests the two samples maintained different levels of personal experiences, social standings, and responsibilities that in turn influenced preference votes. Users with more years of formal education are likely earlier adopters (Rogers, 2003). This claim aligns with the results of the pilot study consisting mainly of graduate students, wherein the 3-D immersive GUI received higher overall preference rankings. Conversely, in this larger study of undergraduates, the 3-D immersive GUI received

mediocre overall preference rankings. Frequency or amount of digital game use between the two groups is not known.

As previously discussed rank-sum scaling results for both Q1 (Library Layout) and Q2 (Information Literacy) did not match those of the pilot study, wherein the 2-D webpage received the highest preference ranking for both questions, versus the audiovisual for both in this research. Furthermore, in both cases circular triad analysis findings mirror those derived from their respective rank-sum scaling. Therefore in both instances circular triad analysis indicated that their respective rank-sum findings were both accurate and consistent.

Conversely, multidimensional preference mapping results here essentially mirror the pilot study results. In every graph from this research, as well as the pilot study, the 3-D immersive GUI aligns with the highest number of participants, locating to the right of the y-axis. Ultimately this consistent observation lends further weight to the idea proposed in the pilot study that there may be some level of latent affinity for the digital game in library instruction idea not overtly evident via the other methods. Visual comparison between outcomes from the two studies is possible by way of tables and figures available in Chapter 4 with those included in Appendix B.

Digital Natives

The purpose of this section is to reflect upon the digital native characterization by synthesizing the concept with discussion of the major findings and Rogers' (2003) adopter categories. In some instances the digital native depiction is apt for these participants, while off-the-mark in others. The participants are first and foremost diverse

individuals with complex perceptions. They maintain a wide range of evolving technology experiences, preferences, and expectations.

At times younger users have collectively displayed a greater propensity for innovativeness in technology adoption than users over the age of 30 (Forrester Research, 2006; Pew Internet and American Life Project, 2009). However, while they appreciate innovation, some interviewees hint perceived usefulness is a more dominant decision making factor when weighing whether to adopt or reject technology. The native-immigrant labels, whether intended or not, place focus on the role of age in technology adoption (Robbins, 2007). Wenmoth (2009) rather aptly refers to this emphasis as a "line in the generational sand." In diffusion research age plays a negligible role in predicting likelihood for adoption (Rogers, 2003).

It is noteworthy that the age emphasis is not simply a result of discourse among technologists and researchers. Some younger users perceive it as well. Consider that one female interviewee said:

> Well I think it's kind of an age thing. Like my Dad if you put a computer in front of him, he barely even knows how to use his email…. Like my Dad is almost 50 years old and um, like, my Mom she… tends to say go to the library and study. And I'm like Mom I can study at home; I don't need to go to the library. So like from like personal experience I think that previous generations were more willing to go to the library and study rather than go to [the coffee shop].

Regarding the participant sample, certain generalizations related to digital natives appear warranted. For example, 97% reported using mobile digital devices. This outcome falls in line with multiple claims that digital natives lead active, mobile lifestyles (Oblinger & Oblinger, 2005a). Observational data also shows participants using technology for various tasks other than library instruction (e.g., texting via mobile phone, messaging online, using online social networking sites, etc.). Participants generally appeared at ease multitasking and interacting with Web-based content. Considering these findings it is increasingly evident why many younger users appreciate speed and efficiency in information and communication technologies (Oblinger & Oblinger, 2005b). Slower technologies and services limit multitasking potential.

Reaffirming the claim that digital natives prefer to learn in experiential ways (Abram & Luther, 2004), one female interviewee stated she uses a “click and see what happens” approach to exploring new technologies, and followed, “I'm probably more willing to try and figure things out rather than like going and asking for help.” Relating her preferred learning style back to digital game use, she also stated, “A lot of times if you just pick up a video game there’s a walkthrough tutorial… [you] rarely ever play that level unless you’re forced to, at least I don’t.” Similarly, as indicated in the Major Findings section, a male interviewee stated, “Interaction and being able to engage in the activity I think always helps in learning.” Additionally, Abram and Luther assert digital natives are the first generation to by and large be tested for learning challenges, like Attention Deficit Disorder (ADD). As a result libraries must plan to meet the needs of such users. Fifty-five percent of participants (n=172) reported using assistive technology for instructional purposes. In this case, Abram and Luther’s assertion seems appropriate

and their recommendations warranted. The assistive technology outcome is discussed further in the UNT Libraries Instructional Programs and Services section.

Innovativeness and Age

Younger users' early adoption of collaborative technologies and services, such as their heavy engagement in online social networking sites, exemplify innovativeness (Abram & Luther, 2004; Skiba & Barton, 2006). In this research over 90% of participants held membership in online social networking sites. Contrary to innovativeness, interview statements suggest some participants view the physical library as increasingly obsolete. Consider that two interviewees described a willingness to "phase out the library" while another claimed he does not "go to the library for any educational purposes anymore." However not all interviewees expressed such perceptions of the physical library. A male interviewee stated, "It's a major factor in terms of a study facility as well as a great source for information needed for any class." Likewise, a female interviewee said, "I think the library is a very necessary part of my education, both for providing relevant and impressive resources, and for providing a good environment for studying."

Innovativeness does not assure early adoption. Although participants were never formally assigned to adopter categories, survey results (i.e., less innovative media ranking higher than the 3-D immersive GUI) coupled with interview data reflect more characteristics of later adopters, thus supporting Rogers' (2003) assertion that age plays a minor role in predicting technology adoption. This claim is not a result of formal comparison. Formal comparison was not a proposed research goal and is not possible with this data set. However, the discord is important because it provides some insight

into participants' complexity and diversity. Conflict between adopter categories, and in turn the digital native characterization, existed throughout this research. In many instances individual interviewees conveyed characteristics of both earlier and later adopters.

One interview question focused on the participant's ability to deal with abstractions, a personality variable reflecting level of innovativeness. Earlier adopters maintain greater ability to use abstractions than later adopters (Rogers, 2003). For example, they may adopt an innovation based upon abstract stimuli like one might encounter via the mass media. When asked if she deals with abstractions well, one female interviewee stated, "No, especially not in education." The previous interviewee ranked 2-D webpage highest overall, signaling behavior more indicative of a later adopter, as the 2-D webpage is a more established instructional delivery method. Another female interviewee provided a similar response, stating, "I deal more with um, learning hands on I guess." She ranked 3-D immersive GUI first for Q1 (Library Layout) and 2-D webpage first for Q2 (Information Literacy), suggesting some potential for behavioral change, with regard to Q1 (Library Layout).

On the other hand, a male interviewee said, "Abstractions often help me understand fundamental key ideas… I start with an abstraction, and work to solidification." Interestingly, he also stated the 3-D immersive GUI was a "significantly odd idea." This interviewee ranked 2-D webpage first for Q1 (Library Layout) and paper-based document first for Q2 (Information Literacy). His case exemplifies a fundamental problem with user profiling (i.e., characterizing on the individual level); he reflects traits

of both earlier (e.g., ability to deal with abstractions) and later (e.g., less innovative objects receiving higher preference rankings) adopters.

Another personality variable related to level of innovativeness is the ability to cope with risk or uncertainty. Earlier adopters are able to manage risk and uncertainty better than later adopters (Rogers, 2003). A male interviewee stated, “I’m not much of a risk taker… I have to be as well prepared as possible.” He also stated that audiovisual presentations “help grasp our attention more than certain books,” therefore suggesting potentially less will on his part for behavioral change toward the more innovative 3-D immersive GUI. The previous interviewee ranked the audiovisual presentation highest overall. Another male interviewee revealed his approach to risk taking, stating, “Usually I just try to really weigh out the benefits and consequences with any risk I take.” He ranked 3-D immersive GUI highest overall.

Communication behavior also reveals much about users’ innovativeness. Earlier adopters maintain greater exposure to mass media and seek information regarding innovations more actively and regularly than later adopters (Rogers, 2003). As a result they generally have more knowledge of innovations than later adopters. The previous male interviewee who indicated an appreciation for abstractions also replied, “I do not know of any place to seek information on new technology. By the time I hear of it, it's already on the shelf and being reviewed by every website on the Internet.”

However most comments related to communication behavior were more expected of earlier adopters. Multiple interviewees described daily use of the Web. One male interviewee stated, “Usually I check [online] every day at least once if not twice,” for information on emerging technologies. Another male interviewee said he reads the

news, “Every other day… at CNN.com,” while another stated that before going to the library, “first I’ll go to the Internet.” The latter interviewee also described using the Web “Every day, at least three times a day.” Additionally, a female interviewee described locating information about new or emerging technologies “Two to three times a week.”

Concerning the digital gaming in library instruction idea, one male interviewee said it “would be more interesting than listening to someone explaining to you.” He also described using multiple resources to locate information on emerging technologies and claimed that if he encounters messages regarding an innovation he locates relevant information “immediately.” He ranked 3-D immersive GUI highest overall. Considering the individual interviewees’ survey results along with their reported communication behavior, two questions arise. Could the digital connectedness of younger users (e.g., frequent, heavy use of online social networking) water down the importance of communication behavior as a factor in predicting technology adoption? Does heavy interaction increase the likelihood that users of various adopter types will encounter technological innovation messages?

Perceived Usefulness and Age

Dillon and Morris (1996) define perceived usefulness as “the degree to which a person believes use of the system will enhance his or her performance,” (p. 11). Useful technologies have a relative advantage over other options (Rogers, 2003). Skiba and Barton (2006) state, “Action and what the technology enables them [younger users] to do is more important than the particular technology.” Among many younger users, technology is simply a tool – a *useful* means to an end (Oblinger & Oblinger, 2005a).

Although perceived usefulness was never an explicit talking-point during interviews, it nonetheless reared its' head several times. All interviewees appeared to value technology they perceive as useful. They summoned terms like "useful," "usable," (albeit not in the formal sense) "handy," "helpful," and "help," often on multiple occasions, to describe their perceptions of technologies' role in their lives. The previous claim by Skiba and Barton (2006) aptly depicts the interviewees in this research.

Again, most interviewees described the Web as their start-point for information access and retrieval, from reading the daily news to locating academic research. Google (2009) and Yahoo (2009) were frequently cited as primary access points. The Web is where increasing amounts of users of all ages go to meet their information needs (Fox, 2008). One male interviewee stated online resources were "easier to access" than their physical analogues, while a female interviewee said she rarely reads news, "Unless it's online." Other female interviewees stated that online resources "really make things handy" and emphasized "using the library resources (especially online)."

The male interviewee who indicated he did not know where to locate emerging technologies information proclaimed, "Innovation may not be good," and followed, "as to whether or not I would find it [digital gaming in library instruction] useful my hesitation leads me to believe I won't." A female interviewee put forward that while a digital game for library instruction might be innovative, that is not sufficient justification for adoption. She stated, "I don't see it as like a useful application." Any attempt to influence her innovativeness level by opinion leaders within her social system should include an innovation message that focuses heavily on the perceived relative advantage of the innovation, over comparable objects or ideas. Opinion leaders are able to influence

other group members' level of innovativeness in a desired way relatively frequently (Rogers, 2003). As such, opinion leaders frequently reflect their group's social norms.

Researchers adopt generalizations because they are useful in comparative analysis. However generalizations can be detrimental when applied incorrectly or excessively, particularly by policy and decision makers. Rogers (2003) states "classification is a simplification… it loses some information as a result of grouping individuals" (p. 280). Such loss can lead to off-the-mark assumptions. Whether based upon insufficient information or interpretative errors, inaccurate assumptions about users can lead to erroneous decisions resulting in negative consequences. With many libraries already forced to endure large budget cutbacks (Kraus, 2007), such consequences are magnified even further in the 2009 global economic downturn.

Socially constructed reality is more complex than generalizations allow. As this research shows, an individual user can maintain characteristics of both early and later adopters. Ultimately, the digital native characterization is only marginally helpful to library technology planners. As Robbins (2007) suggests, it is most useful as scaffolding to place initial discourse concerning certain users. In the end, the concept breaks down because of the age emphasis, intended or not. Perhaps researchers should redirect their focus, away from generational concerns, and toward potential factors like need-for-use, technology competency and experiences. Oblinger and Oblinger (2005b) suggest technology exposure may be a more pervasive factor in predicting technology adoption than age-related concerns. Ultimately LIS practitioners and researchers should use native-immigrant nomenclature with caution, as it remains unclear what role, if any, age plays in predicting technology adoption.

UNT Libraries Instructional Programs and Services

As previously stated, the observational data reflects a consistent struggle by the instructional librarians for the participants' attention. In virtually every session it was apparent that the longer participants were physically present the more their attention diminished. Consider that a male interviewee, when asked what the phrase *information literacy* means, stated, "I think it's being able to comprehend what you're reading basically, almost like reading comprehension." His statement was made after attending a face-to-face library instruction session. These undergraduates were frequently disengaged during their face-to-face sessions, thus raising the potential those sessions were ineffective in achieving their goals.

The staff of the Research and Instructional Services Department is outstanding. They are knowledgeable professionals overtly striving to meet their users' needs. In every session I observed them working diligently to provide participants meaningful library instruction. However the face-to-face format is genuinely disconnected from many interviewees' worldviews. Many younger users prefer to learn in experiential and active ways, and like their instructional information quickly and efficiently so they can maximize their multitasking potential (Oblinger & Oblinger, 2005a).

In short, the results of this research suggest a need for new and/or adapted instructional services at UNT Libraries. The following recommendations are based upon two premises synthesized from outcomes of this research, the pilot study, and relevant literature (see Chapter 2). The first premise is that many younger users are not afraid to explore technology on their own. The second premise is that many younger users prefer technologies and services they perceive, first and foremost, as useful.

Physical Library as Learning Center

Interview data suggests further transforming the physical library space into more of a multipurpose learning center. Consider a female interviewee's statement that:

> …the coffee shop there [UNT Willis Library] is really, really helpful. I've gone there [coffee shop] a couple of times this semester. If we could bring more of the popular culture in there… it would be much more a popular place to go.

Again, the word "helpful" rears its' head. Several interviewees value the physical library as a study facility. For example, two interviewees described the structure as a "major factor in terms of a study facility," as well as, "providing a good environment for studying." A female interviewee also stated, "I feel it is extremely important," and continued, "I think it's great that I can go and study in a quiet place there too; one without distractions." Another female interviewee said, "For me, it's all about like, solace. A place you know where I can go and kind of like be with my thoughts."

From an instructional standpoint, transformation means proactively moving away from framing the library as an information repository toward the library as a third place (Oldenburg, 1999), wherein users first and foremost *learn* 21st century information skills (S. Johnson, 2005). Decision makers must accept that many younger users are comfortable exploring technology on their own, that is, the "click and see what happens" approach described by one interviewee. McNeely (2005) states, "They [younger users] learn by doing, not by reading the instruction manual or listening to lectures. These are the learners that faculty must reach." Furthermore, multiple participants appeared

comfortable interacting with Web-based information. Librarians cannot force such users to seek information residing in physical collections. They go to the Web because, as one female interviewee stated, it is “easier and faster.”

Therefore, the Research and Instructional Services Department should seriously consider transitioning from formal face-to-face introduction to resources (e.g., this is database X and this is its’ search interface) toward information literacy instruction (e.g., how to critically evaluate resources, physical and digital) exclusively. Introduction to resources should be informal and accessible via other means, in addition to face-to-face interaction with library staff. Formal face-to-face instruction should instead focus on critical thinking and resource evaluation concepts, like authoritativeness, as well as skills, such as website evaluation (University of California-Berkeley, 2009) and logic and reasoning in query formulation (British Library, 2008). Research identifies skills related to resource evaluation as potentially major stumbling blocks in the development of current and future younger users’ information behavior (British Library, 2008). Such instruction should be *the* primary focus of the department. Resource introduction should not take priority over providing instruction that younger users can apply both inside and outside the library domain. *Standards for the 21st-Century Learner* (American Association of School Librarians, 2007) can provide a start-point for instructional design and assessing learning outcomes.

Face-to-face instruction focusing on information literacy concepts and skills can first exemplify, then reinforce to younger users why libraries are useful (i.e., helpful). Over the past decade librarians have begun to turn over much of the profession to users, by providing search interfaces visually closer to major Web-based search

engines, and transforming some libraries into community centers with game nights, guest speakers, and other programs. Such transformation must continue. In the Information Age, to a certain extent, everyone is a librarian, some by accident, some by choice. As such we must not hesitate to share with these accidental librarians more of our knowledge. Such sharing will, in turn, allow us to learn from users how to remain relevant deep into the Information Age, and beyond.

Technology-Based Delivery Methods

UNT Libraries should provide multiple technology-based delivery methods for all types of library instruction. Considering the major findings of this study, they should strongly consider producing audiovisual instructional presentations. Perhaps they could partner with the university's Department of Radio, Television, and Film (RTVF). The RTVF department might provide considerable assistance with such an endeavor. In turn audiovisual presentations should be accessible online via the library instruction homepage and/or a third party hosting site. Furthermore, although audio-only presentation received low preference rankings, some assistive technology participants spoke highly of its potential. These users cannot be left behind. For example, a female interviewee stated:

> I think it is VERY important and necessary, and unfortunately very under-used. For those of us with learning disabilities, podcasting can make information accessible that never was before. If there is a podcast available for my textbook or lesson, I listen to the podcast as I read along in order to absorb the material better.

Therefore its inclusion should also be considered. Podcasts can be produced for under $50, using off-the-shelf hardware and open source software like Audacity (2009).

Both the pilot study and this research indicate users prefer a 3-D immersive GUI to acquire physical library layout, over using it for information literacy instruction. Therefore UNT Libraries should consider modeling their physical facilities for presentation within an online 3-D immersive GUI. Start with Willis Library, as it is the centerpiece of the library system. Put together an interdepartmental working group of gaming and simulation enthusiasts. Anecdotally speaking, UNT Libraries is fortunate to have multiple qualified staff members with a passion for digital gaming. Therefore development staff could be derived in-house, elsewhere on campus, outsourced, or a mix of all three. Developers could utilize software ranging from free to high-end, depending upon the resources, goals, and commitment of the institution. However, expectations should be tempered, thus a lower-end approach is likely best initially.

Development staff and resources would in turn dictate the fidelity of the modeled environment. Ultimately such an environment does not have to be precise down to the level of individual resources in the stacks, such detail is simply not necessary. For such a system to effectively convey spatial information to users it only needs to present the

physical layout of objects, paths, and other points of geographic interest to scale within the physical facility. Scale can be determined by measuring distances between points-of-interest using an inexpensive laser pointer and/or tape measure. In other words, take up-to-date 2-D maps and revise and adapt them using the measurement data for presentation within a 3-D immersive GUI. Similar to Battles and Combs (2008), first present a prototype of the first floor to users in an online beta-laboratory setting. Farkas (2009) also touches on this approach in her discussion concerning technology buy-in. Moreover, the reinvention factor should be considered, so it is important in testing to ask users how the system aligns with their worldviews (e.g., social norms). Testing should also include factors beyond technical and usability to develop a richer user experience.

Modeling UNT Willis Library within a 3-D immersive GUI serves as an example to student prospects of innovation at the library level, as well as the overall university. Thus the system itself acts as a marketing device, with implications on subsequent marking strategies and plans. Furthermore, if a prospective or incoming student is unable to travel to the university, he or she could develop a working sense of the library facilities by way of such a system. It also provides users not frequently on campus (e.g., commuters in online and/or blended courses) the ability to walk through physical facilities prior to periodic use. Remember that users under time constraints often fail to see instructional media providing information on physical library layout, thus contributing to library anxiety (Eschedor Voelker, 2006). In relation, a female interviewee described using the physical library in the context of being “up last minute trying to do something like… everyone kind of is.”

Providing users physical library layout information via a 3-D immersive GUI is both useful and doable. Ultimately, this approach may allow digital gaming in library instruction proponents the ability to skirt reinvention concerns since it removes the actual gaming element from the equation, there by lessening the likelihood it invades younger users personal space, by conflicting with their social norms.

Summary

This chapter began by detailing the major findings from the study and followed with a discussion of participants' perceptions of certain technology-based delivery methods for instructional purposes. It continued with items related to the digital native characterization's relevance to the study's participants and included discussion of participants' perceptions of innovativeness and usefulness. The chapter closed with discussion of the applied implications of the major findings.

CHAPTER 6

SUMMARY AND CONCLUSION

This chapter begins with a summary of findings, followed by an overview of lessons learned throughout the dissertation process. Next is a discussion of potential directions for future research related to digital gaming in undergraduate library instruction and related, relevant areas of inquiry. The chapter concludes with final thoughts related to the study, as well as the overall research process.

Summary of Findings

The following subsection is a synopsis of the major findings from this research. Major findings include responses to the research question and sub-questions, as well as major outcomes from the research and applied implications and recommendations. This section follows with additional thoughts related to diffusion of innovations (DOI) and the digital native characterization.

Major Findings

The following is a summary of responses (see Chapter 4) to the research question and sub-questions (see Chapter 1 and Chapter 4). First, on the whole this undergraduate sample *did not* prefer the idea of a digital game system over other technology-based delivery methods to engage in library instruction. Second, the undergraduates in this sample *did not* prefer the idea of a paper-based document over other technology-based delivery methods. Third, this undergraduate sample *did not*

prefer the idea of a 2-D webpage over the other technology-based delivery methods. Fourth, this undergraduate sample *did not* prefer the idea of an audio-only presentation over other technology-based delivery methods for library instruction. Lastly, this undergraduate sample *did* prefer an audiovisual presentation over all other options. The unobtrusive observations and semi-structured interviews reinforced these findings.

Therefore, major outcomes from this research were 1) the 3-D immersive GUI achieved mediocre preference across both questions; 2) the audiovisual delivery method received the highest overall preference ranking; and 3) overall preference for the audio-only delivery method was remarkably low. The most important theme across the observational data was the participants' waning attention during the face-to-face library instruction sessions. Likewise, the most important outcome from the semi-structured interviews was interviewees' stated appreciation for useful technologies.

Considering these outcomes, the University of North Texas (UNT) Libraries Research and Instructional Services Department should strongly consider transitioning from the content areas of current face-to-face undergraduate library instruction to focus in greater fashion on information literacy topics, such as authoritativeness, resource evaluation, and query formulation. Moreover, UNT Libraries should also consider simulating their physical facilities within a 3-D immersive GUI for library orientation purposes. Such an approach is likely the best prospect for successful adoption of a digital game-like system in undergraduate library instruction.

Additional Thoughts

It was possible to reflect upon the digital native characterization relative to the major findings and Rogers' (2003) adopter categories. In some instances the depiction proved apt for the study participants, while off-the-mark in others. The participants are first and foremost diverse individuals with complex perceptions. As such they maintain a wide range of evolving technology experiences, preferences, and expectations. In the end, conflict between adopter categories, and in turn the digital native characterization, existed throughout this research. At times individual interviewees conveyed characteristics of both earlier and later adopters.

Younger users' early adoption of collaborative technologies and services, such as their heavy engagement in online social networking sites, exemplify innovativeness (Abram & Luther, 2004; Skiba & Barton, 2006). In this research over 90% of participants held membership in online social networking sites. However innovativeness does not assure early adoption. Interviewees suggested that perceived usefulness is a more dominant factor than innovativeness when deciding to adopt or reject technology. Although participants were never formally assigned to adopter categories, survey results coupled with interview data reflect more characteristics of later adopters, thus supporting Rogers' claim that age plays a minor role in predicting technology adoption.

Technology exposure may be more influential in predicting technology adoption than age-related concerns. Terms such as native and immigrant are based in cultural discourse. As such, LIS researchers using the native-immigrant nomenclature should seriously consider moving focus away from generational issues to examine cultural, motivational, and need-based factors influencing emerging technology adoption.

Researchers may ultimately confirm what some individuals (Robbins, 2007; Wenmoth, 2009) already suggest, that the characterization is an oversimplification inherently limited by its emphasis, intended or not, on age.

Lessons Learned

The purpose of this section is to review various lessons derived from the research experience, including logistical and methodological. As a burgeoning social scientist I strive to constantly develop a better understanding of the research process. For example, although many participants selected to take part in follow-up interviews only a small portion actually occurred. Reflecting upon this outcome it became apparent that my proposed method for conducting the interviews (i.e., telephone) was likely a deal breaker for many participants because it would require them to give out their telephone number. Therefore I subsequently sent a 10 question email to self-selected participants that resulted in an adequate overall response rate.

The alterations and additions made to the survey instrument since the pilot study were beneficial to both researcher and participant. By adding further demographic questions related to digital game use and other technologies I was able to create a more detailed picture of the sample. Furthermore, when asked if the online survey was easy to use, one male interviewee commented, “Yeah, really easy.” He went on to state that it took around 10 minutes to complete; his comment is congruent with most participants’ experiences in the pilot study, as well as the observational data. Moreover, as addressed in Chapter 3, the survey migration from paper-based to online allowed for

easier analysis and archival of data and removed any potential for data entry errors often inherent with paper-based surveys.

Furthermore, the fact that complexity, trialability, and observability did not factor into participants' decision making is worthy of note. One can only speculate on possible preference rankings had those three perceived attributes come into play as working examples of the five technology-based delivery methods. The issue helps to further frame this experience as unconventional diffusion research. However, just as the case with many libraries today, lack of funding was a major issue, which is why I believe prospective studies, like this one, are useful to practitioners and researchers.

Generalizations can be dangerous constructs. As such, researchers may best explore users' perceptions and needs by investigating them from an individual or small group perspective. The bottom line is that users - people - are the most important component in library and information science (LIS) research. Technology is simply a tool, a means to an end. It should never be *the* focus of inquiry. In the end, this realization is invaluable. Therefore when considering whether to develop or implement technology, library decision makers should first and foremost determine if their users perceive it to be useful. If users do not, no matter how innovative decision makers expect the technology to be, it will likely not reach widespread adoption.

Directions for Future Research

Research that is both sophisticated and meaningful is possible in a variety of areas relevant to digital gaming in library instruction. Potential exists in examining the affective aspects of user information behavior within a multiuser online strategy game.

Competitive digital environments certainly evoke emotional behavior in their users. Throughout game play, these users need, seek, and use information embedded in the game as well as exchange information between one another. Thus a sociological constructivist approach to such research may produce unique perspectives on various sociocognitive aspects of networked game play. Such research may lead to a peer-recognized *gaming informatics* field within the LIS community. Adams' (2005) research is laying the groundwork for such a field to emerge. The primary purpose of a gaming informatics field should be to explore the many facets of user information behavior (e.g., needs, seeking, use, etc.) experienced within a game system or systems.

Discovery of recurring factors influencing perceived usefulness across user groups is needed to better inform library technology planners. Moreover, exploration similar to this study, yet in public, school media, special libraries and even online services such as Amazon (2009) is also needed to determine if users' preferences for delivery methods vary by setting. A reasoned action (Fishbein & Ajzen, 1975) approach might prove useful in making sense of users' intentions, motivations, and technology preferences in such research. Furthermore, it is advantageous for library decision makers to determine if bibliographic instruction is a good idea for younger users. It may be that such instruction is simply outside the worldview of such users, regardless of delivery method. Ultimately it may never satisfy younger users because the content in and of itself may be perceived by them as overwhelmingly boring or irrelevant.

Accurate identification of opinion leaders within younger users' social systems is needed. By identifying such users, library technology planners may be able to better predict potential reinvention mistakes and likewise deploy systems and services

younger users both need and perceive as useful. There are many environments for such exploration, like online social networks. What message patterns exist within an online social network regarding emerging library technologies? Are users responsible for frequent messages about emerging technologies also opinion leaders? If such users are opinion leaders, what personality variables, communication behaviors, and/or socioeconomic factors, if any, do they share?

If replication of this study is a future goal, certain adjustments should be initially considered. Working examples of objects should be included in the survey so that complexity, observability, and trialability overtly factor into participants' decision making. Checking and rechecking of participants' preference votes over a period of time should also be considered, as well as multiple interviews with the same participants. Measuring the time element in diffusion research allows for more formal participant classification by adopter type, if classification is deemed desirable. Analyzing user preferences by dividing them into groups according to their assigned instructional librarian may also be useful. Regarding social systems, such analysis provides further insight on learning outcomes and technology preferences at an additional level. The use of focus groups may also offer a better means for collecting textual data than individual interviews. If possible, semi-structured interviews and focus groups may be further optimized by conducting them onsite, immediately following face-to-face library instruction sessions.

In the end, additional research is needed to predict the extent of adoption of a 3-D immersive GUI in undergraduate library instruction. As the multidimensional preference mapping outcomes in both the pilot study and this research suggest, there is some level of latent affinity by participants, perhaps even interest, in the prospect of

using a digital game for library instruction. In both studies, outcomes also suggest that the use of such a system for acquiring physical library layout, therefore serving as a simulation and not a game, is the preferred prospect. Creating a system for such a purpose may offer the best chance for long term acceptance of a 3-D immersive GUI in library instruction. See Akilli (2007) for additional potential research streams related to digital gaming in library instruction, as well as other educational contexts.

Conclusion

Technology overreach can be a serious issue for libraries as they are increasingly bombarded, both internally and externally, with innovation messages. Therefore libraries must conduct sufficient preliminary research and plan accordingly to make sure proposed technology meets the needs of their users and not simply the innovators and early adopters on staff or elsewhere. P. Wilson (2002) writes, “You become just as interested in seeing where they [technologies] fail to play a role or are easily avoided as where they are useful and necessary.” In many ways P. Wilson’s statement reflects the underlying nature of this research; meaning my desire to explore if the enthusiasm by some information professionals for digital gaming in library instruction is technofit or technolust (Stephens, 2004). By introducing users to hypothetical innovations, prospective studies help tame technolust and aid in the formation of user-centered technology plans.

I have spent the last four years familiarizing myself with claims concerning so-called digital natives’ technology experiences, motivations, and expectations, and in turn thought deeply about this group of participants. This research represents my own

interpretations. Interpretations naturally contain biases. With that acknowledgment, my goal as a researcher was never to further (de)construct generalizations about digital natives, nor to develop a modified theory or model of innovation diffusion. In the end, this research was about this group of participants and not digital natives as a conceptual whole. This research process was complex at times, particularly in the interpretation and writing phase. Perhaps data collection and analysis were not as taxing because of the pilot study experience. Nevertheless, this process has been one of the most rewarding experiences of my life.

Many physical libraries have little room for error in the Information Age. Some younger users' perceptions of their role and relevance are evolving, and any reinvention mistakes representing physical libraries in the near future will reinforce the creeping perception that such institutions are reaching obsolescence. Change – innovation - can be difficult for some, while easy for others; either way, it is a naturally risky endeavor. If the Law of Accelerating Returns (Kurzweil, 2005) remains even remotely accurate, major technology planning decisions will likely become increasingly necessary and thus frequent in the coming years. Therefore, any research that library technology planners can evoke or mimic to help minimize the inevitable risks involved with change should be called upon when and where possible so that decisions are grounded in their users' perceptions, needs, and expectations.

APPENDIX A

SURVEY INSTRUMENT

Exploring User Preferences toward Technology-Based Delivery Methods for Library Instruction

You are being asked to participate in a research study being conducted at the University of North Texas. You understand that Mr. Robertson is working to find out how students perceive and rank various technology-based delivery methods for library instruction.

Participation in this study is completely voluntary. About 5 minutes of your time is all that is needed for you to complete the survey. You have the right to skip any question you choose not to answer. There are no foreseeable risks involved in this study; however, if you decide to withdraw your participation you may do so at any time by simply leaving the website.

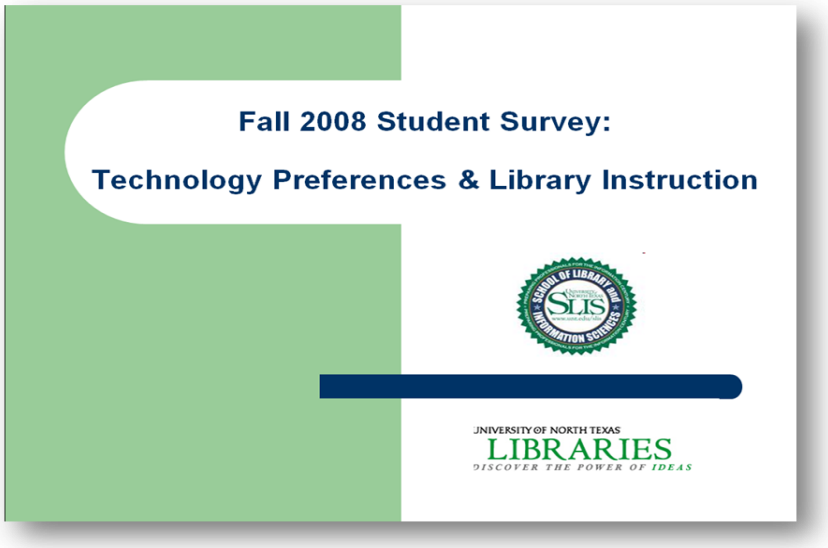
All research records will be kept confidential by the Principal Investigator. If you have any questions about the study, please contact Mr. Robertson, College of Information, Library Science and Technologies, at telephone number (940) 565-2445 or by email at michael.robertson@unt.edu. You may also contact faculty sponsor Dr. Greg Jones, Department of Learning Technologies, at (940) 565-2571.

This research project has been reviewed and approved by the UNT Institutional Review Board (IRB). Please contact the UNT IRB at (940) 565-3940 with any questions regarding your rights as a research participant.

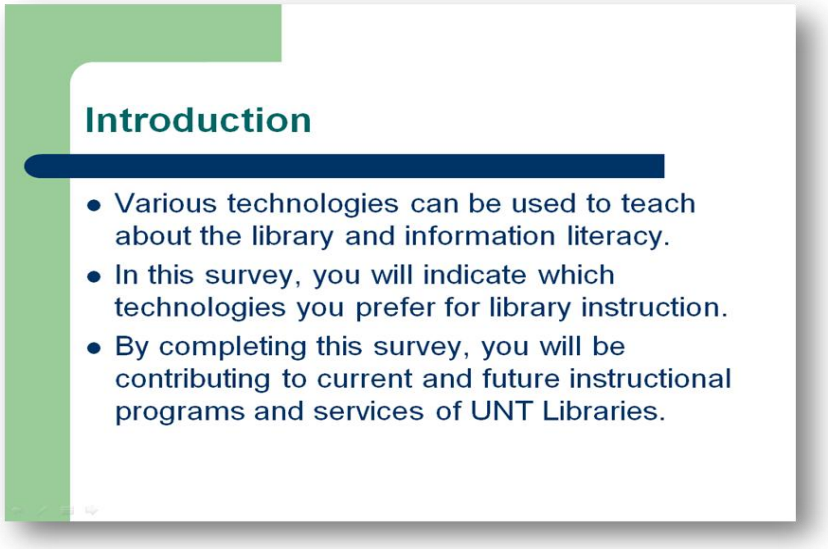
If you agree to participate, you may print this document for your records.

By beginning the survey process below, you are confirming that you are at least 18 years old and you are giving your informed consent to participate in this study.

Begin Survey [Click Here]



NEXT



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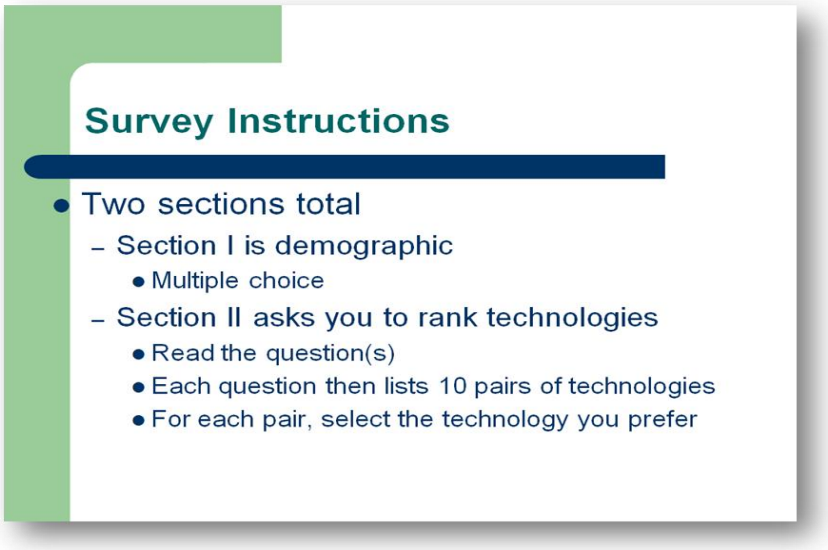

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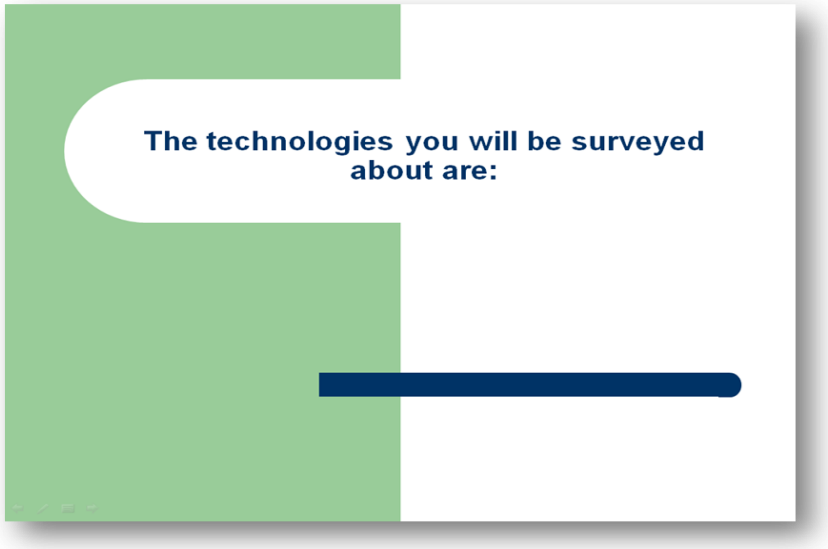

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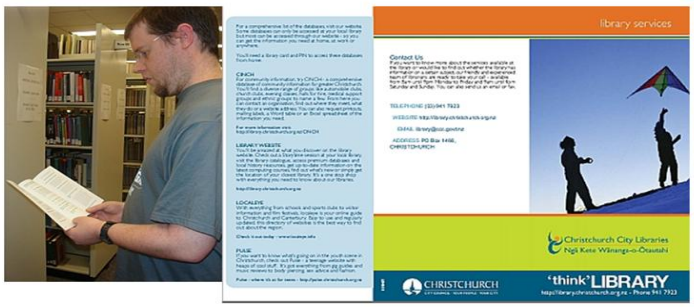
Paper-Based Pamphlet



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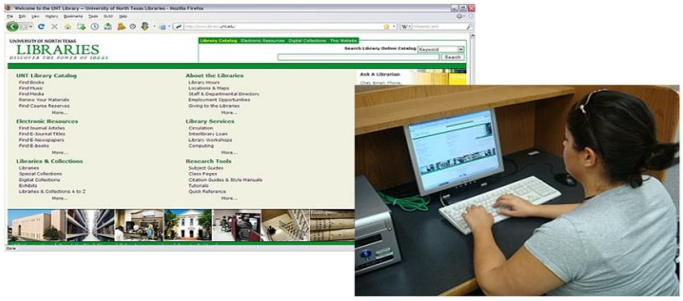
2-D Webpage



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3-D Immersive GUI

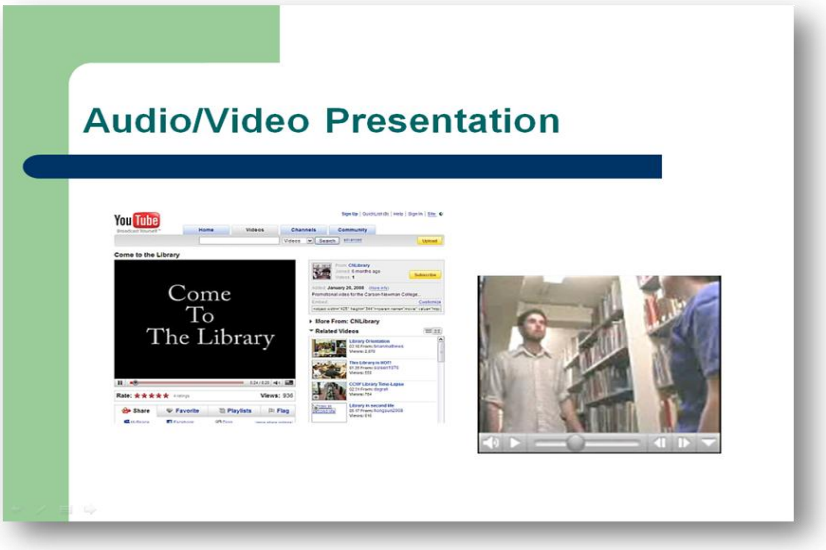
"Like a video game"

Graphical User Interface (GUI)

BACK NEXT

Audio-Only Presentation

BACK NEXT



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Section I: Descriptive Information

1. My age? _____

2. I am:

Male Female

3. On average, the number of hours I study per week is:

7 or less 8 to 11 12 or more

4. I am classified as:

Undergraduate
Masters
Doctoral
Post Graduate
Non-Degree Seeking
Other

5. How many hours a week do you play computer/video games?

0 hours 1 hour 2-3 hours 4-7 hours 8-15 hours 16-31 hours

6. The number of different video, computer, online, or cell phone games I currently play is?

0 1-2 3-4 5-7 8 or more

7. I first played video games in:

Preschool Elementary school Junior High/High School College

8. The number of mobile digital devices (e.g., Cell phone, iPod, etc.) you currently use is?

0 1-2 3-4 5-7 8 or more

9. The number of online social networking services (e.g., MySpace) you currently use is?

0 1-2 3-4 5-7 8 or more

10. Do you use assistive technology for instructional purposes?

Yes No

11. Would you be willing to participate in a brief, follow-up interview concerning this survey?

Yes No

Section II: User Preferences

Q1. Following is a list of 10 pairs of terms. For each pair, please click on the one that you prefer relative to the following question:

Which method would you rather use for acquiring information on the physical layout of the library?

(Ex. Location of specific areas within UNT Libraries: Willis Library.)

Paper-based document	2-D webpage
2-D webpage	3-D immersive GUI
3-D immersive GUI	Audio/Video presentation
Paper-based document	3-D immersive GUI
2-D webpage	Audio/Video presentation
3-D immersive GUI	Audio-only presentation
Paper-based document	Audio/Video presentation
2-D webpage	Audio-only presentation
Paper-based document	Audio-only presentation
Audio-only presentation	Audio/Video presentation

Q2. Following is a list of 10 pairs of terms. For each pair, please click on the one that you prefer relative to the following question:

Which method would you rather use for receiving information literacy instruction?

(Ex. Information literacy instruction includes learning about online search techniques.)

Paper-based document	2-D webpage
2-D webpage	3-D immersive GUI
3-D immersive GUI	Audio/Video presentation
Paper-based document	3-D immersive GUI
2-D webpage	Audio/Video presentation
3-D immersive GUI	Audio-only presentation
Paper-based document	Audio/Video presentation
2-D webpage	Audio-only presentation
Paper-based document	Audio-only presentation
Audio-only presentation	Audio/Video presentation

SUBMIT [CLICK HERE]

APPENDIX B

PILOT STUDY

Exploring Academic Library users' Preferences of delivery Methods for Library instruction Webpage, Digital Game, and Other Modalities

Michael J. robertson and James G. Jones

This article examines research on academic library user preferences related to five communication media used to facilitate two forms of library instruction. The corresponding study began with a survey instrument administered to forty-two participants over a three-week period during the fall of 2006. The authors subsequently applied three nonparametric scaling methods to the data set. Data analysis indicates an overall preference for the 2D webpage approach, as well as notable enthusiasm for the 3D immersive graphical user interface, the principal user interface throughout current digital gaming technologies. An overall lack of preference for the audio-only communication medium is also evident in the results.

This article expands upon recent library and information science (LIS) discourse related to digital gaming by investigating user perceptions of digital games (i.e., video, computer, and online games) relative to other communication media currently used by academic libraries to facilitate library instruction. [1] Adapting previous definitions for the purposes of this discussion, library instruction describes the collective educational efforts—formal and informal—of an academic library. [2] The primary question driving the present research is, Do academic library users prefer digital game systems over other comparable communication media (i.e., information presentation formats or delivery approaches) for engaging library instruction?

Current digital gaming technologies, such as Blizzard Entertainment's massively multiplayer online role playing game (MMORPG) World of Warcraft, provide users with functionality far beyond the traditional competitive aspects of games. They also exemplify social computing. Because of three primary factors, modern digital games are significantly different from their predecessors. These three factors are (1) the exponential increase in computing power, leading to (2) the development of more realistic gaming experiences (i.e., three-dimensional direct manipulation user interface), and (3) the Internet. Increasingly, digital game users expect both immersive and collaborative systems in which meaningful game play experiences include user-to-user communication through text, voice, and even virtual body movement. Ultimately, modern digital games are not just competitive environments; through the Internet they fundamentally act as communication media. Interdisciplinary literature on various sociocognitive aspects of digital-game use reinforces this assertion.[3]

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This article begins by discussing two components of library instruction—providing users with spatial (directional) information on physical library layout and educating users on information literacy topics—and considers how the application of a 3D immersive graphical user interface (GUI), the principal user interface adopted by most current digital games, may benefit library users. Next, it reviews a survey in which forty-two participants ranked according to preference five communication media, including a 3D immersive GUI, relative to the aforementioned two types of library instruction. Remaining sections summarize research findings derived using three nonparametric scaling methods, examine select interpretations of those findings, and discuss their potential contribution to future research.

BACKGrouNd

Outside the LIS community, a prevalent topic of discussion related to digital gaming research is the 3D immersive GUI. [4] For example, some researchers suggest that, in comparison to more traditional communication media, the 3D immersive GUI provides users with an increased real-world sense of spatial context (i.e., spatial information enabling a user to orient and navigate the related environment). Moreover, some researchers suggest that spatial cognition is an important contributor to meaningful learning experiences but is less so in the areas of traditional information access and retrieval.[5]

Many of the current theoretical approaches to cognition, such as trajectories of participation and communities of practice, view learning as a primary activity of human information processing; these approaches reflect to varying degrees historically significant literature by Dewey, Kelly, Bruner, and Vygotsky. [6] Additionally, research suggests that digital animation may support users' abilities to simplify structure during learning activities. [7] This assertion is congruent with research in data-mining presentation techniques and runs parallel with findings in cognitive neuroscience that indicate increased dopamine levels in digital game users during user-system interaction periods.[8]

In practice, academic libraries do far more than provide access to information; they also act as both formal and informal educational agencies.[9] Academic libraries educate users through a range of communication media, stretching from simple pamphlets to extensive instructional websites. The following two subsections expand upon the two forms of library instruction previously mentioned: providing users with spatial information on physical library layout and educating users on information literacy topics. These two forms of library instruction—informal and formal, nontraditional and traditional—provide the basis for the two main questions of the survey instrument discussed in the study section.

Library Layout

Walking into a physical library for the first time and attempting to locate a particular area within the facility can potentially be a frustrating experience. Although not prototypical to many LIS researchers, such a scenario exemplifies a common information-seeking experience that occurs daily in academic libraries. Keefer suggests that academic library users under time constraints and other stresses are more likely to have difficulty conducting independent research; often these users fail to see directional signs and other communication media providing spatial information on the facility. [10] Voelker reinforces this aspect of library instruction in her discussion of freshman users, information literacy instruction, and library anxiety. [11] Ultimately, acquiring spatial information about a physical library facility is necessary for all of the institution's users.

Consumer research indicates that information presentation formats significantly affect information acquisition and subsequent learning processes in users. [12] Thus, when attempting to convey spatial information, choice of communication media can influence the quality of the user's learning experience. Additionally, because of human beings' primary dependence on visual perception, communication media can vary greatly, not only in the literal information provided, but also in the amount of spatial context they offer the user. For academic libraries, frequent means of communicating spatial information include pamphlets, strategically placed signs, and online guides through an institution's Web presence.

From a sociocognitive perspective, proponents of the 3D immersive GUI suggest that the visual navigation features of this design approach, coupled with connection to a library's Web presence, provides a potent interface for the more visually inclined users. Jones and Bronack refer to this ability as cognitive scaffolding. [13] Consider that, in physical reality, users employ various voluntary and involuntary body movements to communicate, that is, facial expressions, hand signals, posture, and so on. Digital games allow users to process information through audio dialogue, text, and avatar (i.e., virtual-self) movement. The 3D immersive GUI approach also permits users to en-

gage one another within an entirely neutral digital reality, an important benefit for freshmen sensitive to their own abilities to integrate into the physical library environment.[14]

Information Literacy

For most academic libraries, a primary component of their service missions is to educate users on information literacy concepts and skills. Such instruction often occurs either in a face-to-face workshop setting or online and may include educating users in evaluating information resources, searching electronic bibliographic databases, and using other services offered by the institution such as interlibrary loan. Ultimately, the goal of information literacy instruction is to encourage library users to be independent researchers confident in their abilities to locate and use valid information both in physical and digital formats.[15]

While limited, digital games and information literacy instruction share some history. The first mention of any relationship is in 1982, with the advent of *Citation*, a digital game designed to teach young people basic information literacy skills.[16] Currently there are a variety of approaches to using digital games in this context, ranging from providing online educational games that incorporate information literacy concepts to presenting an entire online digital library and its services through a 3D immersive GUI.[17] In relation, Lewis describes using digital games to promote library services and reviews two UK programs wherein digital gaming technologies augment library instruction.[18]

Voelker stresses that academic libraries must reach beyond their physical facilities to meet the expectations of freshman users, while Doshi suggests that many academic library users view the physical facility and its services and staff as essentially boring.[19] Research on Millennial users (individuals born after 1980) may shed some light on why freshman students and other Millennials perceive libraries and their constituent parts with little enthusiasm. Abram and Luther contend that Millennials differ considerably from previous user groups in nine fundamental ways, including multitasking as a fundamental pattern of behavior and game-like experiential learning strategies.[20] Consider that Millennials are accustomed to quickly flashing digital interfaces as well as multitasking through numerous digital devices simultaneously.[21] Parallel research suggests that, because of their interactive, participatory nature, digital games provide users with a wide range of multitasking opportunities.[22] Additionally, Rise proposes that Millennials present an entirely new set of values and expectations driven by their overall affinity for digital technology, while Dede suggests that Millennials maintain a unique learning style grounded in ubiquitous, mediated immersion of digital content.[23] Dede also proposes that Millennials are profoundly affecting traditional higher education, sparking institutional changes on strategic investments in physical plants, technology infrastructure, and professional development.

Study

Perception is the operationalized group of nested cognitive processes (e.g., attention, consciousness, and memory) from which users make sense of their external worlds.[24] Understanding how users perceive the applicability of particular technologies in task-oriented contexts is extremely important to both LIS researchers and practitioners. The development of such knowledge aids decision makers in preparing a more accurate view of user expectations. Various interdisciplinary literature on technology adoption and use reinforces this assertion.[25] In such research, user perceptions (i.e., psychological determinants such as perceived ease of use, perceived usefulness, and perceived user resources) are paramount. Ultimately, psychological determinants structure user attitudes toward adoption of a particular technology.

This research uses methods rooted in psychophysics, the measuring of users' perceptions of physical properties of environmental stimuli.[26] Perceptual data contribute to research on the similarity and dissimilarity of stimuli as well as the estimation of perceptual magnitude between stimuli.[27] Today, individuals in both academic- and practice-based contexts use such methods to simplify data sets into underlying psychological constructs representing participants' perceptions of physical objects and alternative representations of physical objects. As such, the focus of this research is to measure the incoming perceptions of academic library users toward the five communication media, not familiarity or comfort with the media. Eisenberg, Oyarce, Rorissa, and Rorvig also use psychophysical methods in LIS research.[28]

During the fall of 2006, academic library users at the University of North Texas (UNT) were asked to participate in this study. Solicitation of participants occurred both by face-to-face contact and through e-mail. As shown in table 1, 43 percent of the participants reported being between nineteen and thirty years old ($n = 18$). By comparison, the mean age of all students at the university during the study period was 24.4 years old.[29] Participation involved users completing a short, paper-based

survey. In total, forty-two users participated, a sufficient number to ensure that the communication media were significantly different. [30] The five communication media (i.e., scalable objects and psychological stimuli) are as follows:

- Paper-based pamphlet (object 1), shown in figure 1
- 2D webpage (object 2), shown in figure 2
- 3D immersive GUI (object 3), shown in figure 3
- Actual survey included a graphic representation (objects 4 and 5)

iNStruMENt

The survey instrument follows a generally accepted format for acquiring data through responses to pairwise (paired) comparisons, a research method used in communication studies, zoology, public health, and various other disciplines. In short, the pairwise comparison method requires a participant to vote on objects presented in pairs relative to a given question or scenario. By counting the

Figure 1. Paper-Based Pamphlet

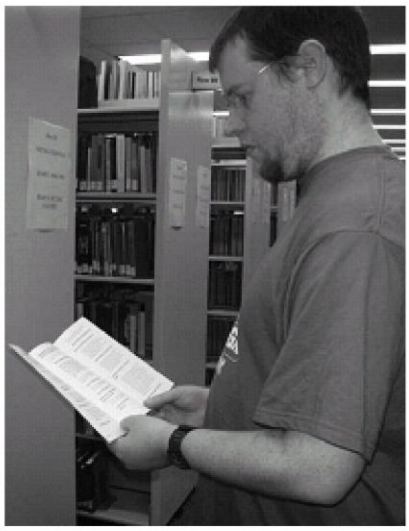


Figure 2. 2D Webpage

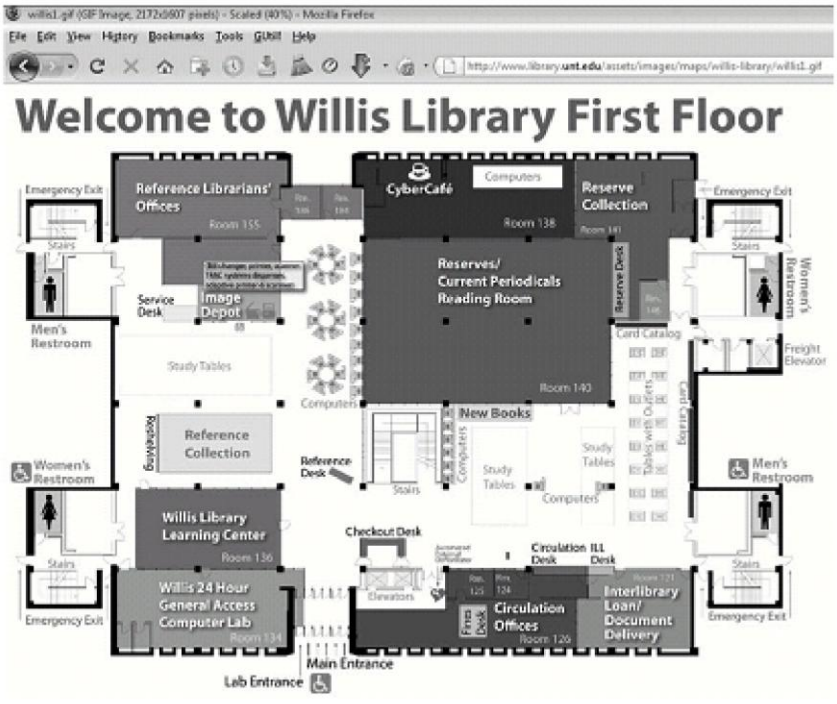


Figure 3. 3D Immersive GUI

votes for each pair, researchers are able to derive a preference ranking of the objects relative to the given question or scenario. Pairwise comparisons are a common voting method, used in the soft drink taste test, for example. In such a test, the participant is first presented with two cups, one marked A and the other B, with each containing a particular soft drink, the specific brand of which he or she does not know. The administrator informs the participant to take a sip from each of the two cups. Next, the administrator asks the participant, "Which soft drink do you prefer, A or B?" The participant then indicates to the administrator or records in some fashion his or her preference. In short, pairwise comparisons solicit votes of preference by participants. The soft drink taste test example presents participants with only one pairwise comparison, whereas the survey instrument used in this study presented participants with a series or group of comparisons for the respective questions.

The textual content of the survey instrument consists of three questions. Using the same list of scalable objects (the five communication media previously listed), two of the three questions include ten pairwise comparisons each, and the third question solicits descriptive information regarding the participant's age bracket. The survey instrument does not collect data on gender, economic background, or hours spent using particular communication media per week because of a desire to keep the data collection process as brief as possible without sacrificing the overall value of the research. Moreover, research on digital game use indicates that age may be the most important categorical factor in predicting user expectations.[31] The first question (Q1) asks, "Which type of medium would you rather use for acquiring information on the physical layout of the library?" The second question (Q2) asks, "Which type of medium would you rather use for receiving instruction on various library services and information literacy skills?" In addition to its textual content, the survey instrument provides graphics exemplifying the scalable objects to guide participants should any confusion on those communication media relative to the given questions arise.

Over a three-week period during the fall 2006 semester, we administered the survey instrument to two participant groups in physical classroom environments on the UNT campus. One participant group had thirty-three participants, the other participant group had nine. The survey process took no more than ten minutes for any participant to complete. Before beginning the survey process, participant groups received brief verbal instructions from the administrator. The instructions focused only on the steps necessary to complete the survey process; no discussion of the communication media occurred beyond pointing to the location of the examples provided in the survey instrument. In addition, if a participant had a question or questions during the survey process, the administrator quietly attended to the individual, independent of the rest of the participant group. In short, administrators approached the survey process as a quasi-formal test situation wherein participants could not pass information to one another in any form. The reason for such an environment is simple—to minimize immediate external peer influence on individual responses to the given stimuli.

dAtA ANALySiS

Detailed analysis of the data set was conducted using three nonparametric scaling methods: (1) rank-sum scaling of the objects, (2) circular triad analysis to identify inconsistencies, and (3) multidimensional preference mapping to graphically superimpose the affinity of specific participants

Table 1. Participants' Age Brackets

Age Bracket	Participants (n = 42)	Percentage
18 or younger	1	2%
19-30	18	43%
31-40	13	31%
41-50	5	12%
51 or older	5	12%

Table 2. Rank Totals and Scale Scores for Q1

object	rank total	Scale Score
Min	42	0
1	141	59
2	163	72
3	157	68
4	62	12
5	107	39
Max	210	100

with specific objects. [32] Ultimately, applying these three related yet distinct methods allowed for the desirable triangulation of analytic efforts. Data collected on participants' age brackets were purely descriptive and therefore not addressed in this section; however, those findings are integrated into both the discussion and conclusion sections of this article.

Comparability of Communication Media: Rank-Sum Scaling

Analysis of Q1 indicated that objects 2 and 3 grouped closely together, with the remaining three spread out across the unidimensional scale (see figure 4). As shown in table 2, rank totals across the forty-two participants' choices for communication media resulted in 62 for object 4, 107 for object 5, 141 for object 1, 157 for object 3, and 163 for object 2. Table 3 shows that rank-sum differences between the five objects range from 6 (the difference between objects 2 and 3) to 101 (the difference between objects 2 and 4). Eight of the ten rank-sum differences are beyond the critical value of 16 to reach significance at the $p < .001$ level. As shown in table 2, rank totals were converted to scale scores on a 0-100 scale and are graphically displayed in figure 4.

Table 3. Rank-Sum Differences for Q1

	2	**3**	**1**	**5**	**4**
2	0				
3	6	0			
1	22	16	0		
5	56	50	34	0	
4	101	95	79	45	0

Analysis of Q2 indicated that objects 1 and 5 grouped together somewhat closely, while object 2 ranked the highest (see figure 5). Table 4 shows that rank totals across the forty-two participants' responses resulted in 73 for object 4, 122 for object 5, 128 for object 1, 141 for object 3, and 166 for object 2. Table 5 shows that rank-sum differences between the five objects range from 6 (between objects 1 and 5) to 93 (between objects 2 and 4). Eight of the ten rank-sum differences are beyond the critical value of 16 to reach significance at the $p < .001$. As shown in table 4, rank totals were converted to scale scores on a 0-100 scale and are graphically displayed in figure 5.

Identifying Inconsistencies: Circular Triads

The second analytic method focused on identifying any circular triads or intransitive choices indicating inconsistencies between participant responses. By identifying the object or objects that caused several participants to be inconsistent

Figure 4. Unidimensional Display of Scale Scores for Q1

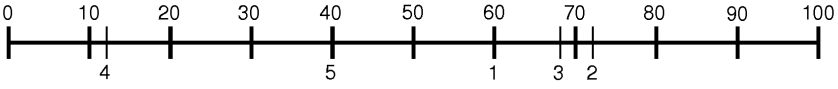


Figure 5. Unidimensional Display of Scale Scores for Q2

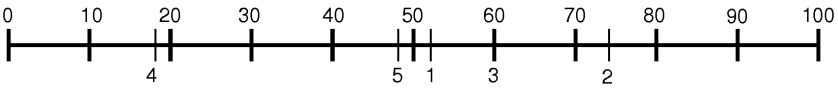


Table 4. Rank Totals and Scale Scores for Q2

object	rank total	Scale Score
Min	42	0
1	128	51
2	166	74
3	141	59
4	73	18
5	122	48
Max	210	100

Table 6. Summary of Circular Triad Analysis for Q1

object	Ct's in	votes	Scaled
1	3	99	58.93
2	3	121	72.02
3	4	115	68.45
4	2	20	11.90
5	3	65	38.69

and/or locate a particular participant responsible for a large number of circular triads, we were better able to determine both object scalability and individual participant consistency. For the first two questions, none of the participants or objects were removed for this iteration of analysis; however, future retests may include such actions. Ultimately, this method helped confirm the rank-sum scaling results as well as assess the overall quality of the previously untested data collection instrument.

For Q1, forty of the participants were consistent in their choices, whereas two responded with circularity. Table 6 shows a summary of circular triad analysis, including an itemization of objects by the number of circular triads associated with each. Note that the scale values provided mirror those derived from the rank-sum scaling analysis described in the previous section. Object 3 produced the most circular triads (4), whereas object 4 generated the fewest (2).

Table 7 provides a general summary of the circular triad analysis for Q2. Object 2 triggered the most circular triads (7), whereas object 1 initiated the fewest (1). Thirty-six of the participants were consistent in their choices, while six demonstrated circularity.

Table 5. Rank-Sum Differences for Q2

	2	**3**	**1**	**5**	**4**
2	0				
3	25	0			
1	38	13	0		
5	44	19	6	0	
4	93	68	55	49	0

Table 7. Summary of Circular Triad Analysis for Q2

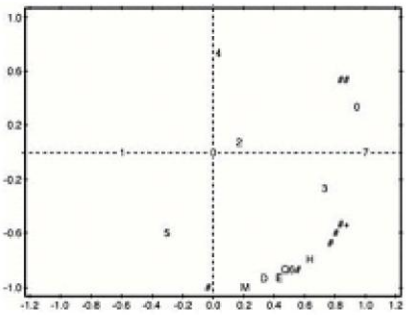
object	Ct's in	votes	Scaled
1	1	86	51.19
2	7	124	73.81
3	4	99	58.93
4	5	31	18.45
5	4	80	47.62

Scaling Participants and Objects: Multidimensional Preference Mapping

Multidimensional preference mapping (MDPREF)—based upon the matrix theorem of Eckhart and Young and also known as geometric factor analysis—was applied to the data set to situate the objects and the participants in the same analytic, psychological space.[33] The primary motivation for using this method was to provide a visualization of specific subgroups of participants with specific objects. The various distances between subgroups and objects represent participants' perceptions of similarity and dissimilarity between points. As the remainder of this section details, MDPREF analysis indicated that, for both questions, each of the five objects maintained different levels of distinctness among one another and participant subgroups.

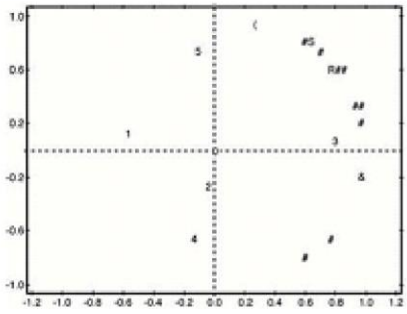
MDPREF analysis of Q1 (see figure 6) indicated various alignments. For example, objects 1 and 5 collocate on the left side of the y-axis, with objects 2, 3, and 4 collocating on the right side of the y-axis. This specifies some level of significant difference between the former objects and the latter. In addition, because each of the three latter objects is located within the right-side plots, some level of alignment is also present among these objects. The most interesting observation is that object 3, as opposed to object 2, lies within the lower-right-hand plot of the graph; this space also includes the majority of participants.

Figure 6. Plot of Objects and Participants in First Two Dimensions for Q1



Note: Multiple points identified as #. First five points are objects, and remaining points are participants.

Figure 7. Plot of Objects and Participants in First Two Dimensions for Q2



Note: Multiple points identified as #. First five points are objects, and remaining points are participants.

Figure 7 shows that, for Q2, objects 1 and 5 are collocated within the upper-left quadrant of the plot, objects 4 and 2 are closer to one another within the lower-left quadrant of the plot, and object 3 is located to the right side of the x-axis. In addition, the participants' locations are more widespread than Q1; however, they do loosely mirror Q1 results, indicating an affinity for particular communication media across both questions. Furthermore, it is noteworthy that the participants appear to align closest with object 3, as they did with Q1.

diSCuSSioN

This section presents select interpretations related to the findings in the data analysis section. Overall, the three interpretations deemed most noteworthy are that (1) the 2D webpage was the preferred communication medium across both questions; (2) preference for the audio-only communication medium was remarkably low across both questions; and (3) the 3D immersive GUI received considerable preference for use in relation to Q1, as well as adequate evidence warranting further research on its use in Q2 instruction.

Q1: Library Layout

Both rank-sum analysis and circular-triad analysis established that the majority of participants preferred the existing 2D webpage communication medium, with the 3D immersive GUI following close behind. The authors initially expected a portable, paper-based document, such as a pamphlet, to be preferred, since the question focuses on concepts related to spatial information. Therefore it is noteworthy that both the 2D webpage and 3D immersive GUI received higher preference rankings. Also, considering the increase in discourse throughout the LIS community championing podcasting, the low preference ranking of the audio-only communication medium is interesting. In addition, MDPREF results indicate that participants' placements appear most aligned, or generally closest, with the 3D immersive GUI. Such placement suggests a level of preference for this communication medium not evident in the rank-sum and circular-triad results.

Q2: Information Literacy

In both rank-sum and circular-triad analyses, the 2D webpage ranked significantly higher than the other four communication media. This outcome was particularly interesting, since this question concerns users involved in tasks associated with learning information literacy skills. It ran contrary to the researchers' initial expectation that Millennial users, the largest subset of the sample, would be more likely to choose the 3D immersive GUI over other communication media. Also, like Q1, a significant lack of preference toward audio-only is noticeable. Perhaps users over eighteen years old (all but one of the study participants) do not associate this communication medium with educational tasks. In addition, 2D webpage, 3D immersive GUI, and A/V each involved similar numbers of circular triads; however, as previously stated in the data analysis section, the decision was made not to remove them from this iteration of analysis. Nonetheless, this observation suggests that participants

had a difficult time making firm decisions on the applicability of each of these communication media relative to one another. MDPREF analysis did not further reveal the relationship between the 2D webpage, 3D immersive GUI, and A/V—although, like Q1, it indicated a certain level of enthusiasm for the 3D immersive GUI not initially evident in the rank-sum and circular-triad analyses.

CoNCLuSioN

This discussion addressed research on academic library user preferences related to five communication media used to facilitate two forms of library instruction. The corresponding study began with a survey instrument administered to forty-two participants over a three-week period in the fall of 2006. Upon completion of the data collection process, three separate scaling methods were applied to the data set. Analysis indicates an overall preference for the 2D webpage approach, as well as notable enthusiasm for the 3D immersive GUI, the principal user interface throughout current digital gaming technologies. Analysis also shows an overall lack of preference toward the audio-only communication medium.

It is noteworthy that the scaling methods used here allow one to quantify user preferences toward an object, concept, and so on. For example, Participant A *likes* the 2D webpage *more* than audio-only and paper-based media. In formal statistics, such data are of the ordinal type. Ordinal data require nonparametric analysis; however, parametric methods are traditionally preferred in LIS research.[34] Parametric methods allow one to generalize findings to a larger population, whereas nonparametric methods are more or less free from assumptions and therefore do not allow for generalizations. Nonetheless, scaling methods offer LIS researchers a variety of important perspectives when properly applied. For example, researchers debating whether or not to conduct extensive statistical studies in areas similar to those presented here could adopt these or related methods for an initial small-scale test period that would allow them to gauge preliminarily the accuracy of their incoming assertions. In such cases, scaling methods would facilitate a sort of statistical litmus test. Thus, while not as powerful or robust as parametric methods, given an adequate participant to objects ratio, the results of these nonparametric methods can guide researchers and other decision makers in determining whether or not more advanced, resource-intensive, statistical studies are appropriate.

Ultimately, in this study it is most important that the 2D webpage received the highest preference ranking across both questions. Furthermore, the significant lack of interest in audio-only is a bit startling, considering the enthusiasm by many LIS practitioners for podcasting in an educational capacity. Perhaps practitioners should investigate more extensively the application of this communication medium for such purposes. In addition, this study indicates noteworthy preference for application of a 3D immersive GUI in library instruction, particularly any educational efforts involving the communication of spatial information concerning a physical library facility. Also, considering the results of all three analytic methods for Q2, the same likelihood may also exist for the 3D immersive GUI as a medium for information literacy instruction. In the future, the authors plan to continue research in the areas of digital gaming and library instruction, in particular improving the data collection instrument through both content expansion and migration onto a digital platform; collecting larger data sets for analysis with similar methods; and interviewing instructional librarians, library administrators, and digital game designers to solicit their perspectives on the findings in this article as well as future outcomes of research.

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APPENDIX C

PERSON AS INSTRUMENT STATEMENT

PERSON AS INSTRUMENT

Academic libraries provide educational programs and services to their users via a range of instructional media. One such medium is the digital game. There are many approaches to using digital games for library instruction, from the provision of online educational games that incorporate information literacy concepts to presenting an entire digital library and its services via a three-dimensional (3-D) game-like user interface.

While library and information science (LIS) discourse concerning digital gaming exists in many areas, including library instruction, there is little discussion within that discourse of whether or not the most important human component in the equation – the user – perceives the idea of digital gaming in library instruction as useful. Thus, the purpose of this mixed methods quasi-case study is to explore undergraduate library users' perceptions of digital gaming in library instruction, relative to other possible instructional media, like audiovisual and audio-only presentations (e.g., podcast). Data is collected via an electronic survey instrument, unobtrusive observations of library instruction sessions, and semi-structured interviews with undergraduate library users. By using these three methods, I take on the role of person as instrument.

Good scholarly research is dependent upon the establishment of trust. As a research instrument I am aware of the various challenges inherent in this study. I am also aware that such challenges are overcome by way of developed knowledge and skills that over time leads to competence and trustworthiness. Furthermore I acknowledge that what I bring to this study is unique, as I believe that individual knowledge is subjectively constructed via social interactions. In other words, every

human being maintains his or her own unique set of perceptions, experiences, values, and attitudes. Thus mine may shape my perspectives while conducting the multiple aspects of the research study. As the following indicates, my background was formed via strong mentorship, active learning and instruction, and professional experiences.

First, I have been playing digital games – primarily console and computer - regularly since elementary school (1980). Today, I am an avid gamer. I am fascinated by the social and technical aspects of the medium, as much as the act of play itself. Ultimately, the totality of my experiences as a gamer strongly supports the claim from educational psychology that the act of play leads to meaningful learning.

Similarly, I have been using digital technology in an educational capacity, from intermediate school (1987) to the present day. I started using Web-based instructional media in 2002 as a student working towards my Masters in Information Science (MIS), with a focus on information systems, at the University of North Texas (UNT), in Denton, Texas. The large majority of courses I took part in while working on my MIS were either entirely Web-based or blended, that is, containing both face-to-face and online components. These courses allowed me to experience a wide variety of approaches to technology-based teaching and learning. Some experiences were positive, others less so. The quality of each experience was in large part driven by three factors: 1) the instructor's willingness to embrace technology; 2) the stability and consistency of the technology; and 3) the appropriateness of the chosen media for achieving the learning objectives as outlined by the instructor. If any one of these three factors was not sufficiently met or addressed by the instructor or the university system, then my learning experience more often than not turned out to be unfulfilling.

Since beginning the interdisciplinary doctoral program in information science at UNT in the fall of 2005, I have worked with and learned from several outstanding faculty members in the Department of Library and Information Sciences (DLIS), such as Dr. Ana Cleveland and Dr. Donald Cleveland, using various Web-based applications to provide graduate level instruction. In every instance I have worked as either a teaching assistant or teaching fellow and coupled with my experiences as a MIS student, labored to incorporate as many aspects of strong pedagogy as possible in a technology-based learning environment. This work has included the design, development, and administration of multiple graduate courses currently offered by DLIS. Ultimately my end-use experiences as both a student and instructor, along with my doctoral research in various areas related to learning technologies, has helped me to develop an intimate knowledge of the strengths, limitations, complexities, and potential various technology-based delivery methods offer undergraduate library users for library instruction.

My coursework as a doctoral student, from 2005 – 2007, also helped to develop my place as a qualified researcher, by laying the groundwork for future research streams. I am so very fortunate to have had a great number of truly brilliant and experienced instructors during that time period; so much so that I cannot list them all here. Nevertheless, with the leadership of committee co-chairs Dr. Greg Jones and Dr. Brian O'Connor I followed a diverse path of coursework. A major component to Dr. Jones' research is in the use of games and simulations for teaching and learning. As such, I have worked with Dr. Jones since beginning the doctoral program, collaborating with him on various research projects, articles, and other endeavors. During the aforementioned time period, my coursework included an introduction to geographic

information systems (GIS) with Dr. Bruce Hunter, wherein I discovered the strength and effectiveness of information visualization on human learning and decision making. I also explored the role of human cognition with regard to teaching and learning with Dr. Jon Young, as well as human factors in computing and technology planning with Dr. Cathleen Norris. Furthermore I am privileged to have had the opportunity to study scaling methods with Dr. Gerald Knezek. Dr. Knezek guided me through the process of how to apply well-established research design and methodology to help solve user problems. His instruction led to my composition of a research article published in the American Library Association (ALA) journal, *Reference and User Services Quarterly* (RUSQ). RUSQ is considered a top-tier journal within the LIS community, particularly on the practice-based side. Ultimately, the study that the article reports on acts as a pilot to my dissertation research, thus lending accuracy to the findings of this larger study.

With regard to practice, I have experience as a user and employee of academic libraries. As a user I have been dependent upon library resources and services since 1994 when I began undergraduate work in writing composition at Southern Methodist University in Dallas, Texas. After transferring to UNT in 1996, I began working as a library assistant at Willis Library in 1999 in the borrowing division of the Interlibrary Loan (ILL) Department. From 1999 through 2004 I took on increasing responsibilities in ILL, including independent duties normally assigned to staff with a Masters in Library Science. These duties included the training of other library assistants on the integrated Web-based interlibrary loan system used by the department, ILLiad. Considering the wealth of positive experiences I accumulated as a library employee, primarily with

regard to user services, that is, helping people meet their information needs, I decided to pursue a long-term career related to academic libraries.

During my course of employment at Willis Library, I developed a number of professional relationships with individuals in various departments. Those relationships exist to this day, and therefore allow me to stay in tune with many of the issues facing the library and its staff. Furthermore, if one stays up-to-date with the professional LIS literature, it is apparent that the library instruction issues facing Willis Library are in large part the same as those facing many academic libraries today. For example, two issues expressed to me by UNT Libraries staff early on in my doctoral work are issues that I believe to have strong potential to influence the long-term relevance of the physical academic library within its broader, parent system. The first issue is determining how best to provide undergraduates engaging, motivating, and ultimately effective library instruction. The second issue is how best to deal with the increasing influx of potential instructional technologies. That is, how to determine what technologies are truly useful to their users amongst a sea of options so that decision makers can develop technology plans that are not constantly threatened by the latest, greatest innovative gadget or application that vendors offer or self-styled trend setters on staff desire.

Therefore, resting upon a social constructivist/pragmatist foundation, my goal is to conduct research with practical applicability, that is, research that is appropriate and useful for academic library decision makers, particularly in the areas of technology planning and instructional services. As such, I am concerned with participants' perceptions of digital gaming in library instruction, as well as the appropriateness of an existing characterization of younger users (i.e., digital natives) relative to the participant

sample. Called for or not, characterizations often influence decision makers' perceptions of library users' technology expectations. Ultimately library decision makers can use knowledge generated from this study to inform the development of current and future technology plans as well as instructional programs and services.

APPENDIX D

LETTER OF ACCEPTANCE BY UNIVERSITY OF NORTH TEXAS

INSTITUTIONAL REVIEW BOARD

UNT
UNIVERSITY OF
NORTH·TEXAS
DISCOVER THE POWER OF IDEAS

May 14, 2008

OFFICE OF THE VICE PRESIDENT FOR RESEARCH
Office of Research Services

Michael Robertson
Department of Learning Technologies
University of North Texas

Re: Human Subjects Application No. 08-162

Dear Mr. Robertson:

As permitted by federal law and regulations governing the use of human subjects in research projects (45 CFR 46), the UNT Institutional Review Board has reviewed your proposed project titled "Digital Gaming in Library Instruction: Exploring Academic Library Users' Perceptions." The risks inherent in this research are minimal, and the potential benefits to the subject outweigh those risks. The submitted protocol is hereby approved for the use of human subjects in this study. **Federal Policy 45 CFR 46.109(e) stipulates that IRB approval is for one year only, May 14, 2008 to May 13, 2009.**

It is your responsibility according to U.S. Department of Health and Human Services regulations to submit annual and terminal progress reports to the IRB for this project. Please mark your calendar accordingly. The IRB must also review this project prior to any modifications.

Please contact Shelia Bourns, Research Compliance Administrator, or Boyd Herndon, Director of Research Compliance, at extension 3940, if you wish to make changes or need additional information.

Sincerely,

Kenneth W. Sewell, Ph.D.
Chair
Institutional Review Board

KS:sb

CC: Dr. Greg Jones

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