

PREDICTING THE PERFORMANCE OF INTERPRETING INSTRUCTION
BASED ON DIGITAL PROPENSITY INDEX SCORE
IN TEXT AND GRAPHIC FORMATS

by

DAVID KENT NORMAN
B.B.A. The University of Texas at Tyler, 2002
M.S. University of Central Florida, 2005

A dissertation submitted in partial fulfillment of the requirements
for the degree of Doctor of Philosophy
in the Department of Educational Research, Technology, and Leadership
in the College of Education
at the University of Central Florida
Orlando, Florida

Summer Term
2008

Major professors: Atsusi Hirumi
Stephen A. Sivo

©2008 David Kent Norman

ABSTRACT

Practitioners have proposed that Digital Natives prefer graphics while Digital Immigrants prefer text. While Instructional Design has been extensively studied and researched, the impact of the graphical emphasis in instructional designs as it relates to digital propensity has not been widely explored. Specifically, this study examined the performance of students when presented with text-only and graphic-only instructional formats. The purpose of this study was to test the relationship between Digital Propensity Index scores of individuals and their performance when interpreting online instruction. A sample of students from the population of a large metropolitan university received the Digital Propensity Index questionnaire, which is a measure of an individual's time spent interacting with digital media. Each student was randomly assigned varying formats of a computer-based instructional unit via a public survey. The instructional unit consisted of the DPI questionnaire and six tasks related to the Central Florida commuter rail system.

Participants were asked to answer the DPI questionnaire on a website by clicking on a link in an emailed invitation. Following the DPI questionnaire, participants were randomly assigned to one of two groups. Group One saw three instructional tasks shown in text and shuffled in random order. Each task was displayed on its own webpage. By submitting an answer to the task, the group progressed through the website to the next task. Group Two saw graphic tasks first, again, shuffled in random order. After the first three tasks, the groups swapped instructional formats to view the opposing group's initial

questions. Participants were timed on how many seconds they spent reviewing each task. Each task had an assessment question to evaluate the learning outcomes of the instructional unit. Finally, the DPI score of the participant was matched with the time spent viewing each presentation format.

The findings indicate that DPI score had a statistically significant prediction of time spent navigating each type of instruction. Though the link between DPI score and time spent navigating instruction was statistically significant, the actual measurable time difference between navigating text and graphic formats was only a fraction of a second for each increment in DPI score. Limitations and potential future research related to the study are discussed as well.

One thing nobody can take from you is your education.
George Norman

ACKNOWLEDGEMENTS

This research would not have been possible without the following people, which earned my sincere thanks:

- Atsusi “2c” Hirumi, Stephen A. Sivo, Laura Blasi, Chuck Dziuban, and Mike Robinson each had an important role in guiding this work to become a body of research.
- My wife Mariann who always knew I could do it.
- Dries Buytaert for managing the Drupal software I used for the survey engine.
- Tia Meier for her occasional high spirited comments late at night.
- My relatives of all types for providing the example that inspired me to go this far.
- Leah Mitchell for just being an awesome graduate coordinator.

TABLE OF CONTENTS

LIST OF FIGURES.....	xi
LIST OF TABLES.....	xii
LIST OF ACRONYMS/ABBREVIATIONS.....	xiv
CHAPTER ONE: INTRODUCTION.....	1
Purpose of the Study.....	3
Null Hypothesis.....	4
Definition of Terms.....	4
Assumptions.....	5
Significance of Study.....	6
Organization of the Study.....	7
CHAPTER TWO: REVIEW OF LITERATURE.....	8
Theoretical Foundation.....	8
Empirical Research.....	9
Digital Differences.....	10
Schema Theory.....	15
Media Research.....	19
Summary.....	23
CHAPTER THREE: METHOD.....	25
Study Population and Sample.....	25
Research Design.....	28

Ethical Considerations.....	29
Instructional Material.....	29
Measures.....	31
Measure Reliability and Validity.....	33
Procedure and Data Collection.....	35
Data Analysis.....	37
Limitations.....	37
CHAPTER FOUR: RESULTS.....	39
Null Hypothesis.....	39
Findings.....	40
Combined Text Question Times.....	41
Combined Graphic Question Times.....	42
Combined Total Question Times.....	44
Question 1: Text.....	45
Question 2: Text.....	46
Question 3: Text.....	47
Question 4: Graphic.....	49
Question 5: Graphic.....	50
Question 6: Graphic.....	51
Self-reported Graphic Preferences.....	52
Post-hoc Analysis.....	52
Chapter Summary.....	53

CHAPTER FIVE: DISCUSSION.....	54
Interpretation of Hypothesis.....	55
Digital Differences.....	56
Schema Theory.....	56
Media Research.....	57
Limitations.....	58
Population Effects.....	58
Ecological Effects.....	58
Repeated Testing.....	59
Ceiling Effect.....	60
Implications and Suggestions for Future Research.....	60
Chapter Summary.....	62
APPENDIX A: STRATIFIED RANDOM SAMPLING CALCULATIONS.....	64
APPENDIX B: DATABASE-BASED RANDOM SELECTION.....	66
APPENDIX C: REGRESSION EQUATIONS.....	68
APPENDIX D: SURVEY INSTRUMENT.....	73
APPENDIX E: SURVEY SOFTWARE ADMINISTRATION SCREENS.....	90
APPENDIX F: IRB APPROVAL.....	97
APPENDIX G: FIRST CONTACT: PRENOTICE LETTER.....	101
APPENDIX H: SECOND CONTACT: QUESTIONNAIRE MAILOUT.....	103
APPENDIX I: THIRD CONTACT: THANK YOU REMINDER.....	105
APPENDIX J: FOURTH CONTACT: THANK YOU REMINDER.....	107

APPENDIX K: COPYRIGHT PERMISSION.....	109
APPENDIX L: PERMISSION TO CONTACT CLASSIC GRAPHICS EMPLOYEES	111
REFERENCES.....	113
INDEX.....	119

LIST OF FIGURES

Figure 1. Examples of text and graphic instructional units.....	30
Figure 2. Instructional task formatting template.....	31
Figure 3. Regression lines for text and graphic performance predicted by DPI regardless of achievement.....	43
Figure 4. Regression lines for text and graphic performance predicted by only correct responses.....	44

LIST OF TABLES

Table 1. Comparison of Digital Immigrants and Digital Natives (Prensky, 2001a).....	11
Table 2. Communication functions of graphics.....	21
Table 3. Psychological functions of graphics.....	22
Table 4. Randomized counterbalancing for instructional presentation.....	28
Table 5. Blueprint of allotment for instruction and assessment presentation methods.....	30
Table 6. HTTP headers for requesting survey from web server.....	33
Table 7. Anticipated reliability coefficient improvements with items removed.....	34
Table 8. Survey process.....	36
Table 9. Summary descriptive statistics on instructional units.....	41
Table 10. Significance of predictor variables for Question 1.....	46
Table 11. Significance of predictor variables for Question 2.....	47
Table 12. Significance of predictor variables for Question 3.....	48
Table 13. Significance of predictor variables for Question 4.....	49
Table 14. Significance of predictor variables for Question 6.....	51

LIST OF ACRONYMS/ABBREVIATIONS

DI	Digital Immigrant
DN	Digital Native
DPI	Digital Propensity Index
GenMe	Generation Me
HTTP	Hypertext Transfer Protocol
N-Gen	Net Generation
URL	Uniform Resource Locator

CHAPTER ONE: INTRODUCTION

In the past two decades, digital revolutions have fundamentally changed the way the world works. The revolutions are perhaps most recognizably related to interaction with information and digital technology (Concerning the effect, 1999). In 1999, sales of software targeted for children age 3 to 6 totaled \$309 million (Galley, 2000). This gives those children the ability to be efficient symbol users and manipulators earlier in development (Elkind, 2001). A new lifestyle, based on digital, self-directed experiences, may have fundamentally and irreversibly changed how today's students think, to a point where our education system is not designed to teach to their new thinking patterns (Prensky, 2001a).

Prensky (2001a) coined the term "Digital Native" (DN) to refer to younger people who are the product of time spent with computers, video games, digital music players, video cameras, cell phones, and other digital toys. DNs are accused of having "the attention span of a gnat" for old ways of learning, favoring instead "anything else that actually interests them" (2001b, p. 4).

Conversely, a "Digital Immigrant" (DI), refers to a person who was not born into a digital lifestyle. An instructor classified as a DI is from the pre-digital age and struggles to teach DNs, whose "native language" is grounded in electronics. Prensky (2001a) identifies the DIs as a population more likely to use the Internet as a secondary resource,

print documents rather than review them on a computer screen, and call email recipients to confirm receipt of emails.

Prensky (2001a) outlines ten generalizations for the preferences of DNs and DIs which he thinks affect learning. He believes DNs prefer to receive information quickly, parallel process, and multi-task. He contends DNs prefer random access to resources, prefer graphics in presentations before text, do best when they are networked, and like to get instant gratification, with frequent rewards. Finally, DNs prefer games to “serious” work. Prensky's DIs prefer performing linear tasks slowly, individually, and as part of a serious process.

As evidence for why DNs and DIs think differently, Prensky (2001b) suggests researching neuroplasticity, psychology, and studies of children using games for learning. He discusses psychological malleability, attention span, and the design of games as variables within each respective category of evidence. He claims the difference between DNs and DIs is evident in teaching styles and is the cause of why DNs can't pay attention to instruction.

A closer evaluation of Prensky's (2001b) evidence shows that he appeals to his readers' idea of common sense; each argument is presented in a format of common, general knowledge. Prensky even admits he had only anecdotal observation of DNs and his evidence is not systematically researched; his statements regarding DNs are left for someone else to prove. A theoretical framework and empirical data are lacking on how to optimize instruction for individuals with a digital lifestyle. Such adaptations may not even be necessary. This study is inspired by Prensky's claim that younger people “prefer

their graphics before their text rather than the opposite” (2001a, p. 2). Specifically, this study examined the performance of students when presented with text-only and graphic-only instructional formats rather than the opposing layouts of presentation suggested by Prensky (2001a).

Purpose of the Study

This study investigates the connection between digital propensity, a measure of an individual’s digital activity, and the performance of students when information is presented with text-only and graphics-only content on separate web page screens. Some examples of digital activity measured by the DPI include hand-held electronics use, gaming, distance education, entertainment, and Internet use. The investigation was conducted in a distance education setting and used a computer-based task. The study works to answer the research question, “To what degree does Digital Propensity Index score predict the response time for instruction moderated by graphics and text formats?” Reviewing the time spent on instruction is not sufficient in educational settings. Achievement is important to measure the take-away from instruction. This study also asks whether any observed performance variations are the result of the participants having answered assessment questions correctly or incorrectly based on the content of each presentation format.

Null Hypothesis

To answer the research question, the following null hypothesis is posed:

There will not be a statistically significant relationship between the participants' time spent viewing graphics as compared to text and their Digital Propensity Index score.

Definition of Terms

Digital activity – Time a person spends interacting with electronic media including, but not limited to, cellular phones, television, video games, computers, and other microprocessor-based devices.

Digital Immigrant – A person who did not grow up with electronics, but at some point adopted aspects of new technology, and is compared to DNs (Prensky, 2001a).

Digital Native – A person, who in present day is in the age group between kindergarten and college. They have spent their entire life surrounded by, and are a “native speaker” of the digital language of, computers, video games, mobile phones, video cameras, digital music players, and the Internet (Prensky, 2001a).

Digital Propensity – Rating on a continuum scale as a numerical representation of how often people use technology in their daily lives (K. L. Henderson, personal communication, June 23, 2006; Henderson & Hirumi, 2005). It follows that Digital Propensity is a product of digital activity.

Graphic – An iconic expression of content, either representational or interpretive, meant to depict an object or illustrate a theory, principle, or cause-and-effect relationship (Clark & Lyons, 2004). For the purposes of this study, a graphic differs from a decorative figure meant to provide aesthetic appeal.

Schemata (schema) – “The idea that there are mental frameworks for comprehension” (Bruning, Schraw, Norby, & Ronning, 2004, p.1). “Schemata are mental frameworks we use to organize knowledge. They direct perception and attention, permit comprehension, and guide thinking” (Bruning, Schraw, Norby, & Ronning, 2004, p. 6).

Assumptions

The scope and boundaries of the study are presented as basic assumptions.

1. Respondents report honestly and provide accurate data and information regarding their digital propensity and reactions to graphics versus text presentations.
2. The survey instruments accurately identify the digital propensity of learners.
3. The Digital Propensity Index Questionnaire is valid outside the realm where it was validated.
4. Graphics are not clearly defined by Prensky (2001a). Therefore for the context of this study graphics will be defined using the interpretive and representational definitions from Clark and Lyons (2004).

Significance of Study

The Digital Propensity Index may be a useful instrument for accommodating new instructional preferences. The relationship of DPI score and learning performance has significance for practitioners and researchers. The analyzed data may produce strategies for instructors to utilize appropriate measures and create instructional materials that more closely match the digital propensity of learners. Findings may help identify tactics to match young adult interests and experience. Matching instruction opportunities to the index propensities of learners may also improve the effectiveness of the instruction.

For researchers, the results of this study will: (a) either add further evidence for or refute findings which previously found reliability in the DPI questionnaire, (b) either add evidence for or bring to question the relationship between Schema Theory and digital propensity, or (c) help determine if digital propensity has a statistically significant impact on the response time for instruction when moderated by text and graphics.

Future lines of research are likely as a result of this study. Future researchers may be able to use the result data as support for linking attitudes, motivations, or performance to varying instruction methods. Modifications to the DPI questionnaire may also need to be investigated. Researching which, if any, schema scripts are linked to each end of the DPI scoring spectrum will provide evidence for the strength of the link between DPI score and Schema Theory as its underlying theoretical framework. Such findings will increase the effectiveness of training and educational materials by outlining general guidelines for the emphasis of graphics and text in instructional content.

Organization of the Study

This dissertation is divided into five chapters. Chapter One introduced the problem statement and described the specific problem addressed in the study. It also discussed design components. Chapter Two presents a review of literature and relevant research associated with the problem addressed in this study, including discussion of digital differences, Schema Theory, and media research. Chapter Three presents the methodology and procedures used for data collection and analysis. Chapter Four contains an analysis of the data and presentation of the results. Chapter Five offers a summary and discussion of the researcher's findings, implications for practice, and recommendations for future research.

CHAPTER TWO: REVIEW OF LITERATURE

Chapter Two reviews research and literature related to each of the major variables under study in order to inform the design and implementation of the study. It begins with a review of empirical literature related to Prensky's (2001a, 2001b) proposition on new, digital brain patterns. Schema Theory is discussed as a possible explanation for the differences between DNs and DIs. The third section reviews brain research related to graphics, their relationship to learning, and strategies for optimizing their use in learning.

Theoretical Foundation

The foundation for this study is grounded in Schema Theory. Schema Theory holds that learners have mental frameworks which are used to direct attention and organize knowledge (Bruning, Schraw, Norby, & Ronning, 2004, p. 48; Henderson, 2007). "Schemata have proposed that knowledge is organized into complex representations called schemata (sing. schema) that control the encoding, storage, and retrieval of instruction (Marshall, 1995; Rumelhart, 1984; Seifert, McKoon, Abelson, & Ratcliff, 1986)" (as cited by Bruning, et al., 2004, p. 48). "Some schemata represent our knowledge about objects; others represent knowledge about events, sequences of events,

actions, and sequences of actions” (Rumelhart, 1981) (as cited by Bruning, et al., 2004, p. 48).

Schema scripts are a repertoire of knowledge structures used to understand a task (Schank & Abelson, 1977). A number of studies have explored the nature of script representation (Abbott, Black, & Smith, 1985; Barslou & Sewell, 1985; Bower, Black, & Turner, 1979; Galambos, 1983; Galambos & Rips, 1982; Grafman, et al., 1991; Haberlandt & Bingham, 1984; Hess, 1992; Hue & Erickson, 1991; Light & Anderson, 1983; Nottenburg & Shoben, 1980; Ross & Berg, 1992; Sirigu, et al., 1995; Sirigu, et al., 1996) (as cited by Rosen, Caplan, Sheesley, Rodriguez, & Grafman, 2003). Specifically, schema scripts are based on the notion that we have episodic memory from personal experiences (Schank & Abelson, 1977). The activation of schema scripts for unfamiliar activities relies on the notion of planning mechanisms which underlie the schema scripts of individuals (Schank & Abelson, 1977). The variation of scripts between individuals is what may explain the performance differences during the instructional intervention of this study.

Empirical Research

This section of the chapter reviews the empirical research on digital learners, Schema Theory, and media. The common trends between various digital populations are identified. These bodies of research provide insight into prior research, suggest strength between the variables, and guide the design of the intervention.

Digital Differences

In a two part publication, Prensky (2001a, 2001b) outlines changes he believes have been contributing to “the decline of education in the US” (p. 1). Prensky makes the assertion that the thinking patterns and brains of today’s students have fundamentally and irreversibly changed, to a point where our education system is not designed to teach to the new thinking patterns. “Digital Immigrants,” those instructors of the pre-digital age, struggle to teach “Digital Natives,” whose “native language” is grounded in the use of digital media. Though Prensky discusses some indirect evidence to reinforce his claims, he confesses he has not systematically researched DNs (2001b).

Prensky’s (2001a) generalizations for the preferences of Natives and Immigrants which he thinks affect learning are outlined in Table 1. The design of the instruction for this study helps determine the validity of Prensky's claims about graphics versus text.

Table 1

Comparison of Digital Immigrants and Digital Natives (Prensky, 2001a)

Digital Immigrants	Digital Natives
1. Merely adopted aspects of new technologies	1. “Spent entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones...”
2. Turn to the Internet second rather than first	2. “Process information differently from predecessors...”
3. Print emails	3. Used to receiving information fast
4. Bring people physically to view websites	4. Like to parallel and multi-task
5. Call to confirm email receipt	5. Prefer graphics before text
6. Used to receiving information slow	6. Prefer random access
7. Prefer text before graphics	7. Function best when networked
8. Prefer linear, step-by-step tasks	8. Thrive on instant gratification and frequent rewards
9. Prefer serious work to games	9. Prefer games to serious work
10. Function best by doing one thing at a time, individually	10. Have short attention spans

Prensky’s list of causes for the differences between DNs and DIs includes the use of computers, video games, digital music players, video cameras, cell phones, and other digital toys. He claims students are spending six times more time playing video games and watching TV than reading. Prensky accuses DNs of having “the attention span of a gnat” for old ways of learning, favoring instead “anything else that actually interests them” (2001b, p. 4); however, complaints of students not paying attention in the classroom is not new (Kassinove & Summers, 1968; Wetstone & Friedlander, 1974).

Just as Prensky coined “Digital Native” and “Digital Immigrant,” Tapscott (1997) coined the term N-Gen which stands for “Net Generation;” he also coined the “Not Generation.” The significant difference between Tapscott and Prensky is Tapscott defined N-Geners by the digital divide, driven by market forces of haves and have-nots, the

wealth gap, and the income of local school districts. N-Geners prefer interactive learning, which includes hypermedia, discovery, and a learner-centered environment in a customized interface. They see teachers as facilitators, think school should be fun, and think learning is a lifelong process. In contrast, a broadcast learning environment is typically teacher-centered, uses a linear process, one-size-fits-all, and a place where learners are supposed to absorb the content. In broadcast learning, the teacher is a transmitter and N-Geners are often disinterested in the teacher's transmission.

Tapscott's proposition regarding the N-Gen also lacks research to support the claimed evolutions of those "who grew up digital." He claims there are pundits for the descriptions of today's youth, but does not say who specifically the pundits are or how they came to their conclusions (1997, p. 9). The explanation on N-Gen learning is based on the discussion of truisms and shifts in learning which have only a loose, almost informal, basis in quantitative or qualitative studies.

Howe and Strauss (2000) have similar weaknesses in their arguments when discussing the people they coined as the Millennial Generation. For example, Howe and Strauss (2000), repeatedly cite emotional high school essays and reports from journalists when discussing the impacts of the Columbine shootings on the Millennial Generation. When Howe and Strauss discuss many of the evolutions and differences in their Millennial Generation, a comfortable majority of the citations are editorials, press releases, news reports, magazines, and op-eds from resources like the Wall Street Journal, New York Times, Forbes, Time Magazine, USA Today, Washington Post, LA Times, Newsweek, and even the fiction novel *Generation X* by Douglas Coupland. These

sources are not necessarily wrong, but rather their content may be more inclined to be based on logical arguments, anecdotal observation, and a sampling of the extremes. This might be done in an effort to drive newsstand sales as opposed to informed research based on a wide range of statistical measures. Howe and Strauss cite statistics from government sources, but draw many conclusions by discussion rather than from statements based on the results of scientific procedure. Critical arguments are illustrated through cartoons rather than statistics and empirical research.

Twenge (2006) presents an academic research angle when defining Generation Me, young people born after 1970. GenMe individuals are known for putting themselves before duty, with a highly optimistic sense of entitlements. Following social rules is not as important as it was 50 years ago, because they can be anything they want to be, though they will be filled with cynicism all the way there. Individual equality is also important to GenMe. Though Twenge has a significant percentage of academic journal citations to support her claims, there is evidence in her citations of just how small the research pool is when trying to describe changes in the new digital population. Specifically, she cites Tapscott (1997) repeatedly and shares some similar citations from Howe and Strauss (2000). Twenge concludes her summary of GenMe with a recommendation to drop self-esteem education, incentives government can provide to help working families, and a tip for parents to teach children self-control. She advises young people to limit TV, avoid over thinking, value social relationships, combat depression, and cultivate realistic expectations; however, none of the conclusions are related to the design of instruction.

Generation M was coined through a study published by the Henry J. Kaiser Family Foundation (Roberts, Foehr, & Rideout, 2005). The study included 2,032 students between the ages of 8 and 18 and noted several major findings. The findings showed young people spend the equivalent of a full-time job with media during the week and have unprecedented access to media. The article called today's youth "masters" of multitasking since two-thirds of the participants reported spending some time using media such as talking on the phone, watching television, instant messaging, or surfing the web while they were doing their homework. Though computers were nearly universal in all households, only 54% of participants used computers in a typical day for recreation versus 81% of participants watching television in a typical day. While the study does find some raw data about the characteristics of Generation M, it confesses the data cannot tell whether heavy media user contributes to a sense of discontent or poor grades. It does not make any attempt to compare or contrast the media use of 8 to 18 year olds with an older population. In fact, the report makes no attempt to draw conclusions beyond merely restating the summaries of self-reported survey responses, meaning the conclusion is simply that 8 to 18 year olds interact with a lot of media. Such findings lend support to suggest a younger population should have a DPI score above 50.

Frans (2000) identified ten characteristics of "the information age mindset" contrasted with the mindset of the industrial age. In the information age mindset, computers are not technology; rather they are a part of life. The Internet, to information age students, is better than TV. To these students, reality is no longer real, doing is more important than knowing, learning resembles a video game and is more trial and error than

logic, multitasking is a way of life, typing is preferred to handwriting, staying connected is a way of life, and they have zero tolerance for delays. The differences between consumers and creators are blurred. Once again, while Frand's observations may make intuitive sense, they are no more than the beliefs of Frand.

A defining thread between GenMe, Millennial, Net Generation, and Prensky's DNs and DIs is their time spent with new technologies as children. The sheer number of hours spent on the Internet has created learning experiences that Tapscott's "Not Generation" does not have, which includes the older population and the children who do not have access to leading edge technologies. In a way, the technology users could be called *digital experts*. A theoretical foundation is needed to explain digital expertise and guide the research. This may be explained by Schema Theory.

Schema Theory

One way cognitive theorists have explained how knowledge is used to interpret experience is a mental framework called schemata. In Schema Theory, long-term memory is used as scaffolding for organizing and processing complex knowledge representations (Bruning, et al., 2004, p. 48; Rumelhart, 1981, p. 4 & 10). The theory focuses primarily on how long-term memory is able to store, recall, and apply information. This section will demonstrate a link between Schema Theory and digital expertise.

As a procedural theory of human information processing (Rumelhart, 1981, p. 11), scripts can develop to execute the schemata knowledge structures. Schank and Abelson (1977) demonstrate with an illustration from Quillian, “The policeman held up his hand and stopped the car” (p. 9). In the process of understanding the passage, we found a schema, which more likely envisioned a person in the car stepping on a brake pedal rather than the policeman physically intervening with the momentum of a rolling box of steel. Note the extrapolation of a person pressing a brake pedal was not in the passage, it was the mental process of a schema falling into a script of events.

When presented with a situation, learners must follow the two step process of “plan understanding” (Schank & Abelson, 1977, p. 73). “We assume that middle-class adults have a very detailed restaurant script which they use for a variety of things” (Schank & Abelson, 1977, p. 222). An informal study with a four-year-old child showed script acquisition had already taken hold with regards to restaurants, however with less detail (Schank & Abelson, 1977, pp. 222-237). The experiences of the child were more likely spent creating initial schemas and scripts, and therefore the child has less to rely on as a basis of forming plans to get to their ultimate goal of eating in similar environments. For example, an experienced adult would know to order an item as an appetizer to receive it before the main course. It is the appetizer sorts of details which may also form the performance differences when navigating instruction. For the instructional intervention in this study, the presentation of new information in a new interface should force participants to engage in the planning aspects of schema scripts.

Schema Theory relates to reader expectations for inputs (Garner, 1987). When incoming information fits readers' expectations, the information can be encoded into memory quickly (Garner, 1987). Therefore, in part as a result of fast sensory memory encoding, it stands to reason in situations where a schema script already exists telling how to react to those inputs, they may also have a faster reaction time. Two studies found older adults produced more idiosyncratic actions when examining their schema scripts (Hess, 1992; Ross & Berg, 1992) (as cited by Rosen, Caplan, Sheesley, Rodriguez, & Grafman, 2003), while three studies found no differences based on age (Light & Anderson, 1983; Grafman, et al., 1991; Sirigu, et al., 1995) (as cited by Rosen, et al., 2003).

A learner's existing schema classifies all propositions of inputs as either relevant or irrelevant (Kintsch & van Dijk, 1978). For example, DNs may be more likely to ignore banner advertisements on web sites than DIs. In the case of DIs, they have likely had more productive or favorable experiences learning from text. This is in contrast to DNs who have likely had more productive experiences with graphic-heavy technology. This study assumes DIs have a larger pool of schema scripts focused on parsing relevant information out of text than DNs.

Expertise has been shown to have an impact on the capabilities of learners. “A schema-based approach has been successfully used to explain differences between expert and novice learners (Chi, Feltovich, & Glaser, 1981; Reimann & Chi, 1989)” (Kalyuga, Ayres, Chandler, & Sweller, 2003, p. 24). Soloway, Adelson, and Ehrlich (1988) found schemas, specifically plans and rules of discourse discussed by Schank and Abelson

(1977), had a significant performance difference between groups of different expertise in programming. In a task where little mental calculation was necessary to fill in a missing blank, experts were significantly faster and had a higher percentage of correct answers.

The more schema scripts a person has, the more expertise they should exhibit related to those scripts. Experts typically spend 10,000 hours or 5-10 years of deliberate practice within a specific knowledge domain (Bruning, et al., 2004). The numerous forms of technological entertainment have made deliberate practice with digital products subliminally effortless. As a result of such a slow process of tacit knowledge collection, experts find it difficult to describe how or what they know about their expertise. This is why the DPI questionnaire is necessary. It will be used to tease that information out since it is in effect a measure of time spent with technology. The DPI score measures the time an individual spends in a digital environment which could relate directly to their level of digital expertise. This is as opposed to using a simplified view which could mistakenly assume a young person is automatically a digital expert and an older person is a digital novice. Statistical analysis by DaCosta, Nasah, Prickett, and White (2007) showed only 6.7% of the DPI score was explained by age, though age was a significant link. In other words, age may not be the best predictor of preferences in instruction, which is why the DPI questionnaire is necessary to measure digital expertise. The DPI may show someone with a high digital propensity will have more schema scripts related to navigating graphical interfaces and therefore more speed in reading graphical instruction and answering graphical questions about it.

Media Research

Research has been done with regards to varying media presentations, but not within the context of a DPI score. Media studies further inform this research.

Smith (2004) discusses two sides of reading, which he names visual and non-visual. The more non-visual (e.g. text) information a person has previously stored in memory, the less visual (e.g. graphic) information they need to understand what their eyes are seeing and vice versa. When reading is difficult, there may be a deficit in one of the two areas of visual or non-visual input. The link between the brain and visual input can be a bottleneck and cause functional blindness (Smith, 2004). Klausmeier, Ghatala, and Frayer (1974) also found “prior experience can lead subjects to ignore attributes in a subsequent task.” Smith and Klausmeier’s work suggests that the preference of DNs to have graphical presentation before text is a result of the failure for the learners to analyze text stimuli in sensory memory as a cue for relevant response (Mueller, 1992).

As part of the instructional content for the survey in this study, the answers to questions were presented with other content, which introduces noise to the message. If there is indeed a difference in DNs and DIs in response time, the underlying idea is the digital expertise as a result of a larger pool of graphical schema scripts of DNs gives them a superior ability to filter the noise in a graphical instructional component.

Graphic noise in instruction, irrelevant details, or lack of relevant prior knowledge may serve as a distraction, disruption, or activation of the wrong prior knowledge in a learning experience (Clark & Lyons, 2004). Harp and Mayer (1998) found adding visuals incorrectly can hamper new information absorption, by interfering with the psychological

processes of learning. In their study, they added flashing graphics of lightning to a lesson about lightning strikes. The students using the basic course without the lighting graphics and audio support learned about 30 percent more. Learners exposed to unnecessary details in instructional materials, are significantly less adept at macroprocessing the main ideas from instruction (Garner, Gillingham, & White, 1989). Using an educational graphic, rather than a decorative one is necessary.

For communication functions of visuals, classification systems help improve plans for visuals, based on their communicative functions, as summarized in Table 2 (Carney & Levin, 2002; Lohr, 2003). Table 2 outlines the communicative functions of graphics in instruction.

Table 2

Communication functions of graphics

Function	A Graphic Used to	Examples
Decorative	Add aesthetic appeal or humor	- Art on the cover of a book - Visual of a general in a military lesson on ammunition
Representational	Depict an object in a realistic fashion	- A screen capture of a software screen - A photograph of equipment
Mnemonic	Provide retrieval cues for factual information	- A picture of a stamped letter in a shopping cart to recall the meaning of the Spanish word, Carta (letter)
Organizational	Show qualitative relationships among content	- A two-dimensional course map - A concept map
Relational	Show quantitative relationships among two or more variables	- A line graph - A pie chart
Transformational	Show changes in objects over time or space	- An animation of the weather cycle - A video showing how to operate equipment
Interpretive	Illustrate a theory, principle, or cause-and-effect relationships	- A schematic diagram of equipment - An animation of molecular movement

Clark and Lyons (2004) revised Table 2 to support six psychological events. This is depicted in Table 3. Clark and Lyons found adding graphics to a lesson which were topically related but extraneous to the lesson goal actually depressed learning by 30 percent. Their revised chart accounts for psychological processes involved in learning and the new chart organizes graphics according to how they support the six psychological events of learning.

Table 3

Psychological functions of graphics

Instructional Event	Definition	Example
Support Attention	Graphics and graphic design that draw attention to important elements in an instructional display that minimize divided attention	<ul style="list-style-type: none"> - An arrow to point out the relevant part of a computer screen - Placement of a graphic close to text that describes it
Activate or Build Prior Knowledge	Graphics that engage existing mental models or provide high-level content overview to support acquisition of new information	<ul style="list-style-type: none"> - Visual analogy between content and familiar knowledge - Graphic overview of new content
Minimize Cognitive Load	Graphics and graphic design that minimize extraneous mental work imposed on working memory during learning	<ul style="list-style-type: none"> - Line art versus photograph - Relevant graphic versus decorative graphic
Build Mental Models	Graphics that help learners construct new memories in long-term memory that support deeper understanding of content	<ul style="list-style-type: none"> - A schematic diagram to illustrate how equipment works - A visual simulation of how genes are transmitted from parent to offspring
Support Transfer of Learning	Graphics that incorporate key features of the work environment; graphics that promote deeper understanding	<ul style="list-style-type: none"> - Use of software screen simulation that looks and acts like actual software - Use of a visual simulation to build a cause-and-effect mental model
Support Motivation	Graphics that make material interesting and at the same time do not depress learning	<ul style="list-style-type: none"> - A graphic that makes the relevance of the skills to the job obvious - An organizing visual that clarifies the structure of the material

Eshet-Alkali and Amichai-Hamburger (2004) published a study that tested five digital skills related to the proposed differences between DNs and DIs: photo-visual skills, reproduction skills, branching skills, information skills, and socio-emotional skills. The results suggest the preference of graphics and text between DNs and DIs is a simple matter of exposure and experience rather than the complete brain re-wiring Prensky (2001b) proposes. Though the experiments showed younger students were more productive with the graphical parts of a lesson and older students were better with literacy skills, Eshet-Alkali and Amichai-Hamburger suggest if both just received more training in the opposite skill areas, their skills would normalize. Bloom (cited by Bruning, et al., 2004) explains the relativity of expertise; even the most experienced person will be outdistanced if they stop practicing by those who continue to develop their abilities. This suggests if a DN were deprived of their digital contact and instead were allowed to work only with text, their DPI score would decrease and comprehension of text would improve. The findings by Bloom help reinforce the need to measure digital exposure from a recent time frame, such as what the DPI questionnaire measures.

Summary

Chapter Two presented differing opinions about the characteristics for a new, digital generation and showed a common thread of digital integration. The number of hours a person is exposed to digital activities creates a level of digital expertise which can be measured by the DPI questionnaire and which may be age-neutral since even some

children today have little exposure to technology. Digital expertise may be a factor of recent exposure to electronics. Schema scripts may provide some mental tools to filter through noise in an instructional unit. Finally, a checklist was identified that helped determine the most relevant instructional graphics for the instructional units in this study's survey.

CHAPTER THREE: METHOD

This chapter describes the method used to test the null hypothesis and answer the research question. The chapter is organized into eight sections, including: a description of how the population and samples were selected, the research design, an overview of the instructional material, a description of measures, analyses of instrument reliability and validity, and a discussion of how the data was collected and analyzed. Also noted are certain limitations that constrain this study.

Study Population and Sample

The subject of this study consists of a sample of students attending a research university which had a Fall 2007 enrollment of 48,699. The student population of the university with email addresses available for this study is 47,343, of which 40,748 are undergraduate students and 6,595 are graduate students. Every participant of the sample received the DPI questionnaire and instructional materials. In the pilot study for the DPI questionnaire, 9.7%, and 20% were the return rates for undergraduate and graduate students respectively.

According to Tchebysheff's inequality theorem, which was used to calculate probability distributions, the range of the variance is approximately 4 standard deviations.

Knowing each question in the materials has 4 answers, the range of possible answers is three, so a population variance of $(3/4)^2$ or 0.5625 was used for sample estimation with a margin of error of 0.10. Equations (1) and (2) proceed from Scheaffer, Mendenhall, and Ott's (1990) calculations for a stratified random sample shown in Appendix A and result in the total of 255 students sampled from the university population of undergraduate and graduate students.

$$D = \frac{(0.10)^2}{4} = 0.0025 \quad (1)$$

$$n = \frac{\frac{40748^2(0.5625)^2}{40748(0.5625)/47343} + \frac{6595^2(0.5625)^2}{6595(0.5625)/47343}}{47343^2(0.0025) + 40748(0.5625)^2 + 6595(0.5625)^2} = 224.4001089 \quad (2)$$

The Neyman allocation method calculations in equations (3) and (4) were used to determine the appropriate percentage to sample from undergraduate and graduate students. Equations (5) and (6) suggest sample sizes of 193 undergraduate and 33 graduate students.

$$w_1 = \frac{40748(0.5625)}{40748(0.5625) + 6595(0.5625)} = 0.8606974632 \quad (3)$$

$$w_2 = \frac{6595(0.5625)}{6595(0.5625) + 40748(0.5625)} = 0.1393025368 \quad (4)$$

$$n_1 = 225(0.8606974632) = 194 \quad (5)$$

$$n_2 = 225(0.146426776) = 32 \quad (6)$$

Based on the return rates from the DPI questionnaire pilot study (detailed in measures), actual participation solicitations were adjusted to contact 194($1/0.09788$) or 1,983 undergraduate students and 32($1/0.2$) or 160 graduate students in an effort to achieve the 194 and 32 samples sizes calculated from the Neyman allocation method. To select the random sample from the student population, a MySQL 5.1 database was created with a table structure as noted in Appendix B.

The email column was setup to be unique to prevent the same student from receiving the questionnaire more than once. To randomize the list of students, queries were executed and exported to spreadsheet files, also noted in Appendix B.

Finally, the first 1,983 of the rows in the undergraduate and 160 of the graduate spreadsheets were used to distribute the questionnaire.

Research Design

Every participant experienced two variations of instructional presentation. To account for order effects, a counterbalanced quasi-experimental research design displayed the instruction in alternating formats. Table 4 outlines the counterbalancing.

Table 4

Randomized counterbalancing for instructional presentation

Random Assignment	DPI Questionnaire	Text	Graphic
Group 1	All	Viewed first, in random order	Viewed second, in random order
Group 2	All	Viewed second, in random order	Viewed first, in random order

Participants received one of two variations in real-time computerized random assignment. Their group assignment was tracked using web browser cookies which automatically self-destructed when the participant closed their web browser. The first variation of instruction was presented with text-only materials and assessment, followed by graphic-only materials and assessment. Each instructional task was presented along with the matching assessment so when the participant located the answer, the response could be immediate. The second variation of instruction had the first two formats of instruction reversed to present graphics only first and text only second. Additionally, the questions within each of the two presentation formats of instruction was shuffled and presented in random¹ order.

¹ Random numbers were chosen using the Matsumoto and Nishimura (1998) Mersenne Twister computerized algorithm.

Ethical Considerations

To minimize potential harm to participants, this study was conducted in accordance with all university mandates. The research proposal was reviewed and approved by the university Institutional Review Board (IRB). Related IRB approval documents are presented in Appendix F. Official approval from the University of Central Florida's Institutional Review Board (UCFIRB) falls under existing approval numbers 05-3084, 06-3778, and 06-4025, but required additional approval as SBE-08-05577.

Instructional Material

A local topic regarding future commuter rail in Central Florida was presented as the instructional material. No prior knowledge of the topic was expected or necessary. The instructional content and interface was never before seen by the participants.

The assessment for each component of instruction was limited to verbal information according to Gagne's domains for measurable verbs and behaviors. As a way of assessing the participants' expertise with graphics and text, half of the instruction was presented entirely in text and half almost entirely graphical. See Figure 1 for examples. One half of the figure was a thumbnail of a text question; the other half was a thumbnail of a graphic question. The question or task for each unit was highlighted in yellow.

Just 3 more!

This question is timed:

00:00:03

DeLand/Orange City/DeBary/Volusia County

- Nearly 50,000 people live in Orange City, DeBary and DeLand, one of the fastest growing areas of Volusia County
- Nearly a quarter of the workforce commutes to jobs outside the county, primarily to Seminole and Orange counties

Sanford/Lake Mary/Longwood/Altamonte Springs

- Home to two major retail malls
- Growing business clusters along the I-4 corridor and individual communities
- County government located in Sanford
- Nearly 400,000 live in Seminole County
- More than 40 percent of workforce commutes to jobs in Orange County
- Passenger counts at Orlando-Sanford Airport nearly doubled between 2000 and 2004

Winter Park/Orlando/Orange County

- Economic and cultural hub of Central Florida
- Home to NBA's Orlando Magic
- Intermodal transfers at Lynx Central Station and the Sand Lake area
- Federal/state/local government and educational activity centers
- Major renovations to the Citrus Bowl, the downtown arena and a new performing arts center planned
- Station stops at Florida Hospital Orlando and Orlando Regional Medical Center, two of the region's largest employers
- Ready access to retail, dining and cultural activities in Winter Park and downtown Orlando
- Amtrak transfer stations

Kissimmee/Osceola County

- Line terminates at the 1,200-acre Poinciana Industrial Park, which now employs more than 1,600 workers with major expansions planned
- Nearly 56,000 residents live within the city limits of Kissimmee, one of the fastest growing counties in Central Florida
- Almost three-quarters of Kissimmee residents commute to jobs outside the city
- More than a third of residents work in the tourism or services industry

Question: In which of these cities do ¼ of residents commute to jobs outside the city?

- Lake Mary
- DeLand and Orlando
- Kissimmee
- Longwood

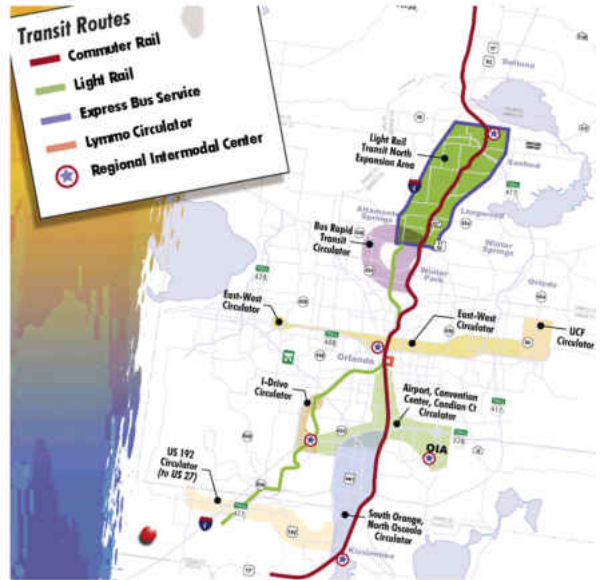
Submit Reset Form

Just 1 more!

This question is timed:

00:00:03

Click on the Regional Intermodal Center for the I-Drive Circulator on Toll 417.



Click on the Regional Intermodal Center for the I-Drive circulator on Toll 417.

Submit Reset Form

Figure 1. Examples of text and graphic instructional units

Table 2 guided the graphic-only instructional components of the survey. The graphics were a map (i.e. organizational graphic) of the proposed transit routes, a pie chart of funding sources, and a bar graph (i.e. relational graphics) of predicted times for the proposed Central Florida commuter rail system. The assessments for the instruction were varied to the instructional presentation method. Table 5 is a blueprint of the instructional assessment. There were three questions for each instructional format, text and graphic.

Table 5

Blueprint of allotment for instruction and assessment presentation methods

Instruction	Assessment	Number of Questions
Text	Text	3
Graphical	Graphical	3

Each instructional task is formatted according to an identical template for consistency as shown in Figure 2.

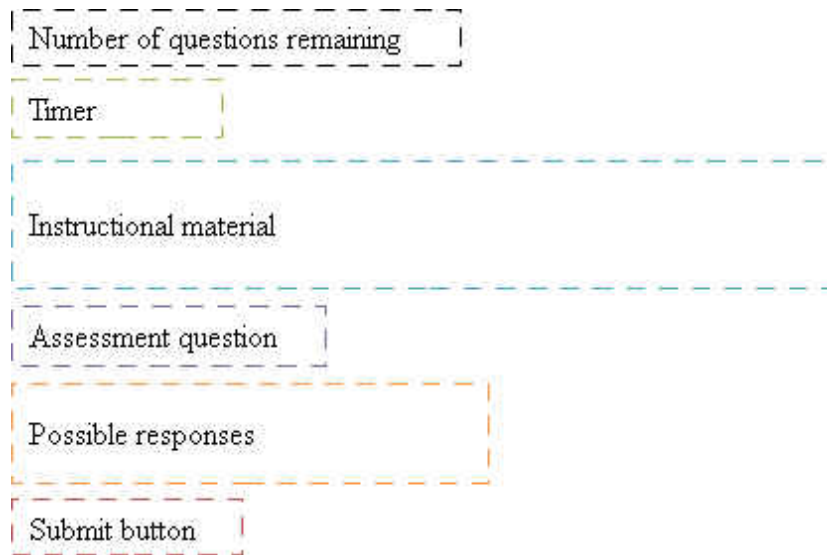


Figure 2. Instructional task formatting template

Measures

One survey instrument was used to collect data relative to the varying presentations of data. The Digital Propensity Index (DPI), as included in Appendix D, calculated a score of the respondents' digital propensity. The DPI is a numerical scale from 34 to 170 as a representation of how technology is used daily in lives of individuals of any age (K. L. Henderson, personal communication, June 23, 2006; Henderson & Hirumi, 2005). DPI score was examined in addition to age group because the DPI presents a more comprehensive picture of the individual. Just because two people are the same age does not mean they are equivalent digital media experience.

Each question in the instructional material was timed by employing three different timers. One timer was written in JavaScript, did not start counting until the webpage was completely loaded, and was what the participants saw when viewing the instructional materials. It also served a secondary purpose to deter the participants from walking away during the instructional portion of the survey.

The other two timers were based on a server-side timer. When each instructional page was requested, the server remembered the Date header from HTTP headers web browsers use to request web pages from the web server, highlighted in Table 6. Each subsequent page request was a simple mathematical calculation to subtract the original page request time from the time the next page was requested. The third timer used a microtime function on the server which recorded the time to the millisecond just before the page content was sent to the participant web browser. The end result was timer records for when each page was requested, the time in milliseconds just before the content was sent to the participants' web browser, and finally a JavaScript timer to account for delay the participants' Internet connection had or processing speed of the participants' computers.

Table 6

HTTP headers for requesting survey from web server

```
GET /dissertation/dpi HTTP/1.1
Host: dpistudy.com
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Cookie: PHPSESSID=fh7qfhaaequ723pohq68eej00s6hg3n3

HTTP/1.1 200 OK
Date: Thu, 05 Apr 2008 03:05:49 GMT
Server: Apache
Expires: Sun, 19 Nov 1978 05:00:00 GMT
Last-Modified: Thu, 05 Apr 2008 03:05:50 GMT
Vary: Accept-Encoding
Content-Encoding: gzip
Content-Length: 4874
Keep-Alive: timeout=7, max=80
Connection: Keep-Alive
Content-Type: text/html; charset=utf-8
```

Measure Reliability and Validity

Two pilot evaluations of the DPI questionnaire were performed to assess the reliability of the instrument. The questionnaire was distributed in paper format through the Post Office to graduate students of Instructional Technology at the University of Central Florida. After removing negatively correlated items and items with low correlations, the reliability coefficient for the scores from the DPI questionnaire was judged to be reliable with a Cronbach alpha of 0.858. A second, larger pilot evaluation

distributed on the Internet, using random samples of 1,980 and 1,890 undergraduate and graduate students, was also judged to be reliable at 0.851 (N = 580).

Reliability analysis was again conducted on the responses collected for the DPI questionnaire as part of this study. Responses for the various aspects of digital propensity were judged to be very reliable with a reliability coefficient of 0.882 (N = 284). A review of the corrected item-total correlation suggested the questions about communicating using email and using a PDA did not correlate with the corrected total very well. Their elimination was warranted on the basis that reducing the scale to only relevant items would make for a better, more parsimonious scale. Removing the items was further motivated by anticipated increase in the reliability coefficient reported in the output to 0.885. The summary of starting values and removed items follows in Table 7. Each item was removed one at a time. This approach was necessary because the impact of removing one item changes the relationship of the other items with the new anticipated coefficients. Participant scores were adjusted for the hypothesis testing based on the removal of poor performing items. Reliability analysis was not performed on the instructional part of the survey in this study. Each question was considered to be its own dependent variable.

Table 7

Anticipated reliability coefficient improvements with items removed

	Item removed	Anticipated coefficient
Starting coefficient = 0.882	Question 1: I communicate with others using email	0.884
Starting coefficient = 0.884	Question 18: I use a portable digital assistant (PDA) (e.g., PocketPC, PalmPilot, Blackberry)	0.885

With regards to validity, the DPI questionnaire followed Prensky's theory for the overall slope of the DPI score to decrease as age increased. Analysis showed younger age groups, under the age of 30, scored on average 7.24 points higher on the DPI scale than those over age 30. DaCosta, Nasah, Prickett, and White (2007) performed correlation tests on the second pilot study results to examine the relationship between participants' age and DPI score. Although there were 42 missing records for the Respondent Age variable, the tests were statistically significant with Kendall's tau b correlation coefficient of .19, $p < .01$. Spearman's Rho results had a correlation coefficient of .25, $p < .01$. They also found statistical significance using Kruskal-Wallis ANOVA and linear regression analyses.

One of the questions on the pilot questionnaire directly asked preferences "for training and/or educational materials that present graphics, rather than text first." A Kruskal-Wallis ANOVA showed significance between the self-reported preferences to display graphics before text and DPI score (DaCosta, Nasah, Prickett, & White, 2007).

Procedure and Data Collection

E-mail mailing lists were used to send four contact letters requesting participation to the sample population of students at the university. The letters followed the templates laid out by Dillman (2006) as prenotice, questionnaire mailout, and two thank you reminders, shown in Appendices E-H. Every email contained instructions to unsubscribe

from future contact if at any time the sample recipients wished to opt-out. Clicking on a URL or copying and pasting it into a web browser was how participants participated in the survey. The URLs contained an identifier to store what population the participant was a member of. People who visited the study website without using the specially formatted address were separated from the study sample, however only one participant did not include the identifier. Table 8 outlines the flow of the survey as they clicked through the screens of the web site.

Table 8

Survey process

IRB Informed Consent	Standard presentation of any risks associated with the study.
DPI Questionnaire	Version distributed with questions removed based on the pilot study.
Random Assignment	Participants assigned to view either text or graphic presentations first.
Instruction	Learners click through the instructional website. Timer on the webserver counts time spent on each page and presentation format.
Score Presentation	Display the participant's Digital Propensity Index score.

Data Analysis

The independent variables for this study were DPI score and treatment. The dependent variable was item response time. Data was imported into SPSS and both descriptive and inferential statistics are reported. A multiple regression was used to assess the major research questions and their respective hypotheses as an inferential statistic.

Limitations

Methodological limitations exist in that scores on the DPI scale may not truly indicate students' skills regarding their ability to use the electronics they claimed to use. A single objective measure cannot fully capture students' cognitive abilities or their broader digital experiences. Other limitations are as follows:

1. The study was restricted to students of a single university as a convenience sample. As a result, generalizations may not be applicable outside the tested population.
2. Respondents were only allowed to reply via the Internet. Learners with low digital propensity may be less likely to complete the survey online as opposed to a paper version sent through the postal service.
3. The environment of the participants could not be controlled.
4. The actual environment where the study took place likely varied for each participant.

5. Computer proficiency should not be considered equivalent for each survey participant.

6. Prior knowledge of the content in the treatment presentations likely varied between participants.

CHAPTER FOUR: RESULTS

This chapter presents an analysis of the data that was collected from the research described in the previous three chapters. The purpose of this analysis is to summarize the degree to which digital propensity, measured through the Digital Propensity Index (DPI), might predict the time a student would spend completing instructional units presented in either text or graphic formats. To examine the hypothesis, the participants were tested using a web-based survey composed of the DPI questionnaire and six timed instructional units in Appendix D. All the data was input and analyzed using SPSS version 16 for Windows.

This chapter begins by reviewing the hypothesis introduced in Chapter One, followed by statistical analysis of each section of the survey. The last section summarizes the findings and the reliability analysis of the DPI instrument.

Null Hypothesis

The following null hypothesis was posited in Chapter One:

There will not be a statistically significant relationship between the participants' time spent viewing graphics as compared to text and their Digital Propensity Index score.

Findings

To examine the relationship between digital propensity and performance during the survey, linear regression analyses were performed. The DPI score and demographic data were used as independent variables. The time spent in each section of the questionnaire according to the server-based timer was the dependent variable. The specific demographic tested was age group, which is question 40 on the DPI questionnaire in Appendix D. A simple linear regression was performed using DPI score to test the hypothesis. During the data analysis stage, age also proved to show some significance in predicting time and regression equations for DPI score and age group is included in those instances. The average DPI score of the participants was 77 meaning the population as a whole is skewed towards being Digital Immigrants. Regression equations for each section are located in Appendix C. Summary descriptive data is outlined in Table 9.

Table 9

Summary descriptive statistics on instructional units

Analyzed group	Valid Responses	Mean time	Percent Correct	Std. Deviation
Combined text		111.8435		
Combined graphics		90.7397		
All questions		201		
Question 1	322	35.2293	96.6	.182
Question 2	325	31.2163	91.7	.276
Question 3	323	43.3843	87.6	.330
Question 4	321	22.2263	97.5	.156
Question 5	319	35.3450	100	.000
Question 6	319	32.9719	36.4	.482

Combined Text Question Times

Times for those who answered all the text questions were added together resulting in the total time spent answering all the text questions. The average time in seconds to complete all the text questions was 111.8435 seconds (N = 312). A simple linear regression was calculated to predict subjects' time spent answering all the text questions in the instructional section of the survey based on DPI score. The regression was a poor fit ($R^2=0.023$), but the overall relationship was statistically significant ($F_{1,269}=6.252$, $p<0.014$). Examining only participants who answered questions 1 to 3 correctly also revealed a statistically significant prediction ($F_{1,233}=4.725$, $p<0.032$, $R^2=0.020$). Accounting for achievement was statistically significant ($F_{2,266}=2.863$, $p<0.025$,

$R^2=0.041$). Of the four independent variables, only DPI score ($p<0.017$) and question 3 were statistically significant predictors ($p<0.037$).

In the regression for only the responses where all three answers were correct, subjects were 0.382 seconds faster for each singular increment of DPI score. As DPI score increased, the time spent viewing text questions decreased. The null hypothesis is rejected with regards to combined question times for the combined text question times. There was a statistically significant relationship between the participants' time spent viewing text and their DPI score.

Combined Graphic Question Times

Times for those who answered all the graphic questions were added together resulting in the total time spent answering all the graphic questions. The average time in seconds to complete all the graphic questions was 90.7397 seconds (N = 312). A simple linear regression was calculated to predict the subjects' time spent answering all graphic questions in the instructional section of the survey based on DPI score. The regression was a poor fit ($R^2=0.058$), but the overall relationship was statistically significant ($F_{1,270}=16.523$, $p<0.001$). Examining only participants who answered questions 4 to 6 correctly also revealed a statistically significant prediction ($F_{1,96}=5.949$, $p<0.018$, $R^2=0.058$). Accounting for achievement was statistically significant ($F_{2,268}=7.828$, $p<0.001$, $R^2=0.081$). Of the three independent variables, only DPI score ($p<0.001$) and question 6 were statistically significant predictors ($p<0.011$).

In the regression for only the responses where all three answers were correct, subjects were 0.486 seconds faster for each singular increment of DPI score. The null hypothesis is rejected with regards to combined question times for the combined graphic question times. As DPI score increased, the time spent viewing graphic questions decreased. There was a statistically significant relationship between the participants' time spent viewing graphics and their DPI score.

The overall graphic prediction equation is graphed alongside the overall text prediction equation in Figure 3 for all responses, correct and incorrect.

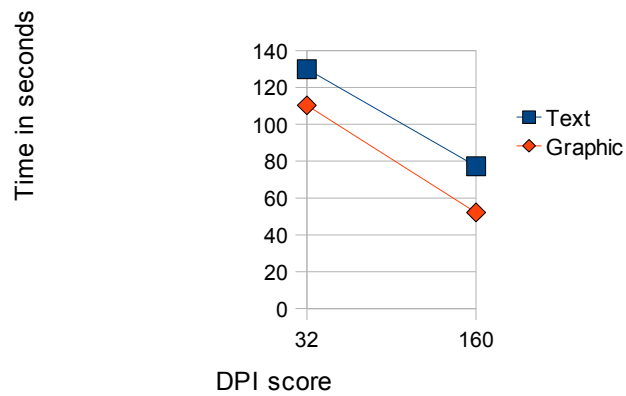


Figure 3. Regression lines for text and graphic performance predicted by DPI regardless of achievement

When the graph shown in Figure 4 uses predictions for only correct responses, the difference between text and graphics is more pronounced. Graphic questions had a sharper negative slope. As DPI score increased, respondents were more productive with

their time in the graphic questions than in the text questions.

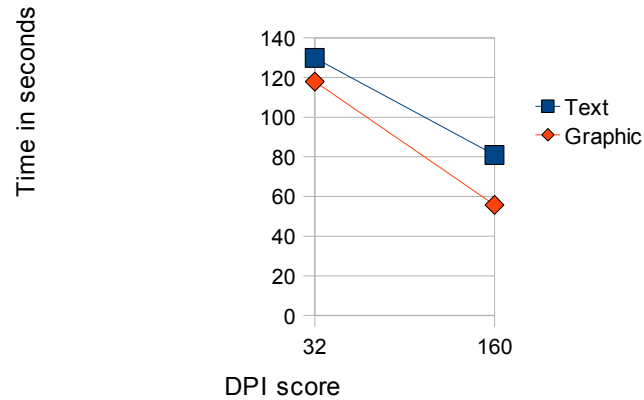


Figure 4. Regression lines for text and graphic performance predicted by only correct responses

Combined Total Question Times

Times for those who answered all the instructional units were added together. The average time in seconds to complete all the instructional units was 201 seconds. A simple linear regression was calculated to predict the subjects' time spent answering all the questions in the instructional section of the survey based on DPI score. A statistically significant regression equation was found ($F_{1,268}=13.422$, $p<0.001$, $R^2=0.048$). Examining only participants who answered all questions correctly did not reveal a

statistically significant prediction ($F_{1,84}=3.163$, $p>0.05$, $R^2=0.036$). Accounting for the achievement in the regression calculation was statistically significant ($F_{2,263}=7.828$, $p<0.002$, $R^2=0.079$). Of the six independent variables, only DPI score ($p<0.001$) and question 6 were statistically significant predictors ($p<0.029$). In the regression for only the responses where all six answers were correct, subjects were 0.840 seconds faster for each singular increment of DPI score. Overall, as DPI score increased, time spent with the instruction decreased. Because the prediction equation including only correct answers was not statistically significant, the null hypothesis could not be rejected with regards to predicting the time spent with all the questions.

Question 1: Text

Of the 322 people who answered the first question, 311 or 96.6% answered correctly. The average time spent answering the question was 35.2293 seconds.

A linear regression was calculated to predict the subjects' time spent answering Question 1 based on their DPI score. The regression was a poor fit ($R^2=0.023$), but the overall relationship was statistically significant ($F_{1,270}=6.362$, $p<0.013$). Narrowing the regression to only examine participants who answered Question 1 correctly also revealed a statistically significant prediction ($F_{1,263}=7.193$, $p<0.009$, $R^2=0.027$). The regression calculation for participants who did not answer Question 1 correctly was not statistically significant ($F_{1,5}=0.057$, $p>0.05$, $R^2=0.011$). Accounting for the achievement in the regression calculation was statistically significant ($F_{2,269}=3.807$,

$p < 0.024$, $R^2 = 0.028$). However, Table 10 shows achievement was not a statistically significant predictor of time spent on Question 1 in the multiple regression calculation ($p > 0.05$).

Table 10

Significance of predictor variables for Question 1

Predictor Variable	Beta	Significance
DPI score	-0.162	0.013
Q1 correct	-8.000	0.265

When accounting for only the participants who answered Question 1 correctly, subjects were 0.170 seconds faster for each singular increment of DPI score. In all variations of the regression calculation, as DPI score increased, the time spent viewing Question 1 decreased. The null hypothesis is rejected for Question 1 because all regression calculations had statistical significance except where incorrect answers were isolated which only accounted for 5 responses. There was a statistically significant relationship between the participants' time spent viewing Question 1 and their DPI score.

Question 2: Text

Of the 325 people who answered the second question, 298 or 91.7% answered correctly. The average time spent answering the question was 31.2163 seconds.

A simple linear regression was calculated predicting the subjects' time spent answering Question 2 based on their DPI score. The regression was a poor fit and not

statistically significant ($F_{1,270}=1.613$, $p>0.05$, $R^2=0.006$). Including only people who answered Question 2 correctly was also not statistically significant ($F_{1,255}=0.708$, $p>0.05$, $R^2=0.003$). Regression analysis for participants who did not answer Question 2 correctly was statistically significant ($F_{1,13}=4.659$, $p=0.050$, $R^2=0.264$). Including whether the participant answered correctly or not as a multiple regression resulted in a poor fit and was not statistically significant ($F_{2,269}=1.461$, $p>0.05$, $R^2=0.011$). Table 11 shows neither DPI score nor achievement were statistically significant predictors of time spent on Question 2 in the multiple regression calculation ($p>0.05$).

Table 11

Significance of predictor variables for Question 2

Predictor Variable	Beta	Significance
DPI score	-0.095	0.230
Q2 correct	-6.937	0.254

DPI cannot be used to predict the time spent viewing the second question. The null hypothesis is accepted with regards to Question 2. DPI score was not a useful instrument for predicting time spent with Question 2.

Question 3: Text

Of the 323 people who answered the third question, 283 or 87.6% answered correctly. The average time spent answering the question was 43.3843 seconds.

A simple linear regression was calculated predicting the subjects' time spent answering Question 3 based on their DPI score. The regression was a poor fit and not statistically significant ($F_{1,270}=2.496$, $p>0.05$, $R^2=0.009$). Including only people who answered Question 3 correctly was also not statistically significant ($F_{1,248}=2.297$, $p>0.05$, $R^2=0.009$). Regression analysis for participants who did not answer Question 3 correctly was statistically significant ($F_{1,20}=0.046$, $p>0.05$, $R^2=0.002$). Accounting for achievement, the result was not statistically significant ($F_{2,269}=3.153$, $p<0.045$, $R^2=0.023$). Table 12 shows neither DPI score nor achievement were statistically significant predictors of time spent on Question 3 in the multiple regression calculation ($p>0.05$).

Table 12

Significance of predictor variables for Question 3

Predictor Variable	Beta	Significance
DPI score	-0.127	0.129
Q3 correct	-10.414	0.053

DPI cannot be used to predict the time spent viewing the third question. The null hypothesis is accepted with regards to Question 3. DPI score was not a useful instrument for predicting time spent with Question 3.

Question 4: Graphic

Of the 321 people who answered the fourth question, 313 or 97.5% answered correctly. The average time spent answering the question was 22.2263 seconds.

A linear regression was calculated to predict the subjects' time spent answering Question 4 based on their DPI score. The regression was a poor fit ($R^2=0.047$), but the overall relationship was statistically significant ($F_{1,272}=13.401$, $p<0.001$). Narrowing the regression to only examine participants who answered Question 4 correctly also revealed a statistically significant prediction ($F_{1,265}=13.629$, $p<0.001$, $R^2=0.049$). The regression calculation for participants who did not answer Question 4 correctly was not statistically significant ($F_{1,5}=0.904$, $p>0.05$, $R^2=0.153$). Accounting for achievement, the calculation was overall statistically significant ($F_{2,271}=7.866$, $p<0.001$, $R^2=0.055$). Table 13 shows achievement was not a statistically significant predictor of time spent on Question 4 in the multiple regression calculation ($p>0.05$).

Table 13

Significance of predictor variables for Question 4

Predictor Variable	Beta	Significance
DPI score	-0.129	< 0.001
Q4 correct	-6.046	0.133

When accounting for only the participants who answered Question 4 correctly, subjects were 0.136 seconds faster for each singular increment of DPI score. In all variations of the regression calculation, as DPI score increased, the time spent viewing Question 4

decreased. The null hypothesis is rejected for Question 4 because all regression calculations had statistical significance except where incorrect answers were isolated. This only accounted for 5 responses. There was a statistically significant relationship between the participants' time spent viewing Question 4 and their DPI score.

Question 5: Graphic

All participants correctly answered the fifth question. The average time spent answering the question was 35.3450 seconds. Because all participants answered the question correctly, no regression analysis was performed relating to achievement for Question 5.

A linear regression was calculated to predict the subjects' time spent answering Question 5 based on their DPI score. The regression was a poor fit ($R^2=0.021$), but the overall relationship was statistically significant ($F_{1,271}=5.805$, $p<0.018$). Subjects were 0.169 seconds faster for each singular increment of DPI score. As DPI score increased, the time spent viewing Question 5 decreased. The null hypothesis is rejected for Question 5. There was a statistically significant relationship between the participants' time spent viewing Question 5 and their DPI score.

Question 6: Graphic

Of the 319 people who answered the sixth question, 116 or 36.4% answered correctly. The average time spent answering the question was 32.9719 seconds.

A linear regression was calculated to predict the subjects' time spent answering Question 6 based on their DPI score. The regression was a poor fit ($R^2=0.029$), but the overall relationship was statistically significant ($F_{1,270}=7.951$, $p<0.006$). Narrowing the regression to only examine participants who answered Question 6 correctly also revealed a statistically significant prediction ($F_{1,99}=6.479$, $p<0.013$, $R^2=0.061$). The regression calculation for participants who did not answer Question 6 correctly was not statistically significant ($F_{1,169}=3.371$, $p>0.05$, $R^2=0.020$). Accounting for the achievement in the regression calculation was statistically significant ($F_{2,269}=8.251$, $p<0.001$, $R^2=0.058$). Table 14 shows both DPI score and achievement were statistically significant predictors of time spent on Question 6 ($p<0.005$).

Table 14

Significance of predictor variables for Question 6

Predictor Variable	Beta	Significance
DPI score	-0.162	0.003
Q6 correct	5.656	0.004

When accounting for only the participants who answered Question 6 correctly, subjects were 0.250 seconds faster for each singular increment of DPI score. In all variations of the regression calculation, as DPI score increased, the time spent viewing Question 6

decreased. The null hypothesis is rejected for Question 6 because all regression calculations had statistical significance except where incorrect answers were isolated. There was a statistically significant relationship between the participants' time spent viewing Question 6 and their DPI score.

Self-reported Graphic Preferences

A simple linear regression was calculated predicting the preferences for educational materials that present graphics rather than text first based on their DPI score. The regression equation was not statistically significant ($F_{1,281}=2.984$, $p>0.05$, $R^2=0.011$). DPI score cannot be used to predict the participants' self-reported preference for the presentation order of graphics and text.

Post-hoc Analysis

On the basis that the literature in a large part refers to generational gaps in life experiences, the age group question on the DPI questionnaire was used to entertain an alternate explanation for data variation. In the cases of questions 1, 5, and 6, age was a better predictor of time spent on each question than DPI score. For all three questions, as the age of the participant increased, so did the time it took to complete each question. Regression equations for each question are in Appendix C.

According to multiple regression analysis on Question 1, subjects were 2.088 seconds faster as the age group got younger and they were 0.091 seconds faster for each singular increment of DPI score ($F_{2,268}=5.046$, $p<0.008$, $R^2=0.036$). On Question 5, subjects were 2.955 seconds faster as the age group got younger and they were 0.089 seconds faster for each increment of DPI score ($F_{2,269}=7.054$, $p<0.002$, $R^2=0.050$). Finally, in the analysis of the time spent answering Question 6, subjects were 3.404 seconds faster as the age group got younger and they were 0.059 seconds faster for each singular increment of DPI score ($F_{2,268}=13.150$, $p<0.001$, $R^2=0.089$).

Chapter Summary

This chapter presented an analysis of the data that was collected. The findings from each section of the instructional portion of the study served as a basis to accept or reject the null hypothesis posited earlier in this study. The null hypothesis was rejected for questions 1, 4, 5, 6, and the sum total of text, graphic, and all the time spent on all the questions. The null hypothesis was accepted for questions 2 and 3 individually. The analysis used an adjusted DPI score, which resulted from the removal of DPI questions 1 and 18 on the basis of improving the reliability coefficient for the DPI questionnaire. In Chapter Five, the results will be interpreted to extract what these results suggest for digital propensity and provide recommendations for future research.

CHAPTER FIVE: DISCUSSION

The purpose of this study was to determine if digital media activity, measured by the Digital Propensity Index (DPI), would make a difference in how quickly students are able to navigate through instructional materials. Digital activity is posited to lead to dramatic learning differences for new generations (Prensky, 2001a). This study examined whether there was any statistically significant, timed performance difference when a learner interacted with purely text versus mostly graphic interfaces in a learning environment based on their regular digital media interaction. If indeed digital media activity has led to problems with pre-digital aged instructors teaching to a totally new thinking pattern, this study expected to find disruptions in the expectations of learners with different DPI scores. This would be observed through different times for participants to review differing instruction in text versus graphic formats.

To examine the research question posed in this study, the participants' digital media activity was assessed using the Digital Propensity Index questionnaire. They were then exposed to either three text or graphic-based instructional units which were based on random assignment. This was followed by three units of the opposing format.

A single, general hypothesis was tested. The findings indicated statistically significant predictions of the time spent taking each instructional format. This chapter interprets the findings presented in Chapter Four in light of generational digital

differences, Schema Theory, and media research, as well as limitations, implications, and recommendations for future research.

Interpretation of Hypothesis

The null hypothesis said there would be no statistically significant link between the time spent viewing instruction and DPI score. This comparison was broken out into tests for instruction in text format and separate instruction in graphic format. The findings showed a statistically significant link between DPI score and the time spent taking each instructional format. Specifically, the DPI score had a measurable impact on the time spent viewing individual questions 1, 4, 5, and 6. The lack of significance between DPI score and time spent on questions 2 and 3, or 66% of the text questions, suggests DPI score may not be a good predictor for performance measured by time on text-based instruction. As for groups of text and graphic formats, the DPI score had a statistically significant overall relationship. Though many of the findings were statistically significant, the R^2 , or the percentage of variability in time spent on each question explained by DPI score, was low. DPI score accounted for approximately 5% of what could be explained for the time spent on each question.

The time spent on the instructional units averaged approximately 3½ minutes, however the difference between DPI score increments was less than one second according to the overall time prediction formula and near one tenth of a second for each individual question with a statistically significant regression.

Digital Differences

Since the slope of the prediction equation is nearly equivalent when predicting text and graphic total question times, the findings do not appear to support literature citing fundamental changes in thinking related to differing text and graphic formats of instruction or other digital media related translation to performance differences when learning in different formats. Digital media activity is framed to lead to a dramatic divide in learning and comprehension differences between generations (Howe & Strauss, 2000; Prensky, 2001; Roberts, Foehr, & Rideout, 2005; Tapscott, 1997; Twenge, 2006); however with such a low amount of variability explained by the predicting variables shown in R^2 values, the data do not support the generational accounts.

Schema Theory

More research is needed to determine the relationship between Schema Theory and digital media activity. As a side effect of repeated testing noted later, schema scripts did appear to be activated according to the more informal post survey information volunteered by the participants. Episodic memory, a component of schema scripts according to Schank and Abelson (1977), was formed and reinforced through having similar experiences on each instructional unit. Participants reported reading all the content from top to bottom on the first instructional unit. However, by the second question they realized they could go faster by viewing the highlighted portion of the unit first, then scanning to find the correct answer, then skipping to the bottom to report the

correct answer. By the second or third question, participants were using script shortcuts to skip the instructional content and move right to the question. Unfortunately since the order of question presentation for each participant was not recorded, no statistical analysis was possible to mathematically substantiate the claim that the reinforcement of episodic memory experiences led to the activation of schema script shortcuts, and therefore potentially improved relative performance on each successive question.

As a result of random assignment and shuffling of the question order, 5/6 of the participants should have been afforded the benefit of script shortcuts by the time they viewed Question 6; 5/6, or 83.3%, is a much larger percentage than the 36.4% who answered Question 6 correctly. With regards to links to schema theory, Schank and Abelson (1977) propose asking why responses were not correct in a frame of failed expectations. One built-in violation of expectation was the removal of the numbers at the end of the bar chart items in the answer choices.

Media Research

Questions 3 and 6 were designed with slight alterations between the instructional content and the assessment. This may have contributed to the statistical insignificance of Question 3 and the poor correct response rate of Question 6. Specifically, in Question 3, the question asked about “ $\frac{3}{4}$ ” of the population in the passage whereas the related information in the passage was written as “three-quarters”. Question 6 had white numbers at the end of the bars in the chart; however the answers to the questions removed the

white numbers at the ends of the bars. Some respondents openly reported guessing on Question 6.

Limitations

This study attempted to minimize threats to external and internal validity. Limitations were noted in both the external and internal validity of the study. The external validity was limited due to population and ecological effects, while internal validity was limited due to repeated testing and ceiling effect.

Population Effects

From the time the DPI questionnaire was first piloted to the study, the core audience of the analyses have been university students. The population for this study should be considered a homogeneous population; they likely have a forced, base experience level with digital media to survive in a university environment. Moreover, the survey was distributed by e-mail, which has its own built-in background of at least having computer experience for reading email and using unfamiliar websites.

Ecological Effects

All of the participants likely participated in the survey in different locations at different times. Their surrounding environment and preceding situations were almost

certainly all different. Each participant was limited to whatever computer technology and Internet connection was at their convenience.

A few participants reported starting the questionnaire then becoming distracted in the middle for something like a telephone call. Due to the anonymous nature of the distribution, there was no way to track the reported distraction back to the response queue to invalidate the responses.

As part of discouraging participants from starting the instructional units and pausing for an alternate distraction, invitation emails alerted participants to the timer on the instructional units. The timer displayed at the top of each instructional unit and counted in real-time on the screen. The practice of noting the timer and displaying it on-screen probably resulted in the Hawthorne Effect. Though the timer was activated on the informed consent screen and on the DPI questionnaire, participants were not informed of its presence in those two locations.

Repeated Testing

Informal discussions with participants after completing the survey revealed a pattern of question identification. On the first question presented to the participants, they often mentioned starting to read the entire content from the top of the page down. They soon realized the highlighted portion of the screen was the question related to the content. By the time the participant was on the second or third screen, they stopped reading all the content from the top of the screen down, instead starting right at the highlighted question

and then scanning the content for the answer to the question. Participants seemed to think it was likely they would try to identify the question first when viewing successive pages even if the question was not highlighted. No records were kept to track which question the participant started with; any one of the six questions could have been presented first.

Ceiling Effect

The instructional units might have been too easy. One of the goals of making easier questions was to increase participation. The questions needed to test only basic verbal tasks, not the amount of mental processing that could stray into testing participants' understanding of concepts and cognitive strategies. Because each question was considered to be its own dependent variable, adding more questions was not considered as part of the design in this study; lengthening or extending the content, or making the questions more difficult would have been more appropriate to the design.

Implications and Suggestions for Future Research

The underlying significance of this study sought to discover the value of the DPI questionnaire in prescriptive learning by varying the text and graphics in instruction. However, with nearly identical regression slopes for each format, the DPI failed to make a basis for prescription in this case. The DPI questionnaire has proven to be a reliable instrument, but has not yet been linked to a topic of usefulness. Anyone can get a DPI

score from the questionnaire, but knowing what that really means has yet to be clearly defined.

Studying the DPI questionnaire to determine a breakpoint of expertise between being defined as a digital novice or digital expert may provide other statistical analyses in studies like this. For example, Soloway, Adelson, and Ehrlich (1988) were able to examine the amount of time it took their subjects to provide a correct response between the two versions of their study in more depth because they had an expertise classification. Using the mean DPI score of 77 from this study may provide a starting point for such future research.

Additional research is needed to find an area to apply the DPI questionnaire in a useful forum. Two areas where the DPI might be beneficial is in the continued study of brain neuroplasticity and educational gaming. There are many other large areas of education where the DPI could find a useful setting for prescriptive learning. Wide areas of audio and video, face-to-face lecture, the handicapped, gaming, and group projects are just some areas where the DPI has yet to be deployed.

The interfaces of this study were relatively simple; the DPI questionnaire might be more applicable as a predictor for success with navigating more sophisticated areas like multi-player, networked computer games. Regarding the simplicity of the questions, the findings did not seem to be impacted materially by excluding incorrect responses to questions. Since the questions were meant to involve as little extraneous mental processing as possible, they served as their own kind of sincerity detector. It could be

inferred for future studies that incorrect responses to at least the first five questions could be ignored because the participants did not make a sincere effort to answer correctly.

The variation to Question 3 was an attempt to force reading the content rather than just scanning the passage. Reports from informal pilot testing of Question 6 identified the question was too easy. When numbers were in the bars on the answers to the assessment in Question 6, the numbers provided an almost entirely text route of answering the question through identifying the city on the left and the numbers on the right. Removal of the numerical identifiers in the answer bars was meant to enforce the graphic properties of the passage that would be required to qualify the question as graphic in nature. Researching the assessment alterations to questions 3 and 6 could reveal strategies for instructional design improvements outside the realm of DPI. For replication studies of this research, adding a formal qualitative component to record violations to the expectations on at least questions 3 and 6 may also prove to be enlightening.

Chapter Summary

This chapter reviewed the findings outlined in Chapter Four, noted some limitations of the study, and outlined some of the implications and suggestions for future research. The DPI questionnaire was not able to show an improved performance for graphics versus text instruction with varied DPI scores. Just as the changes to the world by digital media are innumerable, the number of areas of digital propensity could still be explored are as well. This study investigated how experience with digital media impacts

the performance of students when they are navigating instruction online. Fortunately, this study appears to have added some evidence that the percentage of text and graphics need not be modified in online instruction based on the digital media backgrounds of students.

APPENDIX A: STRATIFIED RANDOM SAMPLING CALCULATIONS

N = Total finite population size

n = Total sample size

B = Margin of error

N_i = Finite population size for each group

n_i = Sample size for each group

w_i = weight for each group (totals 1.0)

$$D = \frac{B^2}{4}$$

$$n = \frac{\sum_{i=1}^2 N_i \sigma_i^2 / w_i}{N^2 D + \sum_{i=1}^2 N_i \sigma_i^2}$$

$$w_1 = \frac{N_1 s_1}{S(N i s i)}$$

$$w_2 = \frac{N_2 s_2}{S(N i s i)}$$

APPENDIX B: DATABASE-BASED RANDOM SELECTION

Database schema chart for student sample

student_list	
<u>email</u>	<u>varchar(320)</u>
lname	varchar(200)
fname	varchar(200)
level	char(4)

Queries executed to obtain random samples from the student_list table.

```
SELECT CONCAT(IF(STRCMP(TRIM(fname),''), CONCAT(fname, ' '), ''), IF(STRCMP(TRIM(lname),''), CONCAT(lname, ' '), '')), '<', TRIM(email), '>') FROM student_list WHERE level = 'UGRD' AND LOCATE(' ', email) = 0 AND LOCATE(',', email) = 0 ORDER BY rand() LIMIT 0, 1983
```

```
SELECT CONCAT(IF(STRCMP(TRIM(fname),''), CONCAT(fname, ' '), ''), IF(STRCMP(TRIM(lname),''), CONCAT(lname, ' '), '')), '<', TRIM(email), '>') FROM student_list WHERE level = 'GRAD' AND LOCATE(' ', email) = 0 AND LOCATE(',', email) = 0 ORDER BY rand() LIMIT 0, 160
```


APPENDIX C: REGRESSION EQUATIONS

Every regression equation predicts time spent answering questions. The variables CORRECT and Q1-6 are coded as 0 for an incorrect answer, and as 1 for a correct answer. Age is coded as 1 = 50 and over, 2 = 40-49, 3 = 30-39, 4 = 20-29, and 5 = 18-19.

All text questions

$$\hat{y} = b_0 + b_1 x = 143.069 - 0.411(DPI) \quad (7)$$

All text questions (correct answers)

$$\hat{y} = b_0 + b_1 x = 142.066 - 0.382(DPI) \quad (8)$$

All text questions (accounting for achievement)

$$\begin{aligned} \hat{y}_i &= b_0 + b_1 x_{i1} + \dots + b_p x_{ip} \\ \hat{y}_i &= 115.800 - 0.399(DPI) + 5.264(Q1) - 0.080(Q2) + 23.216(Q3) \end{aligned} \quad (9)$$

All graphic questions

$$\hat{y} = b_0 + b_1 x = 124.838 - 0.454(DPI) \quad (10)$$

All graphic questions (correct answers)

$$\hat{y} = b_0 + b_1 x = 133.493 - 0.486(DPI) \quad (11)$$

All graphic questions (accounting for achievement)

$$\begin{aligned} \hat{y}_i &= b_0 + b_1 x_{i1} + \dots + b_p x_{ip} \\ \hat{y}_i &= 122.971 - 0.466(DPI) - 1.091(Q4) + 10.334(Q6) \end{aligned} \quad (12)$$

All questions

$$\hat{y} = b_0 + b_1 x = 267.857 - 0.873(DPI) \quad (13)$$

All questions (correct answers)

$$\hat{y} = b_0 + b_1 x = 278.873 - 0.840(DPI) \quad (14)$$

All questions (accounting for achievement)

$$\begin{aligned} \hat{y}_i &= b_0 + b_1 x_{i1} + \dots + b_p x_{ip} \\ \hat{y}_i &= 239.338 - 0.867(DPI) + 17.797(Q1) - 4.693(Q2) + 26.867(Q3) - 17.002(Q4) + 19.117(Q6) \end{aligned} \quad (15)$$

Question 1

$$\hat{y} = b_0 + b_1 x = 47.965 - 0.163(DPI) \quad (16)$$

Question 1 (correct answers)

$$\hat{y} = b_0 + b_1 x = 48.319 - 0.170(DPI) \quad (17)$$

Question 1 (incorrect answers)

$$\hat{y} = b_0 + b_1 x = 27.878 - 0.207(DPI) \quad (18)$$

Question 1 (accounting for achievement)

$$\hat{y}_i = b_0 + b_1 x_{i1} + b_2 x_{i2} = 55.679 - 0.162(DPI) - 8.000(CORRECT) \quad (19)$$

Question 1 (accounting for age)

$$\hat{y} = b_0 + b_1 x = 48.919 - 0.091(DPI) - 2.088(AGE) \quad (20)$$

Question 2

$$\hat{y} = b_0 + b_1 x = 39.882 - 0.101(DPI) \quad (21)$$

Question 2 (correct answers)

$$\hat{y} = b_0 + b_1 x = 37.020 - 0.069(DPI) \quad (22)$$

Question 2 (incorrect answers)

$$\hat{y} = b_0 + b_1 x = 90.583 - 0.710(DPI) \quad (23)$$

Question 2 (accounting for achievement)

$$\hat{y}_i = b_0 + b_{i1} x_1 + b_2 x_{i2} = 46.029 - 0.095(DPI) - 6.937(CORRECT) \quad (24)$$

Question 3

$$\hat{y} = b_0 + b_1 x = 54.218 - 0.133(DPI) \quad (25)$$

Question 3 (correct answers)

$$\hat{y} = b_0 + b_1 x = 55.126 - 0.134(DPI) \quad (26)$$

Question 3 (incorrect answers)

$$\hat{y} = b_0 + b_1 x = 38.568 - 0.056(DPI) \quad (27)$$

Question 3 (accounting for achievement)

$$\hat{y}_i = b_0 + b_{i1} x_1 + b_2 x_{i2} = 44.227 - 0.127(DPI) - 10.414(CORRECT) \quad (28)$$

Question 4

$$\hat{y} = b_0 + b_1 x = 31.833 - 0.133(DPI) \quad (29)$$

Question 4 (correct answers)

$$\hat{y} = b_0 + b_1 x = 31.913 - 0.136(DPI) \quad (30)$$

Question 4 (incorrect answers)

$$\hat{y} = b_0 + b_1 x = 16.259 - 0.179(DPI) \quad (31)$$

Question 4 (accounting for achievement)

$$\hat{y}_i = b_0 + b_{i1}x_1 + b_{i2}x_{i2} = 37.421 - 0.129(DPI) - 6.046(CORRECT) \quad (32)$$

Question 5

$$\hat{y} = b_0 + b_1x = 48.431 - 0.169(DPI) \quad (33)$$

Question 5 (accounting for age)

$$\hat{y} = b_0 + b_1x = 51.693 - 0.089(DPI) - 2.955(AGE) \quad (34)$$

Question 6

$$\hat{y} = b_0 + b_1x = 44.980 - 0.155(DPI) \quad (35)$$

Question 6 (correct answers)

$$\hat{y} = b_0 + b_1x = 55.911 - 0.250(DPI) \quad (36)$$

Question 6 (incorrect answers)

$$\hat{y} = b_0 + b_1x = 40.130 - 0.119(DPI) \quad (37)$$

Question 6 (accounting for achievement)

$$\hat{y}_i = b_0 + b_{i1}x_{i1} + b_{i2}x_{i2} = 43.406 - 0.162(DPI) + 5.656(CORRECT) \quad (38)$$

Question 6 (accounting for age)

$$\hat{y} = b_0 + b_1x = 48.423 - 0.059(DPI) - 3.404(AGE) \quad (39)$$

APPENDIX D: SURVEY INSTRUMENT

Get your Digital Propensity Index score!

A research project is being conducted by Mr. David Norman to study the impact of digital media in daily life. The purpose of this study is to observe whether there is any relationship between digital media interaction and student performance with different forms of instruction.

You are being asked to take part in this study by completing a questionnaire. Please be aware that you are not required to participate in this research and you may discontinue your participation at any time without penalty. You may also omit any items on the questionnaire you prefer not to answer.

There are no risks associated with participation in this study. Your responses will be analyzed and reported anonymously to protect your privacy.

Potential benefits associated with the study include finding new ways to teach students using different approaches based on how much they tend to use technology. There are no direct benefits or compensation for your participation.

Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board. Questions or concerns about research participants' rights may be directed to the UCF IRB office, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246, or by campus mail 32816-0150. The hours of operation are 8:00 am until 5:00 pm, Monday through Friday except on University of Central Florida official holidays. The telephone numbers are (407) 882-2276 and (407) 823-2901.

For any other questions about this study, contact David Norman at da316305@pegasus.cc.ucf.edu. This research is being conducted with Dr. Atsusi Hirumi (hirumi@mail.ucf.edu), Associate Professor & Co Chair of Instructional Technology at the University of Central Florida.

By participating in this survey you voluntarily agree to allow the researchers to use the information you provide for related presentations, publications, and future research. If you decide to participate in this research study, you must be at least 18 years old and click "I consent" at the bottom of this screen.

I consent

I'm not sure. Take me somewhere else.

Digital Propensity Index Questionnaire

- 1. I communicate with others using email:**
 - at no time during the week.
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times daily.
- 2. I communicate with others using instant messaging (IM):**
 - at no time during the week.
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times daily.
- 3. I communicate with others using chat rooms:**
 - at no time during the week.
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times daily.
- 4. I read or contribute to Web blogs:**
 - never.
 - monthly.
 - weekly.
 - daily.
 - more than 3 times daily.
- 5. I share images and pictures online:**
 - never.
 - monthly.
 - weekly.
 - daily.
 - more than 3 times daily.
- 6. I share ideas, papers, information, and knowledge online:**
 - never.
 - monthly.
 - weekly.
 - daily.
 - more than 3 times daily.

- 7. I make online purchases:**
- at no time during the year.
 - annually.
 - 2-3 times per year.
 - monthly.
 - more than 3 times per month.
- 8. I download music from the Internet:**
- at no time during the week.
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times daily.
- 9. I download movies from the Internet:**
- at no time during the week.
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times daily.
- 10. I have updated my website or personal web space (e.g. MySpace):**
- none this year.
 - once this year.
 - 2-3 times this year.
 - once during the past 6 months.
 - more than three times during the past 6 months.
- 11. When playing video games, I customize the characters or scenes within the game:**
- at no point (never).
 - once only.
 - more than once during the ownership of the game.
 - once during the session.
 - more than three times during the session.
- 12. I initially meet or arrange meetings with new people online:**
- at no point (never).
 - 1-5 times.
 - 6-10 times.
 - 11-20 times.
 - more than 20 times.
- 13. I meet with people online:**
- never.
 - monthly.
 - weekly.
 - daily.
 - more than 3 times daily.

14. I have downloaded MP3 files from the Internet:

- none this year.
- once this year.
- 2-3 times this year.
- once during the past 6 months.
- more than three times during the past 6 months.

15. I have downloaded videos and images from the Internet:

- none this year.
- once this year.
- 2-3 times this year.
- once during the past 6 months.
- more than three times during the past 6 months.

16. I use email or the Internet to complete group assignments for school and/or work:

- not at all.
- weekly.
- 2-3 days per week.
- daily.
- more than 3 times per day.

17. I participate in group games (MMORPGS):

- not at all.
- weekly.
- 2-3 days per week.
- daily.
- more than 3 times per day.

18. I use a portable digital assistant (PDA) (e.g. PocketPC, PalmPilot, Blackberry):

- not at all.
- 1-5 times per day.
- 6-10 times per day.
- 11-20 times per day.
- 16 or more times per day.

19. I review online evaluation systems (e.g. star rating system) before making online purchases:

- 0% of the time.
- 25% of the time.
- 50% of the time.
- 75% of the time.
- 100% of the time.

20. I contribute to online evaluation systems (e.g. star rating system) after making online purchases:

- 0% of the time.
- 25% of the time.
- 50% of the time.
- 75% of the time.
- 100% of the time.

21. I play video games:

- not at all.
- weekly.
- 2-3 days per week.
- daily.
- more than 3 times per day.

22. I play 1-2 player video games:

- not at all.
- weekly.
- 2-3 days per week.
- daily.
- more than 3 times per day.

23. I play games requiring more than 2 players:

- not at all.
- weekly.
- 2-3 days per week.
- daily.
- more than 3 times per day.

24. I use handheld game devices:

- not at all.
- weekly.
- 2-3 days per week.
- daily.
- more than 3 times per day.

25. I have taken courses online:

- at no point (never).
- 1-5 times.
- 6-10 times.
- 11-20 times.
- more than 20 times.

26. I found information to complete school or work assignments online:

- at no point (never).
- 1-5 times.
- 6-10 times.
- 11-20 times.
- more than 20 times.

- 27. I have gone online to learn about topics that interest me:**
- at no point (never).
 - 1-5 times.
 - 6-10 times.
 - 11-20 times.
 - more than 20 times.
- 28. I use the internet to communicate with the instructor, fellow classmates, or coworkers:**
- not at all.
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times per day.
- 29. I use search engines to locate information on the Internet:**
- at no time during the week.
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times per day.
- 30. I use filtering tools (advanced search, directories, etc.) when locating information on the Internet:**
- at no time during the week.
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times daily.
- 31. I search for information for entertainment and other personal reasons online:**
- at no point (never).
 - weekly.
 - 2-3 days per week.
 - daily.
 - more than 3 times daily.
- 32. I have expertise in the following number of programming languages:**
- none at all
 - 1
 - 2
 - 3
 - 4 or more

33. I socialize with others online:

- at no time during the week.
- weekly.
- 2-3 days per week.
- daily.
- more than 3 times daily.

34. When I am online, I can manage the following maximum number of conversations at the same time:

- none at all
- 1
- 2
- 3
- 4 or more

35. I travel for business:

- none at all
- 1-5 times per year.
- 6-10 times per year.
- 11-20 times per year.
- more than 15 times per year.

36. My family's annual gross income is:

- \$0-9,999
- \$10,000-19,999
- \$20,000-39,999
- \$40,000-59,000
- \$60,000 or more

37. I have the following number of computers in my home:

- none at all
- 1
- 2
- 3
- 4 or more

38. I have the following number of people in my household:

- 1
- 2
- 3
- 4
- 5 or more

39. I use a computer at work:

- not at all.
- less than an hour.
- approximately 1-2 hours.
- approximately 3-5 hours.
- all day long.

40. My age group is:

- 50 and over
- 40-49
- 30-39
- 20-29
- 18-19

41. My gender is:

- male.
- female.
- transgender.

42. I prefer training and/or educational materials that present graphics, rather than text first:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

43. I prefer training and/or education that allows me to randomly access various components of a lesson, rather than materials that step me through a lesson one component at a time:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

44. I prefer to complete multiple tasks (e.g. Instant Messaging, alternative activities, watching TV) rather than one task at a time while I'm learning:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

45. I prefer training and/or education that is play oriented, rather than work oriented:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

46. I prefer training and/or education that encourages me to communicate and learn with others rather than learning by myself:

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

After clicking submit, you will be presented with 6 timed questions.

Submit

Reset Form

Just 5 more!

This question is timed:

0:00:51

Traffic congestion is a growing concern for those who live, work and visit Central Florida. As our region continues to grow at a staggering pace, that congestion will only get worse. Though there is no one magic bullet to solve our traffic woes, several different modes of transportation options working together - known as "intermodal" in transportation-speak - is a proven way to ease the gridlock.

That's why the Florida Department of Transportation (FDOT), in cooperation with local government officials in Orange, Seminole, Volusia and Osceola counties and the federal government, is looking at a commuter rail transit project to run along a 61-mile stretch of existing rail freight tracks in the four-county area.

The 31-mile Phase 1 segment would serve 10 stations, linking DeBary to Orlando. Service could begin as soon as 2009 - just as FDOT starts a major I-4 reconstruction project through the heart of Central Florida, from State Road 434 in Longwood to Kirkman Road in southwest Orange County.

Question: Referencing the paragraphs above, the definition of "intermodal" is:

- multiple transportation modes working together.
- riding a railroad.
- the average of two populations.
- having a single mode of transportation.

Submit

Reset Form

Just 4 more!

This question is timed:

0:00:04

The clock's winding down on Orange County commissioners doing what the people elected them to do, and that's providing leadership.

The commissioners say they support commuter rail.

They say it will help relieve gridlock by speeding commuters aboard sleek Internet-fitted cars beginning in 2009.

But trains don't run on peanuts -- and that's all the commissioners so far say they're willing to give commuter rail to make it go. Unlike their counterparts in Volusia, Seminole and Osceola counties, most commissioners in Orange County say the county shouldn't have to assume the costs of its stations beginning in 2017. That's the date when localities must take on rail's operations and maintenance costs.

What they say they will do is pay just one-third of the operations and maintenance expenses of Winter Park and Maitland, two cities north of Orlando considering hosting stations. That's what passes for leadership? Passing the buck?

Orange County commissioners will meet Tuesday, one week before Winter Park residents vote on paying for and hosting a station. Residents there in a survey have said they want commuter rail. But many fear the cost.

County commissioners can relieve those fears by agreeing to fully fund Winter Park's share. They also should do the same for Maitland, which is wary of the expense of maintaining a station in 2017.

Question: According to the above editorial excerpt, trains don't run on:

- gasoline.
- diesel.
- peanuts.
- good intentions.

Submit

Reset Form

Just 3 more!

This question is timed:

0:00:03

DeLand/Orange City/DeBary/Volusia County

- Nearly 50,000 people live in Orange City, DeBary and DeLand, one of the fastest growing areas of Volusia County
- Nearly a quarter of the workforce commutes to jobs outside the county, primarily to Seminole and Orange counties

Sanford/Lake Mary/Longwood/Altamonte Springs

- Home to two major retail malls
- Growing business clusters along the I-4 corridor and individual communities
- County government located in Sanford
- Nearly 400,000 live in Seminole County
- More than 40 percent of workforce commutes to jobs in Orange County
- Passenger counts at Orlando-Sanford Airport nearly doubled between 2000 and 2004 Winter Park/Orlando/Orange County

Winter Park/Orlando/Orange County

- Economic and cultural hub of Central Florida
- Home to NBA's Orlando Magic
- Intermodal transfers at Lynx Central Station and the Sand Lake area
- Federal/state/local government and educational activity centers
- Major renovations to the Citrus Bowl, the downtown arena and a new performing arts center planned
- Station stops at Florida Hospital Orlando and Orlando Regional Medical Center, two of the region's largest employers
- Ready access to retail, dining and cultural activities in Winter Park and downtown Orlando
- Amtrak transfer stations

Kissimmee/Osceola County

- Line terminates at the 1,200-acre Poinciana Industrial Park, which now employs more than 1,600 workers with major expansions planned
- Nearly 56,000 residents live within the city limits of Kissimmee, one of the fastest growing counties in Central Florida
- Almost three-quarters of Kissimmee residents commute to jobs outside the city
- More than a third of residents work in the tourism or services industry

Question: In which of these cities do $\frac{3}{4}$ of residents commute to jobs outside the city:

- Lake Mary
- DeLand and Orlando
- Kissimmee
- Longwood

Submit

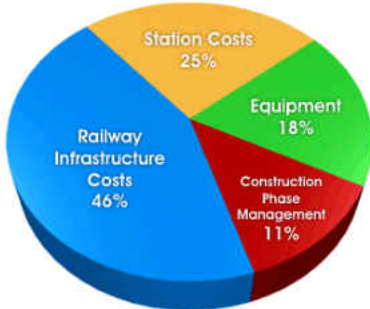
Reset Form

Just 2 more!

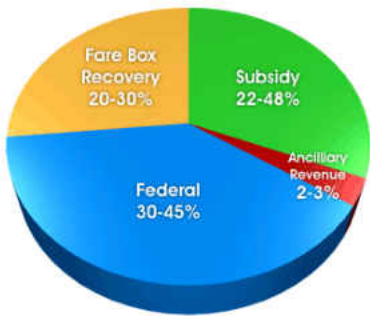
This question is timed:

0:00:01

Capital Funding Distribution



Typical O&M Funding Sources



Select the pie chart representation of "Equipment 18%":

-
-
-
-

Submit Reset Form

Just 1 more!

This question is timed:

0:00:03

Click on the Regional Intermodal Center for the I-Drive Circulator on Toll 417.



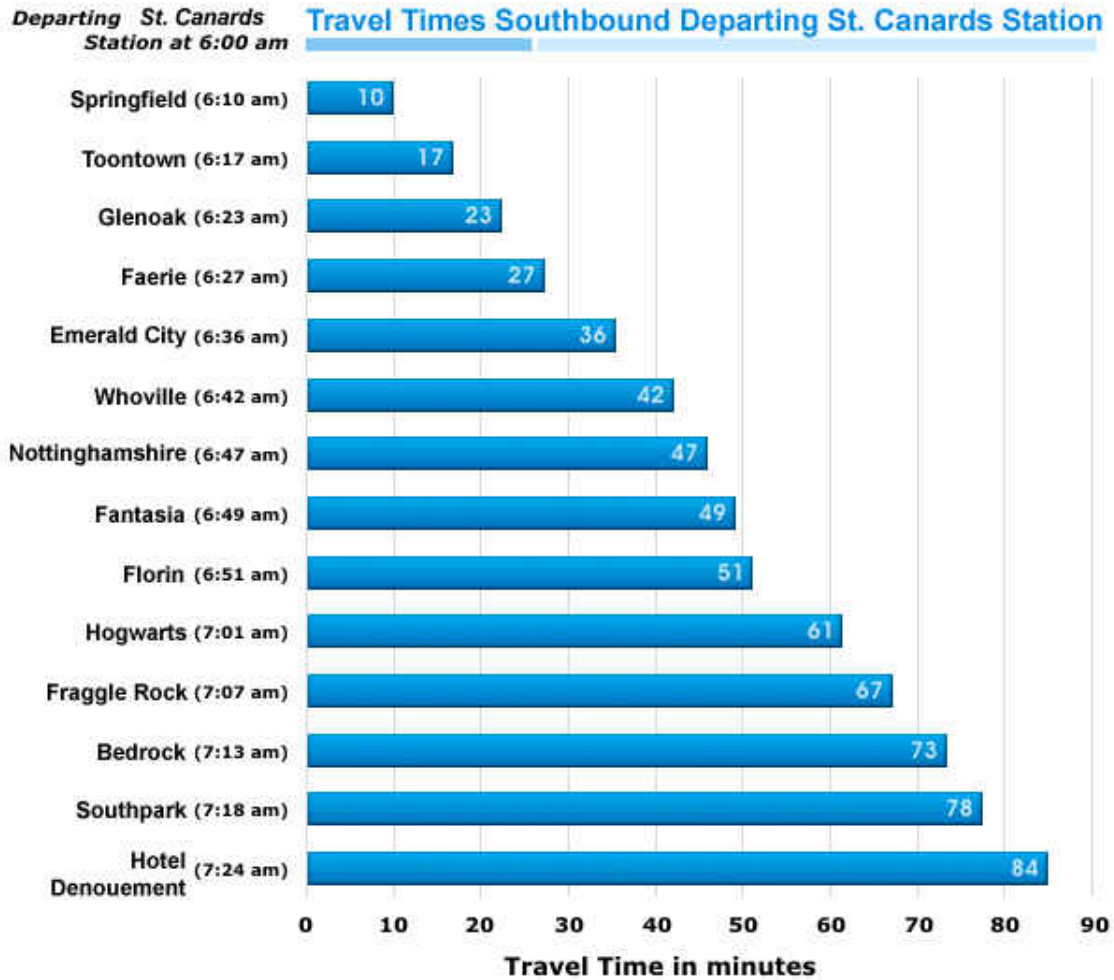
Click on the Regional Intermodal Center for the I-Drive Circulator on Toll 417.

Submit Reset Form

Last one!

This question is timed:

0:00:03



Based on the above chart, the travel time to Nottinghamshire is:

-
-
-
-

Submit

Reset Form

Your Digital Propensity Index score!

Your Digital Propensity Index score is **102**. A score of 34 would represent the far extreme Digital Immigrant as opposed to the other extreme of 170 for a pure Digital Native.

According to Marc Prensky, Digital Natives are more likely to be used to receiving information quickly, like to parallel process and multi-task, prefer their graphics before text, and prefer random access like hypertext you see on websites. They function best when networked, thrive on instant gratification and rewards, and like games.

Digital Immigrants commonly did not grow up with digital media. They prefer linear, step-by-step tasks, perform best when doing one thing at a time, and are used to receiving information slowly. A comparison of Digital Natives and Digital Immigrants is as follows:

Digital Immigrants	Digital Natives
<ul style="list-style-type: none">• Merely adopted aspects of new technologies• Turn to the Internet second rather than first• Print emails• Bring people physically to view websites• Call to confirm email receipt• Used to receiving information slow• Prefer text before graphics• Prefer linear, step-by-step tasks• Prefer serious work to games• Function best by doing one thing at a time, individually	<ul style="list-style-type: none">• "Spent entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones..."• "Process information differently from predecessors..."• Used to receiving information fast• Like to parallel and multi-task• Prefer graphics before text• Prefer random access• Function best when networked• Thrive on instant gratification and frequent rewards• Prefer games to serious work• Have short attention spans

For more information about Digital Immigrants and Digital Natives, read "Digital Natives, Digital Immigrants" by Marc Prensky.

APPENDIX E: SURVEY SOFTWARE ADMINISTRATION SCREENS

DPI Study

Home > Administer > Site configuration

deekayen

- My account
- Create content
- Administer
 - Content management
 - Site building
 - Site configuration
 - Actions
 - Administration theme
 - Clean URLs
 - DPI Study
 - Date and time
 - Error reporting
 - File system
 - Google Analytics
 - Image toolkit
 - Input formats
 - Logging and alerts
 - Performance
 - Site information
 - Site maintenance
 - User management
 - Reports
 - Help
- Log out

DPI Study

Settings

Invite Keys

Questionnaire

Number of answers on add question form:

Consent form

Toggle IRB consent screen:

- disabled
- enabled

Enabling the IRB form will require people to view .

Text to output on the IRB consent form.:

```
<p>A research project is being conducted by Mr. David Norman to study the impact of digital media in daily life. The purpose of this study is to observe whether there is any relationship between digital media interaction and student performance with
```

HTML is allowed.

Score screen text:

```
<p>Your Digital Propensity Index score is <strong>@score</strong>. A score of 34 would represent the far extreme Digital Immigrant as opposed to the other extreme of 170 for a pure Digital Native.</p>
```

Text to output on the final screen where the DPI score is presented. Use @score as the placeholder for the numerical score. HTML is allowed.

Alternate IRB URL:

Alternate URL to link users to under the "I Consent" button on the IRB consent form.

Save configuration

Reset to defaults

DPI Study

Home > Administer > Site configuration > DPI Study

deekayen

- My account
- Create content
- Administer
 - Content management
 - Site building
 - Site configuration
 - Actions
 - Administration theme
 - Clean URLs
 - DPI Study
 - Date and time
 - Error reporting
 - File system
 - Google Analytics
 - Image toolkit
 - Input formats
 - Logging and alerts
 - Performance
 - Site information
 - Site maintenance
 - User management
 - Reports
 - Help
- Log out

DPI Study

Settings

Invite Keys

Questionnaire

Invite Key ▲	Notes	Action
aa	Contacts who have a business relationship with Advanced Automation, Inc, in Lindale, TX.	delete
advd	People who clicked a link from advogato.org	delete
aw	Google AdWords campaign	delete
cg	Employees of Classic Graphics in Charlotte, NC.	delete
d	People referred from clicking a link on deekayen.net.	delete
friend	Personal friend of David Norman	delete
grad	Graduate students at University of Central Florida.	delete
tfsbo	Customers of Timeshare FSBO, Orlando, FL.	delete
ugrd	Undergraduate students at University of Central Florida.	delete

Add new invite key

New invite key: *

Entry can be alphanumeric.

Key notes:

Notes on the audience to be associated with the key.

Add key

DPI Study

deekayen

- My account
- Create content
- Administer
 - Content management
 - Site building
 - Site configuration
 - Actions
 - Administration theme
 - Clean URLs
 - DPI Study
 - Date and time
 - Error reporting
 - File system
 - Google Analytics
 - Image toolkit
 - Input formats
 - Logging and alerts
 - Performance
 - Site information
 - Site maintenance
 - User management
- Reports
- Help
- Log out

Home > Administer > Site configuration > DPI Study

DPI Study

Settings

Invite Keys

Use Database

List questions Add question

Weight	Title
2	I communicate with others using email
3	I communicate with others using instant messaging (IM)
4	I communicate with others using chat rooms
6	I read or contribute to Web blogs
7	I share images and pictures online
8	I share ideas, papers, information, and knowledge online
9	I make online purchases
10	I download music from the Internet
11	I download movies from the Internet
13	I have updated my website or personal web space (e.g. MySpace)
14	When playing video games, I customize the characters or scenes within the game
15	I initially meet or arrange meetings with new people online
16	I meet with people online
17	I have downloaded MP3 files from the Internet
18	I have downloaded videos and images from the Internet
19	I use email or the Internet to complete group assignments for school and/or work
20	I participate in group games (MMORPGs)
21	I use a portable digital assistant (PDA) (e.g. PocketPC, PalmPilot, Blackberry)
22	I review online evaluation systems (e.g. star rating system) before making online purchases
23	I contribute to online evaluation systems (e.g. star rating system) after making online purchases
24	I play video games
25	I play 1-2 player video games
26	I play games requiring more than 2 players
27	I use handheld game devices
28	I have taken courses online
29	I found information to complete school or work assignments online
30	I have gone online to learn about topics that interest me
31	I use the internet to communicate with the instructor, fellow classmates, or coworkers
33	I use search engines to locate information on the Internet
34	I use filtering tools (advanced search, directories, etc.) when locating information on the Internet
25	I search for information for entertainment and other personal reasons online
36	I have expertise in the following number of programming languages
37	I socialize with others online
38	When I am online, I can manage the following maximum number of conversations at the same time
39	I travel for business
40	My family's annual gross income is
41	I have the following number of computers in my home
42	I have the following number of people in my household
43	I use a computer at work
44	My age group is
45	My gender is
46	I prefer training and/or educational materials that present graphics, rather than text first
47	I prefer training and/or education that allows me to randomly access various components of a lesson, rather than materials that step me through a lesson one component at a time
48	I prefer to complete multiple tasks (e.g. Instant Messaging, alternative activities, watching TV) rather than one task at a time while I'm learning
49	I prefer training and/or education that is play oriented, rather than work oriented
50	I prefer training and/or education that encourages me to communicate and learn with others rather than learning by myself

DPI Study

Home > Administer > Site configuration > DPI Study

deekayen

- My account
- Create content
- Administer
 - Content management
 - Site building
 - Site configuration
 - Actions
 - Administration theme
 - Clean URLs
 - DPI Study
 - Date and time
 - Error reporting
 - File system
 - Google Analytics
 - Image toolkit
 - Input formats
 - Logging and alerts
 - Performance
 - Site information
 - Site maintenance
 - User management
 - Reports
 - Help
- Log out

DPI Study

Settings

Invite Keys

Questionnaire

List questions

Add question

Question type:

Radio buttons

Checkbox

Select radio buttons for a single response per question or checkbox for multiple answers to the question. Currently, only radio buttons are supported.

Question title:

Note: A colon is automatically appended to the question text.

Answers

Weight:

Answer 1:

Weight:

Answer 2:

Weight:

Answer 3:

Weight:

Answer 4:

Weight:

Answer 5:

Question weight:

Integer to dictate the order of the questions in the questionnaire. Questions with higher weight will be lower in the question order. Questions with the same weight will order alphabetically. For example, question number 20 would likely have a weight of 20.

Add question

DPI Study

Home > Administer > Reports

deekayen

- My account
- Create content
- Administer
 - ▷ Content management
 - ▷ Site building
 - ▷ Site configuration
 - ▷ User management
 - ▷ Reports
 - Recent log entries
 - DPI Study
 - Recent hits
 - Top 'access denied' errors
 - Top 'page not found' errors
 - Top referrers
 - Top pages
 - Top visitors
 - Access log settings
 - Available updates
 - Status report
- Help
- Log out

Status report

Here you can find a short overview of your site's parameters as well as any problems detected with your installation. It may be useful to copy and paste this information into support requests filed on drupal.org's support forums and project issue queues.

Drupal	6.2
✓ Access to update.php	Protected
✓ Configuration file	Protected
✓ Cron maintenance tasks	Last run 54 min 41 sec ago
You can run cron manually.	
DPI Study responses	374
✓ Database updates	Up to date
✓ Drupal core update status	Up to date
✓ File system	Writable (<i>public</i> download method)
✓ GD library	bundled (2.0.34 compatible)
✓ Module and theme update status	Up to date
✓ MySQL database	5.0.41
✓ PHP	5.2.5
✓ PHP memory limit	64M
✓ PHP register globals	Disabled
✓ Unicode library	PHP Mbstring Extension
✓ Update notifications	Enabled
✓ Web server	Apache

DPI Study

Home > Administer > Reports

deekayen

- My account
- Create content
- Administer
 - ▷ Content management
 - ▷ Site building
 - ▷ Site configuration
 - ▷ User management
 - ▽ Reports
 - Recent log entries
 - **DPI Study**
 - Recent hits
 - Top 'access denied' errors
 - Top 'page not found' errors
 - Top referrers
 - Top pages
 - Top visitors
 - Access log settings
 - Available updates
 - Status report
- Help
- Log out

DPI Study

Visits

Export

Invite Key ▲	Visits	Invite link
	46	http://dpistudy.com/?k=
aa	5	http://dpistudy.com/?k=aa
advo	7	http://dpistudy.com/?k=advo
aw	127	http://dpistudy.com/?k=aw
cg	60	http://dpistudy.com/?k=cg
d	24	http://dpistudy.com/?k=d
friend	4	http://dpistudy.com/?k=friend
grad	44	http://dpistudy.com/?k=grad
tfsbo	108	http://dpistudy.com/?k=tfsbo
ugrd	224	http://dpistudy.com/?k=ugrd

APPENDIX F: IRB APPROVAL



University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Exempt Review Status

From: **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To: **David Norman and Co-PIs: Atsusi Hirumi, Stephen A. Sivo**

Date: **March 31, 2008**

IRB Number: **SBE-08-05577**

Study Title: **The Impact of Digital Propensity Index Score on the Performance of Interpreting Instruction in Text and Graphic Formats**

Dear Researcher:

Your research protocol was reviewed by the IRB Vice-chair on 3/31/2008. Per federal regulations, 45 CFR 46.101, your study has been determined to be **minimal risk for human subjects and exempt** from 45 CFR 46 federal regulations and further IRB review or renewal unless you later wish to add the use of identifiers or change the protocol procedures in a way that might increase risk to participants. Before making any changes to your study, call the IRB office to discuss the changes. **A change which incorporates the use of identifiers may mean the study is no longer exempt, thus requiring the submission of a new application to change the classification to expedited if the risk is still minimal.** Please submit the Termination/Final Report form when the study has been completed. All forms may be completed and submitted online at <https://iris.research.ucf.edu>.

The category for which exempt status has been determined for this protocol is as follows:

2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey or interview procedures, or the observation of public behavior, so long as confidentiality is maintained.
 - (i) Information obtained is recorded in such a manner that the subject cannot be identified, directly or through identifiers linked to the subject, **and/or**
 - (ii) Subject's responses, if known outside the research would not reasonably place the subject at risk of criminal or civil liability or be damaging to the subject's financial standing or employability or reputation.

A **waiver of documentation of consent** has been approved for all subjects. Participants do not have to sign a consent form, but the IRB requires that you give participants a copy of the IRB-approved consent form, letter, information sheet, or statement of voluntary consent at the top of the survey.

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 03/31/2008 11:45:05 AM EST

IRB Coordinator



December 1, 2006

Atsusi Hirumi, Ph.D.,
Kelsey Henderson, and
David Norman
University of Central Florida
Department of Educational Research, Technology & Leadership
ED 320C
Orlando, FL 32816-1250

Dear Dr. Hirumi, Mr. Henderson, and Mr. Norman:

With reference to your protocol #06-4025 entitled, "Digital Propensity Index (DPI)," I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. **This study was approved on 11/30/06. The expiration date for this study will be 11/29/2007.** Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator.

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

A handwritten signature in cursive script that reads 'Joanne Muratori'.

Joanne Muratori
(FWA00000351 Exp. 5/13/07, IRB00001138)

Copies: IRB File

JM:jm



Office of Research & Commercialization

October 12, 2006

David Kent Norman
c/o Laura Blasi, Ph.D.
University of Central Florida
Department of Educational Research, Technology & Leadership
ED 222B
Orlando, FL 32816-1250

Dear Mr. Norman:

The University of Central Florida's Institutional Review Board (IRB) received your protocol IRB #06-3778 entitled "**Instructional Technology Students' Perceptions of How Age Impacts Proficiency with Electronics.**" The IRB Chair reviewed the study on 10/10/2006 and did not have any concerns with the proposed project. The Chair has indicated that under federal regulations (Category #2, research involving the use of educational tests, survey or interview procedures, or the observation of public behavior, so long as confidentiality is maintained) this research is **exempt** from further review by our IRB, so an approval is not applicable and a renewal within one year is not required.

Please accept our best wishes for the success of your endeavors. Should you have any questions, please do not hesitate to call me at 407-823-2901.

Cordially,

A handwritten signature in cursive script that reads "Joanne Muratori".

Joanne Muratori
UCF IRB Coordinator
(IRB00001138, FWA00000351, Exp. 5/13/07)

Copies: IRB File
Laura Blasi, Ph.D.

JM:jt

APPENDIX G: FIRST CONTACT: PRENOTICE LETTER

[Subject]: Questionnaire advanced notice

A few days from now you will receive a request to fill out a brief questionnaire for an important research project being conducted as part of my doctoral candidacy. It should only take 5-10 minutes of your time.

It concerns your experience with digital media and how that experience might impact your performance with instruction. The study will analyze varying types of instruction to determine whether digital media experience could predict better performance in one type over the other. A short portion of the questionnaire is timed, so please set aside a moment of time where you can complete it undisturbed.

I am writing in advance because I have found many people like to know ahead of time that they will be contacted. The study is an important one that will help improve instruction for students with varying levels of digital media experience and may help predict how instruction should change for future generations.

Thank you for your time and consideration. It's only with the generous help of people like you that this research can be successful.

--

David Norman
Ph.D. candidate at the University of Central Florida
da316305@pegasus.cc.ucf.edu

P.S. You will be able to get a score of your digital media experience to compare with your friends as a way of saying thanks.

To opt-out of future emails, send an email with unsubscribe in the subject line to dissertation-request@lists.dpistudy.com or visit <http://lists.dpistudy.com/mailman/listinfo.cgi/dissertation>

APPENDIX H: SECOND CONTACT: QUESTIONNAIRE MAILOUT

[Subject]: Please help improve learning

I am writing to ask your help in a study to learn how digital media impacts performance in instruction. To participate, click the link in the middle of this email. It will only take 5-10 minutes of your time.

You were selected as part of a random sample of students. Results from the study will be used to observe whether there is any relationship between digital media exposure and preferences for different forms of instruction. The study will analyze varying types of instruction to determine whether digital media experience could predict better performance in one type over the other. A short portion of the questionnaire is timed, so please set aside a moment of time where you can complete it undisturbed.

Your answers are completely anonymous and will be released only as summaries in which no individual's answers can be identified. This survey is voluntary, but you must be 18 years of age or older to participate. You can help make learning easier for students like yourself by taking a few minutes to complete the questionnaire.

Thank you very much for helping with this important study.

<http://dpistudy.com/>

Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board. Questions or concerns about research participants' rights may be directed to the UCF IRB office, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246, or by campus mail 32816-0150. The hours of operation are 8:00 am until 5:00 pm, Monday through Friday except on University of Central Florida official holidays. The telephone numbers are (407) 882-2276 and (407) 823-2901.

For any other questions about this study, contact David Norman at da316305@pegasus.cc.ucf.edu. This research is being conducted with Dr. Atsusi Hirumi (hirumi@mail.ucf.edu), Associate Professor & Co Chair of Instructional Technology at the University of Central Florida.

--

David Norman
Ph.D. candidate at the University of Central Florida
da316305@pegasus.cc.ucf.edu

To opt-out of future emails, send an email with unsubscribe in the subject line to dissertation-request@lists.dpistudy.com or visit <http://lists.dpistudy.com/mailman/listinfo.cgi/dissertation>

APPENDIX I: THIRD CONTACT: THANK YOU REMINDER

[Subject]: Reminder: Please help improve learning

Last week a questionnaire seeking your experience with digital media was emailed to you.

If you have already completed the questionnaire, please accept my sincere thanks. If not, please do so today. I am especially grateful for your help because it is only by asking people like you to share your experiences that we can understand how students' background with electronics impacts learning.

If you misplaced the email, the URL to participate is as follows:

<http://dpistudy.com/>

--

David Norman
Ph.D. candidate at the University of Central Florida
da316305@pegasus.cc.ucf.edu

To opt-out of future emails, send an email with unsubscribe in the subject line to dissertation-request@lists.dpistudy.com or visit <http://lists.dpistudy.com/mailman/listinfo.cgi/dissertation>

APPENDIX J: FOURTH CONTACT: THANK YOU REMINDER

[Subject]: Last chance! Please help improve learning

About two weeks ago, I sent a questionnaire to you that asked about your digital media experience. I'm writing again because of the importance that your questionnaire has for helping to get accurate results. Although the questionnaire went to a sample of the student population, it's only from hearing from everyone in the sample that the study can be sure to be truly representative.

I hope you will fill out and submit the questionnaire soon and get your digital propensity index score. If you have questions, please don't hesitate to contact me at da316305@pegasus.cc.ucf.edu.

<http://dpistudy.com/>

--

David Norman
Ph.D. candidate at the University of Central Florida
da316305@pegasus.cc.ucf.edu

To opt-out of future emails, send an email with unsubscribe in the subject line to dissertation-request@lists.dpistudy.com or visit <http://lists.dpistudy.com/mailman/listinfo.cgi/dissertation>

APPENDIX K: COPYRIGHT PERMISSION

From: "Gurnee, Marianne" <Marianne.Gurnee@dot.state.fl.us>
To: "da316305@pegasus.cc.ucf.edu" <da316305@pegasus.cc.ucf.edu>
Date: Mon, 7 Apr 2008 13:40:52 -0400
Subject: RE: copyright permission

Dear Mr. Norman,

You have permission to reprint the text from <http://www.cfrail.com/default.asp>

The Florida Department of Transportation is in the process of updating the [cfrail.com](http://www.cfrail.com) website to reflect travel times from the new DeBary station at Ft. Florida Road and to include Maitland in the travel time schedules, so reprinting that material would not be accurate at present. You may reprint all other information on that page.

If you have any additional questions, or if I can be of further assistance, please do not hesitate to contact me.

Marianne Gurnee

-----Original Message-----

From: David K Norman
To: mgurnee@cfl.rr.com
Sent: Apr 6, 2008 11:16 PM
Subject: copyright permission

I am a Ph.D. candidate at the University of Central Florida. I would like to get permission to reprint a few quotes from [cfrail.com](http://www.cfrail.com) in my dissertation.

Could you give me a contact for someone in a position to grant that?

Specifically, I'm interested in copying the text from the front page at <http://www.cfrail.com/default.asp> and the bullets and graphics on http://www.cfrail.com/cr_wantmoreinformation.asp.

APPENDIX L: PERMISSION TO CONTACT CLASSIC GRAPHICS EMPLOYEES

From: Bryan Stalcup <bryans@CGraphics.com>
To: David K Norman <da316305@pegasus.cc.ucf.edu>
Subject: Re: cgallery permission
Date: Wed, 19 Mar 2008 18:13:57 -0400

David,

that is fine with me.

thanks!

bryan

--

bryan stalcup
vp technology
classic graphics
704.564.4912 cell
704.597.9015 work
704.973.9548 fax

On Mar 8, 2008, at 3:20 AM, David K Norman wrote:

> Bryan:
>
> May I formally have your permission to use the cgallery email list to
> contact employees of Classic Graphics about participation in my
> dissertation questionnaire located at <http://dpistudy.com?>
>

REFERENCES

- Begley, S. (2007, January 19). How the brain rewires itself. *TIME Magazine*. 169(5).
Retrieved April 29, 2007, from
<http://www.time.com/time/magazine/article/0,9171,1580438,00.html>
- Bruning, R. H., Schraw, G. J., Norby, M. M., & Ronning, R. R. (2004). *Cognitive psychology and instruction* (4th ed.). Upper Saddle River, NJ: Pearson Merrill Prentice Hall.
- Carney, R. N., & Levin, J. R. (2002). Pictorial illustrations still improve student's learning from text. *Educational Psychology Review*, 14(1), 5-26.
- Chudler, E. H. (2005, August 6). *Brain plasticity: What is it? Learning and memory*.
Retrieved on May 14, 2007, from the University of Washington, Department of Bioengineering Web site: <http://faculty.washington.edu/chudler/plast.html>
- Clark, R. C., & Lyons, C. (2004). *Graphics for learning: Proven guidelines for planning, designing, and evaluating visuals in training materials*. San Francisco, CA: Pfeiffer.
- Clark, R. C., & Mayer, R. E. (2002). *E-Learning and the science of instruction*. San Francisco, CA: Pfeiffer.

Concerning the effect of technology on the capital markets: Hearings before the Subcommittee on Capital Markets, Securities, and Government Sponsored Enterprises of the House Committee on Banking and Financial Services, 106th Cong., (1999, March 25) (testimony of Laura S. Unger). Retrieved on May 21, 2007, from the Securities and Exchange Commission Web site:

<http://www.sec.gov/news/testimony/testarchive/1999/tsty0799.txt>

DaCosta, B, Nasah, A, Prickett, C, & White, J. (2007) Digital Native and Digital Immigrant Differences. Unpublished manuscript, University of Central Florida.

Dillman, D. A. (2006, Aug 18). *Mail and internet surveys: The tailored design method 2007 update with new internet, visual, and mixed-mode guide* (2nd ed.). Hoboken, NJ: John Wiley & Sons, Inc.

Eshet-Alkali, Y., & Amichai-Hamburger, Y. (2004, November). Experiments in digital literacy. *CyberPsychology & Behavior*, 7(4), 421-429.

Elkind, D. (2001). *The hurried child: Growing up too fast too soon*. Cambridge, MA: Perseus Publishing.

Frاند, J. L. (2000). The information age mindset: Changes in students and implications in higher education. *EDUCAUSE Review*, 35(5), 15-24.

Galley, M. (2000, May 10). Computer companies give birth to 'lapware' for babies. Retrieved February 11, 2007, from Education Week on the Web:

<http://www.teachermag.com/ew/ewstory.cfm?slug=35lapware.h19>

Garner, R. (1987). *Metacognition and reading comprehension*. Norwood, NJ: Ablex Publishing Corporation.

- Garner, R., Gillingham, M. G., & White, C. S. (1989). Effects of “seductive details” on macroprocessing and microprocessing in adults and children. *Cognition and Instruction, 6*(1), 41-57.
- Harp, S. F., & Mayer, R. E. (1998). How seductive details do their damage: A theory of cognitive interest in science learning. *Journal of Educational Psychology, 90*(3), 414-434.
- Henderson, K. L., & Hirumi, A. (2005). Digital propensity index (DPI) questionnaire. University of Central Florida, Instructional Technology. Orlando, FL: Atsusi Hirumi.
- Henderson, K. L. (2007, Aug). *The effects of prior knowledge activation on learner retention of new concepts in learning objects*. Unpublished doctoral dissertation, University of Central Florida.
- Hoban, C. F., & Van Ormer, E. B. (1979). *Instructional film research, 1918 to 1950*. North Stratford, NH: Ayer Company. Retrieved May 14, 2007, from Google Book Search: <http://books.google.com/books?id=jVT0f81Hak8C>
- Howe, N., & Strauss, W. (2000). *Millennials rising: The next great generation*. New York: Vintage Books.
- Kalyuga, S., Ayres, P., Chandler, P., & Sweller, J. (2003). The expertise reversal effect. *Educational Psychologist, 38*(1), 23-31.
- Kassinove, H., & Summers, M. (1968, January). The developmental attention test – A preliminary report on an objective test of attention. *Journal of Clinical Psychology, 24*(1), 76-78.

- Kintsch, W., & van Dijk, T. A. (1978). Toward a model of text comprehension and production. *Psychological review*, 85(5).
- Klausmeier, H J., Ghatala, E. S., & Frayer, D. A. (1974). *Conceptual learning and development: A cognitive view*. New York, NY: Academic Press, Inc.
- Kraidy, U. (2002, October). Digital media and education: Cognitive impact of information. *Journal of Educational Media*, 27(3).
- Lohr, L. (2003). *Creating graphics for learning and performance: Lessons in visual literacy*. Upper Saddle River, NJ: Merrill Prentice Hall.
- Matsumoto, M., & Nishimura, T. (1998, January). *Mersenne twister: A 623-dimensionally equidistributed uniform pseudorandom number generator*. Retrieved April 24, 2007, from Hiroshima University, Department of Mathematics Web site: <http://www.math.sci.hiroshima-u.ac.jp/~m-mat/MT/ARTICLES/mt.pdf>
- Mueller, R. J. (1992). *Instructional psychology: Principles and practices*. Champaign, IL: Stipes Publishing Company.
- Pascual-Leone, A. (2001). The brain that plays music and is changed by it. *The Biological Foundations of Music, Annals of the New York Academy of Sciences*, 930, 315-329. Retrieved on May 14, 2007, from <http://www.annalsnyas.org/cgi/content/abstract/930/1/315>
- Prensky, M. (2001a, October). Digital natives, digital immigrants. Retrieved November 25, 2005, from Marc Prensky: <http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf>

- Prensky, M. (2001b, December). Do they really think differently? Retrieved November 25, 2005, from Marc Prensky: <http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part2.pdf>
- Roberts, D. F., Foehr, U. G., Rideout, V. (2005, March). *Generation M: Media in the lives of 8-18 year-olds*. Retrieved November 2, 2007, from the The Henry J. Kaiser Family Foundation Web site: <http://www.kff.org/entmedia/upload/Generation-M-Media-in-the-Lives-of-8-18-Year-olds-Report.pdf>
- Rosen, V. M., Caplan, L., Sheesley, L., Rodriguez, R., & Grafman, J. (2003). An examination of daily activities and their scripts across the adult lifespan. *Behavior Research Methods, Instruments, & Computers*, 35(1), 32-48.
- Rumelhart, D. E. (1981). Schemata: The building blocks of cognition. In J. T. Guthrie (Ed.), *Comprehension and teaching: Research reviews* (pp. 3-26). Newark, DE: International Reading Association.
- Schank, R., & Abelson, R. (1977). *Scripts, plans, goals and understanding: An inquiry into human knowledge structures*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Scheaffer, R. L., Mendenhall, W., & Ott, L. (1990). *Elementary survey sampling* (4th ed.). Boston: PWS-Kent.
- Smith, F. (2004). *Understanding reading: A psycholinguistic analysis of reading and learning to read* (6th ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

- Society for Neuroscience. (2000). *Brain plasticity, language processing and reading*. Retrieved May 14, 2007, from http://web.archive.org/web/20060209205508/http://web.sfn.org/content/Publications/BrainBriefings/brain_lang_reading.html
- Soloway, E., Adelson, B., & Ehrlich, K. (1988). Knowledge and process in the comprehension of computer programs. In Chi, M. T. H., Glaser, R., & Farr, M. J. (Eds.), *The nature of expertise*. (pp. 129-152). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.
- Tapscott, D. (1997). *Growing up digital : The rise of the net generation*. New York: McGraw-Hill.
- Thevenot, C., Devidal, M., Barrouillet, P., Fayol, M. (2007). Why does placing the question before an arithmetic word problem improve performance? *A situation model account. The Quarterly Journal of Experimental Psychology*, 60(1), 43-56.
- Twenge, J. M. (2006). *Generation me*. New York, NY: Free Press.
- Wetstone, H. S., & Friedlander, B. Z. (1974). The effect size of live, TV, and audio story narration on primary grade children's listening comprehension. *The Journal of Educational Research*, 68(1), 32-35.
- Woelfel, N., & Tyler, I. K. (1945). *Radio and the school, a guidebook for teachers and administrators*. Tarrytown-on-Hudson, N.Y.: World Book.

INDEX

- Abelson, Robert, 9, 16, 56, 57
- Adelson, B., 61
- age, 18, 52
- Amichai-Hamburger, Yair, 23
- ANOVA, 35
- Ayres, P., 17
- bottleneck, 19
- Bruning, Roger H., 5, 8, 9, 15, 18, 23
- Caplan, L., 9, 17
- Carney, Russell N., 20
- Ceiling Effect, 60
- Chandler, P., 17
- Clark, Ruth Colvin, 5, 19, 21
- Columbine, 12
- Coupland, Douglas, 12
- Cronbach, 33
- DaCosta, Boaventura, 18, 35
- digital expert, 15
- Digital Immigrant, definition, 4, 89
- digital media, 56
- Digital Native, definition, 4, 89
- Digital Propensity, definition, 4, 89
- Dillman, D. A., 35
- DPI, 6, 14, 18, 31, 54, 55
- DPI, pilot study, 27
questionnaire, 18, 25
reliability, 33
score, 18, 35
- Ecological Effects, 58
- Ehrlich, K., 61
- Elkind, David, 1
- enrollment, 25
- Eshet-Alkali, Yoram, 23
- expertise, 17
- Foehr, Ulla G., 14, 56
- Frاند, Jason L., 14, 15
- Frayar, Dorothy A., 19
- Friedlander, Bernard Z., 11
- Gagne, 29
- Galley, M., 1
- gaming, 61
- Garner, Ruth, 17, 20
- Generation M, 14
- Generation Me, 13
- Generation X, 12
- GenMe, 13, 15
- Ghatala, Elizabeth S., 19
- Gillingham, Mark G., 20
- Grafman, J., 9, 17
- Graphic, definition, 5
- graphics, 21
- Harp, Shannon F., 19
- Hawthorne Effect, 59
- Henderson, Kelsey L., 4, 31
- Henry J. Kaiser Family Foundation, 14
- Hirumi, Atsusi, 4, 31
- Howe, Neil, 12, 13, 56

IRB, 29	Nishimura, Takuji, 28	Scheaffer, R. L., 26
JavaScript, 32	noise, 19	Schema,
Kalyuga, S., 17	Norby, Monica M., 5, 8	definition, 5
Kassinove, Howard, 11	Not Generation, 11	theory, 15
Kintsch, Walter, 17	null hypothesis, 53	Schema Theory, 7, 9, 15, 17
Klausmeier, Herbert J., 19	organizational graphic, 30	Schraw, Gregory J., 5, 8, 18
Kruskal-Wallis ANOVA, 35	Ott, L., 26	Sheesley, L., 9, 17
Levin, Joel R., 20	Population Effects, 58	Smith, Frank, 19
Lohr, Linda L., 20	Prensky, Marc, 1-5, 8, 10, 11,	Soloway, E., 61
Lyons, Chopeta, 5, 19, 21	19, 23, 35, 54, 56, 89	Spearman's Rho, 35
Matsumoto, Makoto, 28	Prickett, Carolyn, 18, 35	SPSS, 37
Mayer, Richard E., 19	Quillian, 16	SQL, 67
Mendenhall, W., 26	regression, 40	Strauss, William, 12, 13, 56
Millennial Generation, 12, 15	relational graphics, 30	Summers, Marc, 11
Mueller, Richard J., 19	Repeated Testing, 59	Sweller, J., 17
multiple regression, 37	Rideout, Victoria, 14, 56	Tapscott, Don, 11-13, 15, 56
MySQL, 27	Roberts, Donald F., 14, 56	Tchebysheff, 25
N-Gen, 11, 12	Rodriguez, R., 9, 17	thumbnail, 29
Nasah, Angelique, 18, 35	Ronning, Royce R., 5, 8	Twenge, Jean M., 13, 56
Net Generation, 11, 15	Rosen, V. M., 9, 17	van Dijk, Teun A., 17
neuroplasticity, 61	Rumelhart, David E., 15, 16	Wetstone, Harriet S., 11
Neyman method, 26, 27	Schank, Roger, 9, 16, 56, 57	White, C. Stephen, 20
		White, Jontoinette, 18, 35