EXPLORING THE ELECTRONIC CLASSROOM AS A LEARNING SYSTEM

A Dissertation in
Adult Education

by

Richard Kordel

© 2008 Richard Kordel

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Education

May 2008
The thesis of Richard Kordel was reviewed and approved* by the following:

**Patricia A. Cranton**  
Visiting Professor of Adult Education  
Thesis Advisor  
Chair of Committee

**Daniele D. Flannery**  
Associate Professor of Adult Education.

**William D. Milheim**  
Professor of Education

**Richard R. Young**  
Professor of Supply Chain Management

**Edgar Farmer**  
Professor of Workforce Education  
Head of the Department of Learning and & Performance Systems

*Signatures are on file in the Graduate School
ABSTRACT

The purpose of this study is to examine the system that is comprised of teachers, students, content and media, with a focus on the specific consequences of using computers as teaching aids, and to explore the factors that may lead to an understanding of those consequences. I will explore the idea that far from being a passive information delivery and communication tool, the act of moving information onto a computer adds to, subtracts from, and changes the nature of information presentation, comprehension and communication. That change can be situated in the nature of the medium itself, or in how the students and teachers interact with that medium, or in the teachers and students themselves. Hopefully, this study will lead to a more careful consideration on the part of educators of how, in the best of circumstances, the computer has been incorporated into education as a useful research and communication tool, and in the worst, of how education has been compromised by the indiscriminate use of computers. Looking forward it is my hope that this research can serve to guide practice within the evolving field of educational technology.

In this paper I will seek answers to the following research questions:

- What role does the presentation and communication of information on a computer screen play in how students and teachers interpret and react to the information?

- What happens to the learning system when teaching and learning transaction is filtered through the medium of the computer? Specifically, what happens:
  - in the content of discussions?
  - in the conduct of discussions?
- What role do student and teacher background attitudes, personality type, information processing style and self-perceived computer competency play in how those students and teachers perceive discussions, conceptualize knowledge, and perceive purpose of education?

These research questions are viewed as being inter-related and part of a complete system. Implicit in these questions is an applied research orientation which assumes there is a way to improve teaching and learning through an understanding of how the use of computers affects students, teachers and information
# TABLE OF CONTENTS

Chapter 1  Introduction and Overview................................................................. 1  
  Background of the problem ............................................................................. 1  
  Purpose of the research .................................................................................. 6  
  Guiding Research Questions........................................................................... 6  
  Conceptual Theoretical Framework............................................................... 7  
  Overview of research methods and design ...................................................... 14  
  Significance of the Study.............................................................................. 16  
  Assumptions and Limitations of the study....................................................... 18  
  Definitions of terms ....................................................................................... 19  
  Organization of the study.............................................................................. 21  

Chapter 2  Literature Review ............................................................................ 23  
  Introduction..................................................................................................... 25  
  Learning and the computer .......................................................................... 32  
  Information Visualization .............................................................................. 44  
  Considerations of Media............................................................................... 52  
  Post- McLuhan............................................................................................... 60  
  Educational Foundations.............................................................................. 69  
  Educational Framework............................................................................... 85  
  The Educational System............................................................................. 91  
  Discussion...................................................................................................... 98  
  Conclusion................................................................................................... 105  

Chapter 3  Research Design and Methodology............................................... 106  
  Research Paradigm and Rationale .............................................................. 107  
  Research Design......................................................................................... 109  
  Data Collection ............................................................................................ 116  
  Participants................................................................................................... 118  
  Data Analysis ............................................................................................... 120  
  Validity ......................................................................................................... 130  
  Summary...................................................................................................... 133  

Chapter 4  Research Results .......................................................................... 134  
  Overview...................................................................................................... 134  
  Teacher: A—............................................................................................... 138  
  Background and Initial Interview .............................................................. 138  
  Learning Style Instruments......................................................................... 141  
  On-Line Observations............................................................................... 144  
  Post-Class Interview................................................................................... 146
Summary and Findings .......................................................................................... 149
Student B— ................................................................................................................. 153
  Background and Initial Interview ................................................................. 153
  Learning Style Instruments ........................................................................ 154
  On-line observations .................................................................................... 160
  Post-Class Interview ...................................................................................... 162
  Summary and Findings .................................................................................... 165
Student S— ................................................................................................................. 168
  Background and Initial Interview ................................................................. 168
  Learning Style Instruments ........................................................................ 170
  On-Line Observations ................................................................................... 176
  Post-Class Interview ...................................................................................... 176
  Summary and Findings .................................................................................... 180
Student W— ................................................................................................................. 183
  Background and Initial Interview ................................................................. 183
  Learning Style Instruments ........................................................................ 185
  On-Line Observations ................................................................................... 190
  Post-Class Interview ...................................................................................... 192
  Summary and Findings .................................................................................... 195
Student D— ................................................................................................................. 197
  Background and Initial Interview ................................................................. 197
  Learning Style Instruments ........................................................................ 199
  Gregorc ........................................................................................................... 201
  On-Line Observations ................................................................................... 202
  Post-Class Interview ...................................................................................... 205
  Summary and Findings .................................................................................... 207
Learning Materials ............................................................................................. 209
  Angel System Background ............................................................................ 211
  The Angel System Student Interface .......................................................... 214
  Course Content .............................................................................................. 222
  Discussion ....................................................................................................... 229
Chapter Summary and Findings ........................................................................ 232

Chapter 5 Discussion and Conclusions .............................................................. 234
  A Further Consideration Of Carspecken ..................................................... 235
  The system ...................................................................................................... 237
  System components ....................................................................................... 239
  The Students .................................................................................................. 246
  The instructor .................................................................................................. 248
  The Material ................................................................................................... 249
  Revising the System ....................................................................................... 251
  Considering the System in Action ............................................................... 253
  Concept of knowledge .................................................................................... 256
  Purpose of Education ..................................................................................... 258
Chapter 1

Introduction and Overview

Background of the problem

There is an increasing dependence of adult educators and adult students upon the computerized tools used in the educational process. That dependence takes different forms in different venues. In traditional educational settings such as the university classroom, computers are used as tools to facilitate presentations and supplement communication between teacher and student and from student to student. In distance education settings these tools often move to the forefront as the sole presentation and communication method. As Schifter (1999) notes, this has the effect of turning environment into curriculum, and bringing into the equation matters of aesthetics, ethics, and culture. In industry, more training and education is being moved to a standardized delivery platform. The requirements for this platform are being set by committees such as the Airline Industry CBT Committee (AICC) and the Advanced Distributed Learning Initiative (ADL), and with published guidelines such as the SCORM (Shareable Content Object Reference Model) becoming industry standards. The primary focus of these groups is on the interoperability of the output of disparate authoring systems and the standardization of data communication rather than a platform for good instruction or improved learning. Whatever good these groups may do for the training industry and for the communication of educational data, this attempt to quantify learning, to reduce it to
easily manipulable bits and bytes puts that learning at risk in our new computer enhanced classrooms. Those systems that were supposed to help with administrative and facilitation details of class have, many times inadvertently, been granted the capability of shaping the message being communicated.

After examining the literature, it becomes clear that there is a tendency to think that computers and their use in education are actually two discrete yet linked topics, on one side the specific topics and subsets of topics related to technology and on the other by the equally specific topic and subsets of topics related to education. It is assumed in the literature that the concatenation of these two topics results in a third, a new topic created by the intersection of the first two. Indeed, this seems to be true. The new topic has a research literature. That literature finds a definite correlation between the use of the computer and the concomitant presentation of information on that computer and the communication and comprehension of that information. Several areas within this literature suggested as worthy of further study include Hewitt and Scardamalia’s (1998) study of distributed cognition in software environments as a way to use the computer to improve our ability to construct knowledge in classroom settings; Mayer’s (1989) use of conceptual modeling as instructional method; Hill and Hannafin’s (2001) use of metacognitive knowledge as an aid to problem solving with computerized tools; and Herrington and Oliver’s (2000) study linking content and presentation as a method of creating an authentic problem solving environment. Of note is the fact that each of these studies takes the traditional view, that studying a small piece of the learning interaction will eventually aggregate knowledge until an understanding of the entire learning interaction reached. The analogy that comes to mind is that of a bicycle wheel, with each
spoke contributing to the wheel-ness of the whole. What becomes clear over time is that much of the current literature is still studying the individual spokes and we have yet to look at the educational wheel formed from the individual pieces.

The use of the computer in education follows a clear technological tradition. Reiser (2001) has compiled a detailed history of educational media providing the historical context to place the computer, and the content viewed upon that computer, as the next logical step in the ongoing development of educational media. It is therefore something of an effort to step outside this rich thread and consider some “other aspects” of the intersection of computers with education. Among those “other aspects” are things that involve the affective domain, defined loosely as a consideration of how the interaction with computers may involve more than purely cognitive factors, and extend into attitudes, biases and preferences, and such things as the digital divide, issues of gender and the interrelationship of gender with computer use, the tendency of the media to shape the message, and the cultural positionality of any message placed on the computer. These other aspects do not readily appear in the Proquest listings, nor do they leap readily into the forefront of thought when the topic of computers in education is raised. They are instead the result of considerations outside the scope of most of the formal studies of computers in education, and intersect those topics with the ideas of information presentation, media and visual studies, human-computer interaction and are perhaps rooted in the somewhat vague idea that computers have affect on us while they have effect us; or alternately, that the interaction with computers is much more bidirectional, and that many aspects of the interaction have been unanticipated. The
answers to such questions do not yet exist because the questions have not yet been formulated.

The implications of this on a societal level are great. Vast amounts of money are being spent on computers as educational tools at every level of schooling from elementary to postgraduate. Businesses are increasingly moving to computerized informational and training presentation. Standardized testing is moving from paper and pencil to computerized delivery. In is frightening to think that much the same way that promised gains in productivity have been compromised by the increasing chaos of computer worms, Trojan horses and viruses, the use of computers in education may be compromised by things beyond the control of educators. McLuhan (1964) in studying media notes that each medium forces the information it communicates into a view compatible with that medium:

A new medium is never an addition to an old one, nor does it leave the old one in peace. It never ceases to oppress the older media until it finds new shapes and positions for them (p.174).

It is the fit of this new understanding into the educational process that presents questions. There is a tendency on the part of many of the authors to view the use of the computer as a neutral technological delivery mechanism. Individual authors are often more interested in a particular use of the computer in education, and narrow their focus to just that narrow band. The view that will be taken here is that the computer is not neutral, but is instead a reflection of current cultural conceptions of information, communication and learning and as such contributes to the learning environment. The purpose in this
study is to take a step back to widen the field of view to include a focus on the
interactions of the various elements, and to review the various components that now
comprise the computerized educational environment.

A scan of that environment reveals multiple uses of computers in the educational
process:

- information presentation (PowerPoint in the classroom and as format for handouts
  and note taking)
- information retrieval (student note taking through the use of laptops)
- information sharing (course management systems, distance education,
  the evolution of hybrid distance/on-campus classes),
- research (both through the use of computerized databases to search for the sources
  of information that may still be in hard copy form, and to access the electronic
  versions of current research journals).

Each of these elements may be independently shaping information and
communication. The concentration of all these media in a single place and time, and
which interacts with both students and teachers is worthy of study.
Purpose of the research

The purpose of this study is to explore the system that is created when computers are used as teaching, learning and thinking aids. I will explore the idea that far from being a passive information delivery and communication tool, the act of moving information onto a computer adds to, subtracts from, and changes the nature of information presentation, comprehension and communication. That change can be in the content selected for presentation, the nature of the presentation medium itself, in how the students and teachers react to and interact with the content, the medium and with other students and teachers. Hopefully, this study may lead to a more careful consideration on the part of educators of how, in the best of circumstances, the computer has been incorporated into education as a useful research and communication tool, and in the worst, of how education has been compromised by the indiscriminate use of computers. Looking forward it can serve to guide practice within the evolving field of educational technology.

Guiding Research Questions

In this paper I will seek answers to the following research questions:

- What role does the presentation and communication of information on a computer screen play in how students and teachers interpret and react to the information?
- What happens to the learning system when teaching and learning transaction is filtered through the medium of the computer? Specifically, what happens:
in the content of discussions?
- in the conduct of discussions?
- in how students and teachers conceptualize knowledge?
- in how students and teachers envision the purpose of education?

What role do student and teacher background attitudes, personality type, information processing style and self-perceived computer competency play in how those students and teachers perceive discussions, conceptualize knowledge, and perceive purpose of education?

These research questions are viewed as being inter-related and part of a complete system. Implicit in these questions is an applied research orientation which assumes there is a way to improve teaching and learning through an understanding of how the use of computers affects students, teachers and information.

**Conceptual Theoretical Framework**

Stating a conceptual theoretical framework for this research will require some careful distinctions to be drawn and maintained in the mind of the reader, however, in return for this effort it will be possible to capture and sort a great deal of data. There are several theoretical frameworks that superimpose themselves over the work which provide an entry point into and a way to organize the necessary richness of detail. Patton provides some idea of the way this superimposition is framed in discussing the traditional views of qualitative research:
…I shall displease those who prefer to separate paradigms from philosophies from theoretical orientations from design strategies. For example, social constructivism may be viewed as a paradigm, ethnography may be considered a research strategy, and symbolic interactionism may be examines a theoretical framework (p. 80.)

In considering how to establish a base from which to consider the topic, two complementary ideas rise, the use of critical ethnography as a research strategy and systems theory as a theoretical framework. Each will be examined to see the interrelationships with the topic.

Carspecken (1996) establishes a methodology for critical ethnography that posits five stages in interpreting data. Hardcastle, Usher and Holmes (2006, p. 153) create the following table as an aid to understanding Carspecken’s model:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Data Collection</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Building a primary etic record: What is going on?</td>
<td>Fieldwork, nonparticipant observer, nonparticipant unobtrusive, reflection</td>
<td>Cultural reconstruction (etic)</td>
</tr>
<tr>
<td>2</td>
<td>Researcher interpretation: etic perspective</td>
<td>Preliminary reconstructive analysis</td>
<td>Cultural reconstruction (etic)</td>
</tr>
<tr>
<td>3</td>
<td>Dialogical (emic) data generation, collaborative stage</td>
<td>Fieldwork, participant observer, interactive, interviews, reflection</td>
<td>Cultural reconstruction (emic)</td>
</tr>
<tr>
<td>4</td>
<td>Describes systems relations to broader context</td>
<td>Conducting systems analysis between locales/sites/cultures (discovery)</td>
<td>Systems analysis (etic)</td>
</tr>
<tr>
<td>5</td>
<td>Explains relational systems</td>
<td>Links findings to existing macro-level theories (explanation)</td>
<td>Systems analysis (etic)</td>
</tr>
</tbody>
</table>
This five step methodology provides a way to integrate the various data sources into a single coherent entity useful as a way to organize and conduct this. It addresses many of the issues of this study, and, while Carspecken is firmly grounded in critical theory, many of his observations about the holistic nature of this project, the validity of data collection and the preliminary interpretation of results are apropos to a study of a system:

The contexts of action and experience, moreover, are holistic: they are not in essence a set of secrete terms readily translatable into “variables.” If they were, then the problem of context could be reduced to the examination of how many variables “interact” with each other. A number of statistical methods have been developed to explore variable interactions. But very often the holistic quality of action contexts simply cannot be captured through a model of interacting yet discrete factors. The factors are simply not discrete by nature, so making them discrete conceptually can greatly distort our understanding of what is taking place (p. 25).

It is of note that Carspecken describes his method as critical ethnography, and while there are some incidental observations that may relate to critical theory, this study is firmly grounded in systems theory, with the view that the classroom is a system (to be expanded upon later in this section).

This will be the approach used to view the topic, as opposed to a method for organizing and validating data collection. It views the educational “system” as comprised of teachers, students, materials and the various interactions between them. While many of the details of the study will be concerned with specific theories proposed by
researchers in computerized education, much of that previous literature focuses on a narrowly defined and specific interaction with the computer. It is one of the underlying premises of this study that this previous research was foundational and that these interactions are actually part of a larger system. That larger system needs to be recognized and addressed in order to understand how the various components interact. By selecting the systems approach, it is possible for the study to include both the details of the specific types of interaction, as well as the affective elements adult students and teachers bring with them to the study of any subject on the computer.

There are several inspirations for the use of the systems approach to this research, and the fact that this idea is derived from multiple sources gives it the weight needed to justify it at the basis of a research project of this nature. Pratt (1998) provided the initial germ of the idea in his discussion of teaching perspectives that range from the traditional to the radical. His presentation of these viewpoints shared the common elements of teacher, student, content and instructional philosophy, and each differed in the way each of the elements interacted with the others. This view of teaching and learning was not described as a “system” by Pratt, but it becomes clear from his presentation that the interaction of the four elements in the classroom defines a system quite well. The explicit link to systems theory is provided by Patton (2002), who uses the word holistic in describing this interaction of elements, and describes the center of the systems approach to research as a:

whole that is both greater than and different from its parts. Indeed a system cannot validly be divided into independent parts as discrete entities of inquiry because the effects of the behavior of the parts on the whole depend on what is happening
to the other parts. The parts are so interconnected and interdependent that any simple cause-effect analysis distorts more than it illuminates (p.120)

I propose to look at the same elements as Pratt, teacher, student, content and presentation, but with the inclusion of the computer as the primary medium of communication for content and presentation. This will include the use of the computer to present information, and student and teacher attitudes toward the computer, teaching and learning. The object of the study therefore will be the system that is created by the addition of the computer into an educational setting, specifically, modern computer facilitated adult education.

In reviewing many of the studies of how people react to computerized education, it is often assumed that the computer, and information presented upon it, is transparent. No mention is made of the effect of moving information onto the computer. The computer is considered on a par with other communication media, a simple medium for information transference. The simplest of analysis will reveal however that any information placed on the computer is comprised of at least two elements, the content and the interface. Regarding the content, Edward Tufte in his books on information design (1990, 1997, 2001, 2003), argues passionately that clarity of thought and clarity of presentation are related. As to the interface, Lohr (2000) hints at the scope of the requisite knowledge, “Designing the instructional interface is a challenging endeavor requiring knowledge and skills in instructional and visual design, psychology, human-factors, ergonomic research, computer science and editorial design.” Both content and interface are addressed by McLuhan (1964), who argues that the placement of the information on
the computer changes the very nature of the information and, consequently, those who view it. In consideration of this body of literature, to be more fully reviewed in Chapter 2, it is clear that the computer, the information on it, and the format chosen to present that information must be considered as one computer related component when examining the learning system.

The attitudes, abilities and preconceptions students bring to computerized education must also be considered a second consideration of the system. Lin, Cranton and Bridglall (2005) note:

New developments in adult learning have led to descriptions that are more holistic then ever before. Instead of a cognitive machine processing information, the learner is seen as coming with a mind, memories, conscious and subconscious worlds, emotions, imagination, and a physical body, all of which interact with new learning (p. 1789).

In order to gain perspective on the complete student it is therefore important to gain an understanding of both the psychological type of the student, their general information processing modalities and world view, as well as their affective attitude and impressions they bring to their work on the computer.

The final component of the system to be considered is the instructor. In addition to the fact that instructors are flesh and blood, and therefore arriving at the leaning equation with a different mix of mind, memories, emotions and imaginations from the students, they also arrive with a philosophy of instruction, either explicit or implicit, that
shapes what they present and how they present it. This paper will seek to examine these three elements in relation to one another.

As noted earlier, the second philosophical framework, the constructivist orientation of much of the literature, will be addressed in chapter 2. The final theoretical component to be discussed here is the philosophy that I feel underlies my interest in this topic. While it is not intended here to plant a philosophical stake in the ground, this view should be acknowledged as it may manifest itself in assumptions about teaching, about students, and about the purpose of education that may color the presentation and research.

As might be deduced from the arrangement and organization of the topic, a somewhat eclectic approach to an underlying guiding philosophy seems to be in play. From the liberal tradition I draw on the idea of knowledge as the systematic grasp of the content to be communicated in the details of the computer transaction. As Elias and Merriam (2005) state, “Knowledge differs from information in that the person who possesses it can go beyond the facts to grasp the principles or assumptions, analyze a situation, and develop an ordered synthesis (p. 28).” By studying the on-line learning experience as a complete system, I hope that some knowledge of how learning is accomplished will be revealed. It is also of interest consider how those classes that address the traditional subject areas of “liberal arts” may be affected by on-line presentation.

It is this idea of subject matter that also opens the need for more than a liberal tradition, specifically a progressive point of view that considers the individual and society and views education as also having a utilitarian purpose and which allows consideration of subject matter that is more technical and practical. Finally, from the humanist tradition
will come the focus on the student in the learning situation. This may be a focus on those
things traditionally associated with humanist philosophy such as freedom, autonomy, and
self-actualization through the learning achieved via on-line interactions. But it may also
extend to a consideration of how the human characteristics inherent in one person
learning from another are maintained across an electronic communication and
presentation medium that adds multiple unanticipated elements into that learning
transaction.

**Overview of research methods and design**

Against an overall focus of applied research, this study will use a qualitative
methodology to explore the various components of the computer based learning system.
Several different but complementary qualitative methods will be used. In addition to the
now traditional method of participant interviews, the research will also include the use of
a combination of a personality type instruments to determine learning style and
information processing preferences. James and Blank (1993) critique a number of
personality instruments and group them by focus. These foci include perceptual modality,
information processing style, and learning and thinking styles. Since one element of this
study is to determine if there is a correspondence between personality type and how a
person perceives and uses information presented on the computer, several instruments
will be administered to the study group to determine personality type or learning style.
These instruments will be detailed in the research methodology section.
The qualitative component will consist of participant interviews to determine perceptions of on-line learning, self-appraisals of computer efficacy and competence, and conceptions of knowledge and the information space within the computer. There has been much discussion in the literature as to the nature of how and why people who use technology well can do so, or alternately, authors who seek to discover the root cause of why some have been challenged by technology.

Both the personality instruments and participant interviews will include the faculty of the research class in order to consider their personality types and perceptions of technology. Course content will be viewed in two ways. Both students and teachers use the computer to present information, whether that is by a PowerPoint presentation, an email contribution to a discussion, or other methods to be discovered during the research, so the content will be of interest. However, there may also be passive or subliminal information transmitted, whether it be through PowerPoint’s forced hierarchies, the at times bewildering variety of navigational choices found on most course management web sites, or the myriad potentially unintended inferences that can be drawn from size, location or placement of graphic elements, text and input locations.

The ideal subjects for this study will be adults and participants or members in a university based distance learning course. The system here will consist of the aforementioned components of students, teachers, materials and media, and with the benefit of the subjects’ explicit awareness of their participation in the “system” of higher education.
Significance of the Study

If the learning system can indeed be viewed as the interaction of the components of students, teachers and content and presentation, then this study will be significant in several ways. It will add to the understanding of the interaction of those components and how we view the interaction of those components. It will confirm just how far beyond the traditional boundaries of the learning transaction many of the relevant factors can come, and in the process help point the way for inclusion of those factors in future research. It will address why so many of the comparative media studies conducted to date have failed to find significant differences as a result of the delivery media of the education. Finally, and perhaps most importantly, it may indicate some correlation of factors that might contribute to improving the practice of on-line education.

The literature that comprises the background of this study actually breaks into several sub-literatures. It is of note that several of these are not traditionally associated with educational topics. In broad terms, there is a literature that focuses on students and how they learn, and the related topic of teachers, and how they do or should teach. It is after this obviously relevant topic that the literature begins to disperse into a variety of specialties. There is also a distance learning literature that addresses some, but not all of the issues that will concern this study. It is in fact that lacuna in the distance literature that inspires an explicit study of information presentation and it is this study that brings into relevance the study of media, and how it affects those who perceive and use information.

This diversity of relevant and important sources is acknowledged by Lohr (2000), who hints at the scope of the requisite knowledge when discussing just the instructional
interface, “Designing the instructional interface is a challenging endeavor requiring knowledge and skills in instructional and visual design, psychology, human-factors, ergonomic research, computer science and editorial design.” It will confirm just how far beyond the traditional boundaries of the learning transaction many of the relevant factors can come, especially when considering the structure of information, the presentation of that information, and the reaction to and retention of that information.

It will address why so many of the comparative media studies conducted to date have failed to find significant differences in the delivery media of education. Reiser (2001), in reviewing the history of instructional media, points out that much of the comparative media research studies, those who have attempted to measure how much students learn after being taught with a particular medium, have failed to reveal any significant differences. This was the focus of much post-war research, efforts that were mostly abandoned in the mid 1970’s due to the inability to attribute any differences in results to the media themselves, and not any confounding factors. It is only recently that interest has again risen in the concept of comparative educational media, this time from the pure media comparison to media comparison in context, that is, in the research of such fields as attributes of media, how media influence learning, or how instructional methods use media. The use of a systems approach may help in the advancement of this knowledge.

Perhaps the most important potential benefit of this research may be to indicate some correlation of factors that might prove promising in contributing to an understanding of the practice of on-line education.
Assumptions and Limitations of the study

There are several assumptions made in defining this study. The largest, and perhaps primary one, is that the interactions between students, teachers and content can be properly viewed as a system, and that each component interacts with the others in meaningful ways. While in some cases this is presumed to be obvious, i.e. teachers and students are supposed to interact, the system view in use also presumes that there are unanticipated interactions in play. Perhaps the largest albeit not the only such unanticipated interaction in this study is that the form of information presentation may influence the content and the perception of that information. If the system does not function, and all consequences are anticipated, then this study has a significant problem.

It is also assumed that the information revealed through the use of the psychological instruments will represent actual personality traits. It is further assumed that those traits can be expected to be part of the system that is under review. This assumption is the cornerstone of the qualitative approach chosen for the research methodology. It should be noted as a limitation in this study that these instruments were used only as indicators of general trends of participant growth and development.

It is assumed that while students and faculty will self-assess their own proficiency, these self assessments will be representative of reality. That is, someone with limited computer skills will assess themselves honestly; someone with above average skills will assess themselves relative to the group they are in and not to the group they want to join.
There are also several limitations to the study. Since the scope of this study will be one class at one time, the meanings and interpretations may not project beyond the current class under the current conditions. Since one part of the ability to use the computer well consists of experience, this may also extend to the subjects of the study at a point in time after this study.

A significant limitation to the study is the current lack of a formal methodology to analyze effectively the content of computer screens. While authors such as Tufte and McLuhan have analyzed the content and presentation of images, and new fields such as Visual Studies have examined how visual media fit within and reflect society, there is no current synthesis of these methods. While the prototype of such a synthesis will be used to analyze the screen presentation and structure of the screens used in the class under study, such an analysis will remain for the moment only a prototype and should be viewed with some skepticism.

Definitions of terms

Computer Based Training (CBT) – A form of computer education that relies on stand-alone prepackaged courses that do not have a teacher. Students interact with the computer and with the information presented on it as their primary means of learning. CBT is often associated with corporate/technical training.

Computer Mediated Communication (CMC). Communication that is computer based. In its most accessible definition, an email system is a form of computer mediated communication. Many Course Management Systems provide a means of conducting
"threaded" discussion, that is, email chains that allow students and faculty to respond to specific emails, and then present the results in an easily perceivable format.

*Course Management System (CMS)/Learning Management System (LMS).* These terms are used synonymously and describe the interface presented to students taking an on-line course, or the on-line components of a traditional course. This usually consists of some security system, a way to retrieve materials, respond to threaded questions, and obtain grades.

*Distance Learning.* Education conducted at a distance. There is no assumed need for advanced or electronic technology, although the two are often considered together. Distance education can be conducted via handwritten letters.

*Information Presentation.* The art and science of presenting information. This can involve a mix of text, graphics, media elements, and is judged on its success or failure as a communication medium.

*Medium/Media.* A communication channel. For the purposes of this study, the Computer will be considered a medium in its own right. It will contain elements of most previous media, such as text, graphics, sound, motion. When placed on the computer these elements form a new gestalt that will be considered as a unit.

*Landing Page.* This is the default home for a web based application or sub application. In this instance the Angel LMS will have one landing page, the course will have a different landing page and each of the case studies will have a landing page.
Organization of the study

This study will be organized in the following manner. In Chapter 1 an overview of the problem has been described, research questions proposed and the organization of the rest of the study outlined. In Chapter 2 the literature will be explored. It should be noted that this literature review will be extensive because it will need to review several, normally unrelated, bodies of literature in order to fully develop the background necessary to understand the various components of the educational system under study.

In Chapter 3 the research methodology and proposed details for participant selection for the actual study will be detailed. Included here will be the proposed rationale for participant selection, proposed psychological instruments, and an overview of the strategies for analyzing information presentation. In Chapter 4 the study will be reported, including details of the results of the psychological instruments and interviews with the participants, and including an analysis of the information presentation strategies used during the study. In Chapter 5 several informed opinions as to the meaning and significance of the study will be presented
Chapter 2

Literature Review

Since this research will take a view of the topic that is simultaneously more global as regards the components of an educational system, and more focused as regards the construction and interaction of an educational environment, this literature review explores a more diverse collection of literature to establish a suitable background. The danger with this approach is that the goal of the review, to establish precedent and need for the current research, could be lost amid what could easily become a scattered and unfocused collection of sources. It is with this in mind that this initial section will present a brief preview of the chapter, and hopefully provide the unifying theme which binds the literature together.

The argument of this review, and of the proposed research, rests upon the following logical presentation of topics:

- **Visual Thinking** – Referencing the works of Tufte, Arnheim and Card, this establishes the foundation for a visual component of thought.

- **Considerations of Media** – Centered on the work of McLuhan, this section establishes the need to consider the specific media used for the presentation of learning materials, and the potential effect of “cyber-psychology.”

- **Educational Foundations** – This section provides the initial exploration of the research literature on visual thinking, media and learning.

- **Educational Framework** – This section expands the areas and concerns specific to the educational literature on electronic learning,
• Systems Theory – This final section provides the background for viewing the electronic classroom as a system.

It is hoped that within this framework the proposed research will be seen to be both a needed addition to and a logical next step from the existing literature. While it does span a wide range of topics, it is hoped that those topics merge to form a logical next step and valuable contribution to the existing research.

The review is structured so as first to provide a more robust discussion of the points made in this introduction, then to tend to the more pedestrian administrative details needed for a literature review presented in a venue of this nature. The actual discussion of the literature(s) is then undertaken in the body of the review. The final sections provide opportunity for discussion and conclusion and provide the bridge to the actual proposal for the research.
Introduction

The idea of enumerating all the diverse elements that comprise computer assisted learning might seem overly ambitious, and the attempt to assemble those enumerated elements into a system and then to examine their interactions might be considered too large a task for any single effort. Fortunately, it is not without some precedent in the literature. It is that literature which has provided inspiration and direction, and which will be presented here.

Recent articles give some confirmation that this literature review is treading upon a useful path; however, despite these steps into a more systemic analysis of the inherent interrelationships, many of the components of the proposed system have not yet been incorporated into a unified view. The available research and analysis of the various components treats each as an isolated phenomenon, or as a smaller system with much narrower scope. In this chapter, I endeavor to review these stand alone literatures, but then move to create a synthesis of the independent components that I believe comprise the overall system, both by reviewing the existing literature on educational systems, and by interrelating this system view with the existing stand alone literature. This presents something of an organization and presentation problem. Since one goal in a review of this type would normally be to start with the general and then sharpen the focus to the specific some latitude must be taken with that form. The first topics here can follow the traditional pattern, but in order to incorporate those additional elements that comprise the overall system I need to engage in several iterations of re-widening the focus to incorporate the
next element of the system, then re-focus that element to the specifics of adult education. Once I have embraced and synthesized all the requisite elements it is hoped the scope of the system and the reason for the inclusion of any given element will become clear. Thus the purpose of this introductory section is to present an overview that enumerates the components of the system, justifies the presence of each as a component of the greater whole, and situates each within the context of adult education. In short, the system that will be proposed for study will first be defined and justified.

The exploration of the literature begins with what was the genesis of my own interest in this topic, and with what appears to be a logical entry point into the discussion, the area of graphic design, specifically that subset of graphic design that considers its use as a means of instruction and communication, and which is presented on and influenced by the computer screen. Initially inspired by Edward Tufte’s work on excellence in graphic representation and communication (1990, 1997, 2001), the connections within this topic extend backward to Arnheim and forward into the field of Information Visualization. In order to build from a solid foundation however, the specifics of that discussion are left until I create a unity between the broad topic of graphic design and the considerably more narrow concern of how that design is implemented within an educational setting, in this case specifically within an adult educational setting and implemented upon the various available technologies.

Care must be exercised on this point. It would be easy to become lost in technology. In fact, Reiser (2001) provides a detailed history of this technological fetishism. He documents the development, enthusiastic adoption and subsequent disillusioned abandonment of a series of “new” educational technologies over the past
one hundred years. In the process of positioning and reflecting upon old technology he
may help us to more accurately assess the position and potential of various new
technologies. As this examination of the literature continues it illustrates the details of the
interrelationship between presentation, technology and thought. While it may illustrate
the potential benefits or pitfalls of computer assisted learning, it will hopefully also begin
to show the inadequacy of viewing any technology as an isolated phenomenon.

The logical process of the review starts with an examination of the link between
graphics and thinking, and it is this link that makes relevant the contributions of Arnheim
(1969) and the work done in the field of information visualization. Both are concerned
with the use of graphics as tools for thinking, and the consideration of these topics leads
to a consideration of the more recent field of Visual Studies. Although the concern of
visual studies in theory extends across those things describable as “visual,” it seems to
concern itself more with the content and meaning of graphic works against a cultural
backdrop. While of some interest relative to the topic of education, specifically in the use
of illustrations, animations and sequencing, the most useful aspect of the discussion of
visual studies is that by considering the unconscious effect of content, it opens a train of
thought that moves rapidly and inevitably to a consideration of the effect of the medium
itself used to transmit the visuals.

It is at this point that the inadequacy of viewing the various components as
anything but a system begins to manifest itself. When considering current educational
computer interfaces with a background that now includes Tufte, Arnheim, Reiser and
others, it becomes apparent that there is more going on here than meets the eye, and it is
in pulling back from the specifics of the educational interface to the general field on
which it is painted that allows the focus to shift to the medium itself. Once that focus is on the computer screen, and the interface is seen as just another media element, the work of McLuhan becomes very relevant, and almost immediately informs a number of questions that have been carried forward as worthy of further study, but a study that was previously vague and unfocused. By engaging the computer as medium, it becomes possible, and in fact necessary, to consider the work of McLuhan on media, and of the subsequent work done as a result of his inspiration on the computer as medium. This leads recursively back to Tufte (2005), but this time to a narrower consideration of his thoughts on the cognitive style of PowerPoint, and the various PowerPoint-like presentation methods employed in computer assisted and distance education.

The final elements needed to complete the view of the system are now within reach; the influences on the learning system that derive from the interaction of personality with it. Starting with McLuhan and Tufte, and the conception of a media influenced cognitive style Moore and Kearsley (1995) and Dron (2002) add the specifics of on-line learning as a system, one that can be considered to interact with the user on multiple levels. These can start with the basic personal classification system the user brings with them for the sifting and sorting of on-line resources, and extend into the more complex details of communication. Galimberti and Riva (2003) bring this specifically into the realm of the affective when they speak of on-line communications with words that apply to many aspects of the system in discussing a term they call cyberpsychology.

Thus the review starts with the specifics of the graphic elements that comprise the system, and by analyzing those elements in variety of ways, build the system that now needs to conclude with a consideration of the psychological interactions possible with
and on the computer. Concepts such as the interaction of psychological type with on-line communication and the effect of personal and social identity upon learning in the online environment become the critical final considerations in looking at the working of the system.

Looking forward into the research, the system that will be studied has now been defined; no longer a thing comprised only of content, students and teacher, but a thing in which all those elements must necessarily be considered as interrelated and interrelating, the reader now has grounding upon which to evaluate the research design and to interpret the results to be derived from that research. The next task is to walk the path only sketched in this overview.

**Literature Review Methodology**

This literature review is an attempt to assemble the elements and consider the boundaries of the educational system posited to exist and proposed for study. As such it consists of several explorations of topics related to each other, but not considered as part of a complete system until now. Some of these topics consist of theoretical writings, other of actual research. As such, some sections will consist of the work of one or two writers exploring a single aspect, others of multiple authors considering a general topic from multiple points of view. Of these sub-reviews, the relationship between information presentation and learning outcomes has a larger base of literature to search, and this larger base provides a greater opportunity to relate the topics of information design and adult education. Others, such as the literatures on feminism or the digital divide have a large body of work, but those components relative to this topic are either a small subset of that work, or require looking at the existing literature through a very narrow filter.
There is a third type of literature which considers the relationship between the medium of computer presentation and learning, or thinking graphically and learning. Here there are limited resources, with most of those resources consisting of theoretical pieces, perhaps because the question has not yet been asked in the appropriate format.

The tension between this “new” view and the current literature can be seen in microcosm in the seemingly simple question of what constitutes the content areas relevant to the instructional interface. Lohr (2000) includes instructional and visual design, psychology, human-factors, ergonomic research, computer science and editorial design. Hill and Hannafin (1997 extend those further into the fields of instructional systems design, psychology, communications, computer science, and information science. It is at this point the daunting question might better be, what does not contribute to an understanding of the instructional interface? Perhaps the attempt to reconcile this broad range of topics into a coherent unity and set some limits to the discussion may have provided the first spark needed to move to a systems view of the topic.

The initial searches were conducted using the Proquest and ERIC databases. Searching was initially conducted on the terms: information design, technical communication, human factors, cognition, instructional psychology, internet research, and design. The initial searches resulted in numerous hits, ultimately numbering over 500, which needed to be sorted based on abstracts and an initial appraisal of contents. This sorting resulted in a reduction to 21 articles that seemed worthy of further evaluation relative to the area of information design and educational efficacy. In some cases this elimination of articles was the result of a review of the abstract which indicated the article was not apropos of any specific topic related to information design; others were
eliminated further along the process when the scan of a promising article indicated that although the abstract indicated a positive link, the actual article dealt with some topic only tangentially related to information structure and design.

The iterative and interactive nature of this search process is ongoing and demonstrated by the fact that the search terms “distributed cognition” and “ecological psychology” were terms used in articles found in the initial search. Further searches were conducted on author names found as a result of references listed in both the initial and secondary articles. In some cases these articles had been returned on some of the searches; other searches yielded related but new results from the same authors. Given the nature of this paper, if a graphic representation of the search process could be envisioned, it would be a Mandelbrot set, where each zoom in or back results in a graphic that looks the same as the previous view. The review process suggests that further and ongoing exploration could prove fruitful.
Learning and the computer

Multiple learning theories have been developed to explain how learners learn. While it is beyond the scope of this chapter to explore all of these theories in depth, there is one that has a particular association with computer assisted learning, that of Constructivism. The interest in this theory in this particular venue resides not only in how it may explain the mechanics of learning and how to optimize the mechanics of instruction, but also in how constraints, both conscious and inadvertent, may be introduced by the technology used in the learning environment. This section will focus on recent trends in Constructivist theory as a method of grounding the discussion that follows clearly within the boundaries of adult educational theory.

There are numerous theories that seek to explain how people learn and consequently, how teachers should construct and deliver material (for example, Andragogy, Behaviorism, Cognitivism, and Constructivism). Of these, one particular theory, that of constructivism, is of especial note. When the topic of computers and education are considered together it seems to have moved from theory to assumed belief system in much of the literature. Because of this, an initial discussion of constructivist theory, especially as it relates to the specifics of the computer in the educational setting, is seen as useful introduction to the topic.

The roots of historical constructivism have been traced in the developmental work of Jean Piaget, the cognitive psychology of Jerome Bruner and Ulric Niesser, and the
philosophy of Nelson Goodman (Perkins, 1992). It is, however, a more recent historical aspect of constructivism that is of interest here which links technology based instruction with constructivism. This link seems to have formed when theory intersected with technology at the time of the introduction of hypertext systems. As a general trend in the literature, it has grown stronger as technology has become more pervasive. The first task that must be addressed in this literature review is to examine constructivist thought to determine whether this constructivist/technology link is solid and if the theory is sound.

Fortunately, this is not the first time such an examination has been proposed. Much of the material will be drawn from a written dialogue moderated by Duffy and Jonassen (1992). The fundamental raison d’etre of this dialogue is expressed by Bednar, Cunningham, Duffy, and Perry (1992):

Instructonal design and development must be based upon some theory of learning and/or cognition; effective design is possible only if the developer has developed reflexive awareness of the theoretical basis underlying the design (p. 19).

The purpose of the dialogue is to work out the theory that should underlie the development of learning with the computer. It immediately engages the objective/subjective dichotomy central to the discussion with a consideration of constructivist thought framed as instructional design requirements. The analysis of content is presented first as in its objective frame of course content and instructional methods, each considered as a separate entity. It then presents the constructivist counterpoint:
Since the learner must construct an understanding or viewpoint, the content cannot be prespecified. Indeed, while a core knowledge domain may be specified, the student is encouraged to search for other knowledge domains that may be relevant to the issue. (Bednar, el al., 1992, p. 23).

The core difference between objectivist and constructivist viewpoints are most clearly seen in the description of the design phase of the instructional design process.

The objectivist tradition would consider design to be a topic of interest, but one outside the content of the instruction, while the constructivist perspective would counter that the core work of the designer is to encourage the construction of understanding from multiple perspectives. In the constructivist paradigm, “‘Effective’ sequencing of the information or rigorous external control of instructional events simply precludes that constructive activity (Bednar, el al., p. 25).”

The topic of learner assessment within a constructivist viewpoint presents something of a dilemma. In an objective system, assessment is seen as a relatively benign process of some expert determining what the student should learn, then conducting a task analysis of the knowledge. A pretest determines the learners existing knowledge, a method and strategy is determined to meet the communication requirements of the material, and the learner is then tested to see if the communication process has been successful. The alternative to this objective evaluation is a constructivist evaluation, presumably of constructivist instruction, suggested to be a better assessment of successful
accomplishment; if the students can successfully construct solutions to problems they are presented with, then instruction can be evaluated as successful.

The nature and elements of a constructivist classroom, of especial interest to this research proposal, is addressed by Perkins (1992), who considers the “construction” of the constructivist classroom. Each learning environment consists of 5 components:

- Information banks - textbooks, dictionaries, encyclopaedia’s.
- Symbol Pads - writing surfaces, notepads, computers
- Construction Kits – lab equipment, physical objects to manipulate, programming languages to manipulate
- Phenomenaria – an area used to present phenomena and make them available for observation. This can include simulated environments available via computer assistance.
- Task Managers – teachers, computer based training programs, text questions, independent study.

The stress is placed upon the idea that the learner is an active component of the instruction, not merely a vessel to store knowledge and uses the classroom as scaffold for their learning. New information is taken in, subjected to a tentative interpretation that is then tested and elaborated upon. As will be seen in subsequent sections of this review, many of the components Perkins considers as part of the constructivist classroom are also methods of externalizing cognition, and as such are subjects of concern to the overall system. This will be considered in greater depth shortly, but the element to consider here are the references to these external mechanisms as components of constructivist learning.
theory. It should also be noted that the mere presence of an object or objects in the environment is not sufficient:

Of course, as a brand of constructivism, this approach would recognize that mere exposure to certain ideas and experiences would not suffice. The learners would need to work through their understandings in various ways (p.50).

Each of the components proposed as a component of the learning environment is assessed with regard to constructivist principles and as a contributor to the total learning experience. This review will engage many of these topics in the sections that follow this introduction.

The structure of subject matter is the next issue to be addressed in the dialogue and Spiro et al (1992) use it to address one of the core dilemmas facing the designer of instruction. They suggest that the often poorly structured features of most knowledge domains argue against neat pre-packaged explanations. The hope is for a flexible ensemble of information better suited to constructing the solutions to problems too fluid or too ill defined to be solved through the application of a single predetermined solution. This is not, however, a simple prescription for a computerized solution. They foresee the problem of such a technology-only solution:

It is not a simple matter of just using the power of the computer to “connect everything with everything else.” There are many ways that hypertext systems can be designed, and there is good reason to believe that a large number of those do not produce successful learning outcomes (e.g., because they lead the learner to
become lost in a confusing labyrinth of incidental or ad hoc connections). (p. 67-68)

The specifics of the differences between constructivist learning theory and instructional design theory form the core of a rebuttal to the constructivist arguments by Merrill (1992). A point significant to the theoretical discussion is raised:

The construction of a mental model by a learner is facilitated by instruction that explicitly organizes and elaborates the knowledge being taught, during the instruction; – there are different organizations and elaborations of knowledge required to promote different learning outcomes." (p. 101)

In discussing the constructivist premises of Spiro et al in constructing a technology based hypermedia delivery, it is pointed out that the knowledge to be represented is in some knowledge base. It had to be placed there. He further questions whether the constructivist view that context can never be separated from use actually denies the teaching of abstractions, one of the most powerful uses of the human mind.

It is Merrill’s position that the activities of both moderate constructivists and instructional designers are the same—active learning, relevant tasks and experiential learning—but that the positions of the extreme constructivists, that learners arrive at self chosen positions, is nonsense.

If I hire a surgeon to do heart surgery, PLEASE let me have one who has learned the trivial case and knows that my heart looks like every other human heart.
Please don’t let him negotiate new meanings and hook up my veins in some “self-chosen position to which [he/she] can commit [herself/himself] (p. 108).

This criticism goes to the heart of constructivism as a learning theory. The response to the criticism addresses the core of Merrill’s criticism:

As soon as there are two views, one of two things must occur: The idiosyncratic views must be brought into harmony or the individuals involved must ‘agree to disagree.’ In other words, the individual is free to build his or her own interpretation of the world, so long as that interpretation is coherent with the general zeitgeist. Knowledge is a dialect process the essence of which is that individuals have opportunities to test their constructed ideas on other, persuade others of the virtue of their thinking, and be persuaded (Cognition and Technology Group, 1992, p. 116).

Although this appears to address the criticism, it does put an extraordinary burden on the learner. They must not only acquire new knowledge, they must also negotiate its meaning within a domain that, by constructivist definition, they are not expert on and which does not have clear boundaries.

The purpose for this section has been to establish clearly for the reader a background in at least one educational theory which seems to have a special relationship with computerized learning, and upon which considerations of information presentation and media can play. This is certainly not to preclude other theoretical bases; the theoretical orientation of a faculty member will remain a part of that person’s
presentation and instructional style. This may become an item of note during the actual research, should there be a conflict between the presentation or instruction and the presentation media. Should this occur, it would be more appropriate to comment on the specifics discovered in the research. It was important to establish this background on constructivism, since many of the concepts that arise in a study of educational technology seem rooted in constructivism, whether as explicit theory or as assumed background.

**Visual Thinking**

*This section of the review considers the general concepts of visual thinking and information presentation as background topics to the general discussion of computers in education and the subject of the proposed research.*

The span of the concepts embedded within the idea of visual thinking extends well beyond the boundaries and time limitations of this current effort. Our earliest ancestors recognized something so special about images that they paused in their struggle to exist to leave a record of that struggle painted on the walls of their caves. Artists throughout the centuries have used the images they have created to reflect their life, their times and their cultures. The focus in this paper is a far more narrow view of the topic of graphic design and expression, but hopefully, in that consideration, to remain aware of the magic inherent in the topic.

The starting point for the consideration of that magic will be with Arnheim (1969) and his discussion of a concept best summarized in the title of his work, “Visual Thinking.” Arnheim asserts that the process of thinking itself is perceptual in nature, and that the traditional split between seeing and thinking is false and misleading, the two are
in fact parts of the same process. The function of the graphic might be thought of as an artifact which provides a bridge to the abstracted essence of a thing or an idea:

By furnishing images of kinds of qualities, kinds of objects, kinds of events, visual perception lays the groundwork of concept formation. The mind, reaching far beyond the stimuli received by the eyes directly and momentarily, operates with the vast range of imagery available through memory and organizes a total lifetime’s experience into a system of visual concepts (p. 249).

The graphic expression of a concept moves that concept closer to direct experience by evoking the visual memory of previously stored similar concepts, bypassing the verbal and accessing memory more directly. This can be the result of individual differences, differences based on learning style or psychological preference. It may also be based on purpose and purposes may vary. In this case it may take very different forms for artists and scientists, but it serves a similar function for both.

That function is to allow the mind to create a universal model or archetype of a concept. This idealized expression of things as archetypes runs as an undercurrent throughout human history. Its earliest expression in the works of Plato evolved from an attempt to explain the mechanics of the world to an attempt to define those concepts philosophically. Its most recent and more relevant to the topic of this paper in the work of Hawkins and Blakeslee (2004) who view archetype as a means of explaining the mechanics of cognition. The relevant component for this discussion is that Arnheim as proposed an idea that uses graphic design and expression as the means by which this archetype is made visual, and by being visual, becomes real.
Arnheim identifies two kinds of perceptual thinking, intuitive cognition and intellectual cognition. Intuitive cognition is described and understood to be the process by which someone “sees” a painting. There is an area enclosed within a frame and as the eye scans that space the content, color, shape are perceived and the relationships between those elements noted. Very little of this metacognitive detail forces itself upon the viewer however, since the primary goal of the various forms of abstraction and generalization on the part of the painter are part of an intentional effort to communicate something. The alternative to this is intellectual cognition. This is far more self-consciously cognitive, with the viewer analyzing the frame to determine shape, color and relationship, and using those elements to form concepts and ideas. It is more descriptive of someone attempting to make sense of a graphic illustration, aware that the illustration is a representation of a real thing.

This use of the visual to communicate concepts has specific and pertinent relevance to educational illustration. Arnheim’s caveat is that the use of illustration may serve to make a problem or concept visible, but in doing so it may also falsely communicate the idea that the concept is static. It is of note that one of the solutions to this dilemma proposed by Arnheim is the production of mobile models that will allow students to understand the dynamic nature of the model. Since Arnheim is working in 1969, the wide scale adoption of computer animation is still two decades away, however, that suggestion does create a segue into the consideration of Arnheim’s conception of the graphic against a computerized backdrop.

Arnheim frames his definition of intuitive cognition by noting that the viewer sees what is enclosed within the frame. When this idea is restated here with the understanding
that the frame may be the edges of the case of the computer monitor we not only move the idea of intuitive cognition forward, but also introduce a tension that Arnheim could not have predicted. The shapes and colors and the relations between the elements on the screen at any given moment are in part random, and although they may sometimes be the result of conscious choice, at other times they may be the result of various presentational accidents or the result of decisions made by programmers remote in distance and time.

Windows are opened by users when they perceive the need for the window to open, an effect caused by following the advice “click here.” This action may take them someplace new, or spawn a new window. These “child” windows may spawn additional children. Unrequested or unexpected pop-up windows appear over everything demanding attention. The thing to consider, however, is that we have spent a lifetime looking at pictures, and there is an anticipation of form derived from some grounding in the visual tradition described by Arnheim, whether that tradition is artistic, typographical, or print based, and whether it is conscious or unconscious. A consideration that provides background motivation for this study is the effect this random composition will have on the educational content. What will be the effect on the user’s attitude to that content, or to the delivery mechanism, and perhaps most importantly, to material presented upon it that is there for the purpose of “learning?”

Arnheim starts with the consideration of the aesthetics of painting, and moves to the efficacy of educational graphics. Edward Tufte, in his books on information design (1990, 1997, 2001), uses the illustrative graphics of the past 500 years as his canvas. He argues passionately that clarity of thought and clarity of presentation are related. The timelessness and importance of this idea is demonstrated by the examples that Tufte cites.
When logical thought and clear presentation are both present, ideas can be communicated. Tufte cites numerous examples to illustrate this point; perhaps the one most notably associated with him is an examination of Minard’s graphic illustration of the ineffectiveness of Napoleon’s attack on Russia, described as “the best statistical graphic ever drawn” (Tufte, 2001, p.40). The alternative, the absence of logical thought and clear presentation, can result in disaster, as Tufte describes in his analysis of the PowerPoint presentation used to make the decision to land the Space Shuttle Columbia.

The actual design principles that underlie Tufte’s work might be ascribed to common sense, if only they were not so uncommon. While there are many individual components that can add or subtract from a graphic, the one theme that remains consistent across all his observations and suggestions is that graphic design is a form of communication; anything that promotes better communication is good, and anything that detracts from it is bad. Whether we are considering the elimination of chart junk, defined as the meaningless detritus of graphic illustration, or the worse idea of graphic fluff, the inclusion of unrelated and un-illustrative decoration in graphic design, or maintaining a consistent scale in statistical graphics, or simply keeping the intelligence of the audience foremost in the mind of the designer, the consistent goal is to promote graphics that communicate accurate, precise and concise information. In order to light the path, Tufte’s books contain copious examples of excellence in graphic design culled from illustrations that span centuries.

While Tufte argues his point quite convincingly, the question that must concern this analysis is the question as to whether any empirical data exists to confirm his hypotheses. This idea is examined in greater depth in a separate and later section of this
review, however, with more and more adult education and corporate training being delivered either on or with the assistance of computers, and the inescapable link between content, graphic presentation and understanding in this environment, the question becomes more than a simple intellectual inquiry. Is there a link between the clear presentation of information, and the clear understanding of that information?

**Information Visualization**

While Tufte and Arnheim provide the intellectual foundation, the concepts needed to move the ideas of information design to a useful place for the purposes of an educational system derive in large part from the ideas of a field that has come to be called “Information Visualization.” A core element of the system under consideration and explored further in this review is based on the concept, summarized best by Card, Mackinlay and Shneiderman (1999) in their use of the words “external cognition.” They quote Norman (1993) in describing this concept:

> The power of the unaided mind is highly overrated. Without external aids, memory, thought, and reasoning are all constrained. But human intelligence is highly flexible and adaptive, superb at inventing procedures and objects that overcome its own limits. The real powers come from devising external aids that enhance cognitive abilities. How have we increased memory, thought and reasoning? By the invention of external aids: It is things that make us smart (Norman, 1993, p.43).
There are a number of simple examples posited by Card et al, but one is so intuitive as to be immediately recognizable and therefore of use to serve the purpose of the illustrative example for the concept. It is the use of paper and pencil to do multiplication. The average human mind can cope with simple examples of multiplication such as nine times seven without assistance, but when the numbers become larger the difficulty increases. When asked to multiply six hundred seventy nine by two hundred eighty one in their head, however, most people would hesitate. However, translate the words to numbers, 679 X 281 and the problem becomes a bit easier, use paper and pencil to write those numbers in a familiar manner and the problem becomes child’s play:

\[
\begin{array}{c}
679 \\
\times 281 \\
\end{array}
\]

By doing the work externally, using the paper and symbols to hold intermediate results and temporary calculations, and internally, to actually make the small calculations, we achieve some understanding of the idea of external cognition. This simple example however is merely the entry point to the concept.

Card, Mackinlay and Shneiderman cite additional examples that add to the extent of the problem. Items that are of particular note include the Nomograph, an old style of printed graphic calculator, navigation charts, and the same diagrams cited by Tufte involving the challenger disaster. Simply put, the history of civilization and the history of cognition are interwoven with our visual artifacts, in a progression that starts with writing and mathematics, through printing and diagramming, ending with the current state of visual computing.
The authors are extremely helpful in providing a number of clear and useful definitions that help frame the ongoing discussion. The first of these is the definition of visualization, “The use of computer-supported, interactive, visual representations of data to amplify cognition (p. 6).” They define cognition as “the acquisition or use of knowledge.” An interesting, and telling, distinction is made early on in the discussion as to the nature of the object visualized. The early objects of visualization were concrete things; that is, visualization was used to see patterns in objects such as the human body, the earth, space. It is when the same concepts are used to visualize what non-concrete objects such as financial data, business information, abstractions, meta-data about documents, that the definition requires modification. Visualization is split into two components, scientific visualization retains its concrete foundation, information Visualization” becomes the tool to assist in understanding any abstract information task.

The following table is adapted from Card, Mackinlay and Shneiderman and serves to show the relationship between cognition and visualization. Indents are interpreted as an implied hierarchy:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Cognition</td>
<td>Use of the external world to accomplish cognition</td>
</tr>
<tr>
<td>-&gt;Information design</td>
<td>Design of external representations to amplify cognition</td>
</tr>
<tr>
<td>-&gt;Data graphics</td>
<td>Use of abstract, nonrepresentational visual representations of data to amplify cognition</td>
</tr>
<tr>
<td>-&gt;Visualization</td>
<td>Use of computer-based, interactive visual representations of data to amplify cognition</td>
</tr>
<tr>
<td>-&gt;Scientific Visualization</td>
<td>Use of interactive visual representations of scientific data, typically physically based, to amplify cognition</td>
</tr>
<tr>
<td>-&gt;Information Visualization</td>
<td>Use of interactive visual representations of abstract, non-physically based data to amplify cognition (p.7)</td>
</tr>
</tbody>
</table>
Each layer of the hierarchy facilitates understanding. The placement and redundancy of icons and other aspects of the desktop interface within the desktop metaphor become relevant, not in the manner that is of interest to the study of human factors engineering, but as a question of how the arrangement facilitates learning.

The placement of icons within the desktop metaphor used by the various windowing systems is of direct relevance to the realm of information visualization this project. The arrangement of objects in a computer based learning environment becomes the focus of interest. The authors do not limit the use to any specific type of information workspace, thus permitting any use of the computer as a learning tool from stand alone computer based training to a networked learning management system.

The authors cite Larkin and Simon (1987) in order to explain how visualization amplifies cognition, positing that the use of visualization achieves three things:

1. By grouping together information that is used together, large amounts of search were avoided.
2. By using location to group information about a single element, the need to match symbolic labels was avoided, leading to reduction in search and working memory
3. In addition, the visual representation automatically supported a large number of perceptual inferences that were extremely easy for humans. (p.16).

Card, Mackinlay and Shneiderman (1999) contribute a reference model for the process of information visualization, something that can be used for those who need to translate data to a visual form. A progression is seen from raw data to organized data tables to visual structures and finally to views, which arrive at the visualization stage and
enables the viewer to experience the benefits. The critical element is that the structures they arrive at, the actual data mapping, are useful or not, depending on how the human perceives it. “A mapping is said to be more effective if it is faster to interpret, can convey more distinctions, or leads to fewer errors than some other mapping (p.xx)” While of interest in the literature review in general, this concept will also be considered in the discussion of the analyzation of web sites for their “learn-ability.” It also provides a clear entry into the last subtopic of this section, Visual Studies.

**Visual Studies**

The last piece to be considered in this introductory and general focus on graphics is the topic of Visual Studies, and while the subject matter might be considered peripheral to the topics discussed to this point, in fact it provides the last element necessary for the discussion on learning systems. Most of the writers on graphics reviewed to this point have considered the topic in a fairly objective manner, even when discussing their ability of the graphic image to assist in the very personal act of cognition. The meaning of the graphic is more or less what the graphic designer intended it to mean, dependent only on the ability of the graphic designer to isolate and express the core idea of the data, and to express it cleanly and without any distracting visual or extraneous detail. Phrased alternately, any failure of the graphic to convey accurate information is the result of some failing on the part of the graphic designer, not of the viewer. Visual Studies bridges the objective and subjective views of graphic composition, and thereby justifies the systems view of the computerized learning process.

This interrelated subjective/objective view of graphic expression Visual Studies is evident in the introduction to the topic provided by Elkins (2003). He describes it as a
potential link between the various isolated disciplines currently in existence within the academy, specifically with various text-centric studies within the humanities. Elkins lists “computer graphics” in a taxonomy of apropos subjects for the field of Visual Studies, and as one way to transcend the traditional boundaries between media. On a trivial level this addresses the problem of what to do with text displayed on a graphic based computer screen, but Elkins is describing the larger and more traditional boundaries between media, boundaries blurred by the convergence of access platforms for music, video, text and image commonplace on the internet. In addition to the now commonplace and often discussed convergence of media formats is the new convergence of media viewpoint, of the elite and the popular, the fine and the vulgar, the highbrow and the lowbrow.

One of the curious conundrums of using the computer for education, a conundrum exacerbated by the recent trend to move away from proprietary delivery platforms toward a focus on Web-centric, or browser-centric, delivery methods for training, has been the placement of educational media within a format often bounded by and inclusive of the unexpected and often unwelcome. A browser based platform provides the convenience we get from a standard platform for development and delivery, standard tools and standard navigation, unfortunately, we also get a now standard way of browser-based seeing, which often includes unanticipated artifacts of previous work, unexpected issues of size and resolution, network delays and other browser related, yet educationally unrelated issues. This becomes part of the background noise that users often accept because they cannot see any way to effect change. In addition, other questions arise, what effect does web browsing have on concentration, on attention span, on how we see, on how we anticipate the next logical connection, and most importantly, on having to cope with the
fact that education is co-resident on the web with all the other content. Elkins is aware of these themes, and sees visual studies as way to address the convergence of scholarship necessary to adequately study the interrelationship of form and content on the web.

One area of significant interest and related to this convergence of scholarship concerns something that has been observed in a variety of recent writings, the seeming dichotomy between science and social construction. Elkins writes:

There are two large obstacles to broadening visual studies in the direction of science. First, it is necessary to find a way to welcome science into the discourse of the humanities without introducing it or framing it as a social construction. Vision science has a great deal to say about issues that preoccupy visual culture, such as attention, memory, and the recording of perception; but it can contribute only if it is not always already historicized and treated as the most recent convention. (p.93)

His interest and concern is centered on a number of scientific phenomenon that seem worthy of an extended exploration within the scope of how computers are used in education. The details of those phenomena are beyond the scope of this exploration, but the issue that is directly relevant is the idea that science and social construction are linked within the screen we view training and computerized education upon. Considered within the light of a communication medium which consists of equal parts text, typography, graphics, animations, icons, hot spots, linked text, and embedded video and audio, the following passage from Elkins addresses the reason why Visual Studies must remain with those subjects relevant to the student of computers and education:
Within Mayan studies, a tremendous amount remains to be done to understand how a Mayan viewer would make his or her way through a complex image made of mingled words (glyphs) and images. Most viewers, presumably, would have only had a vague notion of the writing, although some larger number would have been able to recite dates and names. But among the few literate Mayans, how would complex images have parsed? Some Mayan objects are astonishingly complex, and art historians can only guess at how they might have been seen. (p. 150)

Elkins does not make the leap from ancient Mayans to current Web users, but the facility that many web users demonstrate in parsing the multiple information streams available on their screen may someday seem as arcane as the abilities he attributes and speculates upon with the Mayans. At the very least, how educational users, who bring with them different cognitive styles, perceptual skills and navigational abilities, make sense of the often contradictory messages on the screen must be considered a part of the system and worthy of study.
Considerations of Media

This section of the review examines the potential effect the medium itself may play in the larger issue of how students react to computer assisted learning. McLuhan’s comments are discussed, as well as the work of others derived from his ideas.

As this study has evolved one of the things that has become apparent is the widely diverse applications of computers in education, and the diverse research these have engendered. Before considering these studies, it will be helpful to consider the computer itself as a new medium, independent of the content it might carry. The primary means of entry into that analysis will be, perhaps curiously, through the work of someone who never really experienced computer communication in its current form, but whose writings on media may help to position the computer within the realm of educational technology. By retreating back to the original work of McLuhan (1964) and then advancing to more recent writings emanating from the McLuhan center, it becomes apparent that the computer is in one sense, nothing new, but simply the latest device to extend man. As such it has much in common with any media, and can be analyzed as a communication medium with certain unique capabilities. The consideration of it as medium provides the common language developed from a study of media in general. It permits a view of the computer that focuses less on its identity as “the latest technology,” and more of those aspects that would label it as the latest “next technology,” with effects that could have
been, and which still can be predicted by those familiar with the rites of passage of previous “next technologies.” This will also be conducted but with a caution that this particular technology is still evolving, the unanticipated consequences have not yet manifested, and the interactions that result in the learning environment are far from their final form. In this section I would like to step back from the specifics of the content on the screen, and consider whether it is the screen itself that may be affecting what we see on it.

To properly accomplish this task we need to rewind to a point before the omnipresence of computers in the culture. Unfortunately, much of the contemporary literature involved with computers at this time treats them as special artifacts, objects of wonder or technical challenges. Within the social and media landscape of the time, the work of McLuhan is uniquely prescient, in that in observing television, he predicts the computer. It only takes a moment to situate McLuhan in a historical context which will prove his import to this paper. In 1964 there is not yet an internet, nor will there be one anytime soon. There is not yet a world wide web. None of the newest of the media we are inundated with has yet developed. While computers did exist and had existed for some time, they were in no way “personal.” They were the size of rooms. They calculated and stored data, much of it business or scientific, and results were returned in days or weeks, not minutes or seconds, or milliseconds.

When watching television, there is no cable as we know it. Television consists of the major broadcast channels, with a few UHF incursions in the major cities. Consumer video cassette recorders do not exist. Music is distributed on vinyl disks, which can still be purchased in either monophonic or, at an added cost, stereo, and except for a few new
FM stations, broadcast over noisy and low fidelity AM stations. Cassette tapes are newly invented and low fidelity. Yet McLuhan predicts what will be present in the someday that he views as both inevitable and soon to be; a someday that looks remarkably like the day we awoke to today:

Rapidly, we approach the final phase of the extensions of man – the technological simulation of consciousness, when the creative process of knowing will be collectively and corporately extended to the whole of human society, much as we have already extended our senses and our nerves by the various media (p.3).

In our current environment television now consists of hundreds of channels that can be delivered via broadcast, satellite or cable, and which can be programmed by the user to start programs when a button is pushed. Video cassette recorders not only exist, but have become just one of a multiplicity of technologies used to record and playback video. Delivery mechanisms now range from DVD’s and multiple tape formats, and include new digital technologies like TIVO which allow pause and replay of live television, and perhaps most interestingly, allow the creation of robotic agents who will watch television for the owner, tailored to his or her tastes, and saved for later consumption. The picture itself is available in multiple resolutions and formats, from high definition projections that cover the wall to tiny and portable devices that can be used to fill the idle moments of the day. Music is encoded in multiple surround sound formats and distributed in so many different ways the music industry is suing to restrict the channels and regain control of what has become chaos.
Within this media saturated environment, McLuhan’s idea of the technological simulation of conscious finally finds resonance within an educational environment described by such terms as “external” and “distributed” cognition. Both of these terms are used in an examination of the problems and potentials of this new environment as if it were just another, however interesting, collection of technical problems in need of solution, and skills that need to be learned. There is not the consideration of what might be the most important concept behind the technology, that “the medium is the message.” That message may be the most significant component students bring with them when using the computer in an educational setting. McLuhan writes, “For the message of any medium or technology is the change of scale or pace or pattern that it introduces into human affairs (p.8).” Consider the changes this medium has introduced into current educational processes.

At most universities and colleges students access a course management system which allows on-line access to things such as the syllabus and course handouts. The faculty uses the same system to conduct on-line discussions which can extend or supplement class discussions, and which result in a hybrid of in-class and distance education. For many students, visiting the library is not the first but rather the final step of their initial research. The locating of source material is conducted on-line and away from the library. Often the library visit is superfluous as all the needed material may have been discovered in full-text form on-line. It is perhaps of note that many of these students obtain the actual page-view of their materials, and either read it on a computer screen or print it out to read off-line. The library as McLuhan’s tactile sensorium has
been relegated to the role of museum rather than tool; the information is now accessible anywhere and anytime, as long as the connection is hot.

One of the core concepts attached to McLuhan is this concept of “hot” and “cold” media; hot used to define something that extends one sense with lots of information, for example a photograph, and a cold medium defined as one that is marked by a lack of information, such as a telephone conversation. How does a photograph have more information than a telephone conversation? Aren’t they just using different senses? Cold media cause other senses to supply the missing information, such as the imagined gestures, facial expressions and body language that are all missing from the telephone call conducted within a narrow bandwidth of sound that filters out the highs and lows.

For McLuhan, hot media require little participation by the audience to get a lot of information; cold media require a great deal of participation. Web pages expand this in a new way, with the same medium capable of juxtaposing both hot and cold components on the same page. High-speed network access and the corresponding fast screen refreshes now add a new component to the discussion, slow speed modem connections become old.

It is McLuhan’s next thought however, that actually expands this discussion into a more interesting area relative to the educational use of the computer. At some point in the use of a new medium, that use expands and creates what McLuhan describes as a “break boundary.” At this point “the system suddenly changes into another or passes some point of no return in its dynamic processes (p.38).” In looking at what has been happening with the PC, specifically, at things like the declining number of people who are watching TV in favor of surfing the web, or the increasing number of writers commenting on the cognitive style of PowerPoint, we seem to have crossed that “break boundary” for this
new medium. The challenge then becomes to recognize that which is now in front of us, too close to draw into sharp focus, and perhaps too obvious to draw attention to itself, a new cultural artifact hiding in plain sight.

In considering this question, and how to address it, there seem to be two major threads that interweave. The first is how people interact with other people across the net; how the computer has created a global society unlike any we have seen before. The second is how people interact with computers and the information within the machine and on the screen, and how people are now linked to machines, creating new forms of consciousness that have yet to be fully explored. The writings of McLuhan and the topic of how people connect with information is very dense, with many divergent paths. Initially, this focus on education was hoped to provide a natural filter to the information, a way to focus on the matter of immediate concern. It does not take long to find McLuhan himself challenging the possibility of such a focus:

Even specialist learning in higher education proceeds by ignoring interrelationships; for such complex awareness slows down the achieving of expertness (p.101).

In reviewing the literature on information presentation one of the notable findings has been a need on the part of most researchers to redefine the field they are researching. Previously, defining oneself as a chemist or a philosopher allowed the presentation of material within comfortable and recognized boundaries. As we shall see in the next section, those boundaries have proven insufficient for the new explorations of the dual field of information presentation and the computer. Of note in this section is the fact that
its effect on the university has not gone unnoticed. Some would deny the existence of knowledge, others would view that knowledge as commodity. The usual dichotomy is expressed as that between the humanities and science curricula, but McLuhan may more correctly situate it as a clash between the humanities and business. He discusses this as echoing the previous conflict over information which occurred between the castes of priests and merchants and soldiers. As he notes, the nature of education has changed:

Until the electric age, higher education had been a privilege and a luxury for the leisured classes; today it has become a necessity for production and survival (p.103).

In considering the actual effect of placing learning on computers, one of the things that must be considered is the result of the presentation and of what is being presented. A typical computer screen now contains text. It contains graphics, which should be further divided into traditional visual images and newer iconic navigation aids. In some cases combinations of both of these functions are combined in one image. In McLuhan’s view this is a natural progression; new media absorb and re-channel old media, not only creating a new form of expression, but forever altering the old. What is the shape and affect of this new media as it relates to learning? Unfortunately, to date it has been little considered. In most of the literature that looks at the current population of adult learners and their use of computers there is a consideration of how people react to the information, but no consideration of the delivery mechanism. If anything, there is an attempt to use the attributes of one medium to describe another. Again, this was presaged, albeit in terms of the education of the young:
The same fallacy besets our thinking about TV and education. We think of TV as an incidental aid, whereas in fact it has already transformed the learning process of the young, quite independently of home and school alike (McLuhan, p.219).

One of the more powerful considerations that comes from this study of media is that the effect of the medium, even if it is recognized and understood, cannot be stopped. Content will be changed because the medium frames experience:

It is the theme of this book that not even the most lucid understanding of the peculiar force of a medium can head off the ordinary “closure” of the senses that causes us to conform to the pattern of experience presented (McLuhan, p.329).

In the end, moving educational information onto the computer has had a profound impact on what we see, how we learn it, and ultimately, how we know it. This makes it a valid object of study in any circumstance, but as a part of the current effort to understand computer assisted learning as part of a system, it becomes a component that cannot simply be accepted as inevitable.

Reiser’s (2001) history of instructional technology and instructional design presents each successive technology, along with the details of the related instructional design philosophy, as a repeated pattern, like waves beating against the shore, each new technology is welcomed into the classroom with hope and anticipation, only to recede, leaving behind disappointment and unfulfilled promises. In each case, however, the societal impact, the affect, of the technology has not been considered to be an intrinsic part of the technology. We read about comparative media studies to determine the best
way to present information without realizing that the way we present information changes the information, changes us, and changes the way we interact with others who also use that information. The next step seems to be to determine what we should do about this, and how we should react to it. Unfortunately, given the current political, social and business background of education, McLuhan may provide little help. Consider the following with a backdrop that Google, a company that in essence has no assets in the traditional sense, is worth billions of dollars:

Centuries of specialist stress in pedagogy and in the arrangement of data now end with the instantaneous retrieval of information made possible by electricity. Automation is information and it not only ends jobs in the world of work it ends subjects in the world of learning (p. 346).

**Post- McLuhan**

It is important to remember that McLuhan wrote prior to the development of the internet, the World Wide Web, or what might best be described now as well connected computers. His was an analysis of the past and present of the 1960’s. His view was a prediction of the future. While we may marvel at the accuracy, what is of concern here is the next step, how does his work affect current research and thought? What might McLuhan say were he to see the current state of the world wide web? On one hand this is impossible for obvious reasons. Fortunately, a window into that area of thought is available through the work of the McLuhan Program at the University of Toronto. Since
one purpose here is to use this chapter to initiate a discussion of alternatives to the
previous and “traditional” understandings of the link between computers and education,
these writings will suffice as a springboard into that discussion. The first consideration is
to expand McLuhan in a context that contains things such as the World Wide Web.

There are many reasons why it might be appropriate to describe current use of the
computer as pervasive. Once the domain of hobbyists and technicians, acceptance of the
computer has steadily expanded beyond its original base into almost every aspect of the
culture. It is clear that something has changed. As this pervasiveness becomes clear what
is also becoming clear is that there has been an effect upon society. The unanticipated
details are slowly unfolding and becoming, if not obvious, then at least unhidden. Recent
events surrounding the interaction of traditional media outlets with the decentralized
universe referred to as the blogosphere only highlight the fact that television and
newspapers have been replaced as the centerpiece of our shared experience of culture.
The figure/ground relationship between old and new media that has changed, and relative
to an exploration of computers in education this relationship needs to be understood. The
PC is far more than just a delivery mechanism for education or training.

Unfortunately, experience shows that the one thing that is predictable in most
rollouts of new technology is that there is a dynamic at work that defies attempts to step
back and look at it. At first the technology is too rarified, too expensive, too limited in
distribution, with limited content and limited distribution. At this point there is no
guarantee of success (does anyone still connect their Betamax player to their
quadraphonic sound system?). Once a technology catches fire however, there are
dynamics that become operative that could not have been predicted – and those dynamics will only become obvious in retrospect.

Federman (n.d.) continues the discussion extending the ideas of McLuhan into the current internet era through a consideration of McLuhan’s four media probes, or key questions, about media. As restated by Federman, those questions are:

1. What does the thing — the artifact, the medium — extend, enhance, intensify, accelerate or enable?

2. When pushed or extended beyond the limits of its potential, the new thing will tend to reverse what had been its original characteristics.

3. If some aspect of a situation or a thing is enhanced or enlarged, simultaneously, something else is displaced. What is pushed aside or obsolesced by the new thing; the new medium?

4. What does the new medium retrieve from the past that had been formerly obsolesced?

The most accessible example of how these questions should be used is that of email, so to use that example, the first answer, what does email extend, enhance or accelerate, is communication. People can place information in a written message and distribute to multiple recipients simultaneously. Communication is practically instantaneous. The answer to the second probe now also becomes obvious. What is the reverse? There is too much email. This is most clearly exemplified by the simple fact that we now have a word, spam, for excessive email. The answer to the third question requires some thought, but eventually becomes clear. Displaced by email are the detailed pink
phone messages, and, more importantly, the people who take them. Additionally, the memos that moved around the office with checklists of sequential recipients, and the implicit time hierarchy implicit in the distribution list have been eliminated; email has flattened the management structure.

It is on the fourth point that Federman makes a curious observation. The question is what from the past has been retrieved as a result of the new media. Federman presents Hermes the messenger as that thing that has been retrieved from the past. However poetic, this seems to miss the point. What is both more to the point of a thing retrieved from the past and more directly related to email is the return of the idea of the quasi-independent craftsman. The concept of working from home has a new word, telecommuter, associated with it. Specific jobs, often held by people described as “knowledgeworkers” can be done independent of location through the use of technology, specifically telephone, email, and instant messaging. Occasional trips into the office are made to assure people that the telecommuter has a face. During their time at the office they will occupy, or, using another repurposed word, “hotel” in a temporary space set aside for such workers.

It is the fit of this new understanding into the educational process that presents questions. One item that should be addressed is the multiple uses computers may have in the educational process. It may serve to enumerate these roles here:

- information presentation (PowerPoint in the classroom)
- information retrieval (student note taking through the use of laptops)
- information sharing (course management systems and the evolution of hybrid distance/on-campus classes)
research (both through the use of computerized databases to search for the sources of information that may still be in hard copy form, and to access the electronic versions of current research journals).

Each of these uses of the computer should be subjected to a McLuhan-like analysis to determine where it might be going, and what it might be doing. One such analysis surfaces in an interview with Derrick de Kerckhove, the director of the McLuhan Program. He was asked how he “saw” the internet:

It is a hugely busy hypertext pressing behind the screen even as I am writing this (on line, of course). But it is not really amenable to sight as much as to touch. Navigating the web is a tactile affair. Things emerge on the screen in a way comparable to how they emerge at the front of your mind when you think or remember. (Bermejo, N.D.)

The question that becomes immediately apparent and immediately of relevance to this project is, “how do students see the internet?” and “how do teachers see the internet?” Is there a relationship between how they see the internet and how they learn or teach using the internet?

This chapter began with a consideration of the work of Arnheim, Tufte and Card as proponents of a form of external and assisted cognition. Graphics were presented as a way of visual thinking, but the addition of considerations from the study of media and the use of the computer within than framework move the discussions into a new area. Bermejo uses the term “psychotechnologies” as more accurate and apropos of what is happening.
I call them psychotechnologies because they have one specific feature that they do not share directly with genetic engineering, that is their relationship to language. All technologies that code, sort and transport language also modify it and modify the speaker, listener, and generally the user of language. Language entertains an intimate relationship with our mind and all technologies that affect language also affect the strategies we use to organize time, space and self. Hence psychotechnologies restructure our minds (Bermejo, N.D).

The actual effect of psychotechnologies on content is perhaps more easily seen in Tufte’s (2004) description of how PowerPoint changes the nature of presentation and content. Tufte makes a number of observations concerning the use of PowerPoint in a variety of settings, but the one that may have the most relevance to the current topic and best illustrates the concept of psychotechnologies is his description of how PowerPoint’s reliance on bullet lists limits thought and discussion to three logical relationships; sequence, priority, or membership in a set.

Kerckhove views the net as a new type of human memory and a new mode of information distribution, ideas which make it relevant to education. One issue it does raise is the often unpleasant question of how much of the information on the net is verifiable. Search for “moon hoax.” There are many pages that spend a great deal of time proving that the Apollo program and the actual moon landing was a hoax. They are all linked to one another. Through a judicious (or injudicious) use of the net, we can all become John Forbes Nash, fixating on conspiracies of the bizarre.
The ability to read information the web critically is just one component that addresses how to define literacy in this new media environment. Defining text is no longer a simple matter. Text is no longer just text; it has as additional, and as yet not fully understood, components. Logan (2000) writes:

This work led to the hypothesis that speech, writing, math, science, computing and the Internet represented six independent languages each with its own unique semantics and syntax (Logan 1995; 2000a).

Heath (2000) makes the point that the concept of literacy is expanding. Reading was once defined as the ability to decode text, but it is evolving into something new. Information is now coded in multiple layers, with content consisting of the standard text, but also expanded into hypertext: text that can link to deeper, more robust explanation, graphic images, moving images, and audio. Links can come in the form of text, but also might be included as icons, image maps or other visuals. Within this context, we have not yet learned how to define, or to redefine, literacy. With what has been said before regarding navigating the web with sight, sound and tactile components, it is also clear that Heath did not consider the multimedia components as components of literacy. Logan elevates it to the status of independent language.

The distance between how the educational community views good computing practice and how the media community interprets that practice becomes clearer when viewing how both consider the management of knowledge. Federman (N.D.) writes:

We collect and manage knowledge. We create elaborate systems to disseminate that knowledge. … We create elaborate mental models of how things are
supposed to work. We create conceptions, and then manage our affairs so that our business attempts to match those preconceived notions. We are completely unable to perceive all of the dynamics of our environment because our conception limits our perception.

One of the persistent themes in the educational literature is the use of cognitive or mental models as a guide to students on how to use the web to search for information. Mayer (1989) researched the ability of learners to creatively solve problems based on the use of a conceptual model. If Federman’s considerations are to be accepted, then it would seem that there is a tension between guidance and the danger of limiting the student’s understanding. When Tufte’s observations concerning information design are added, specifically his ideas about PowerPoint, the task awaiting the course designer becomes that much more difficult.

Donna Haraway (2004) has written of humans as cyborgs, an echo of the idea of the concept of “distributed cognition.” The use of the computer as a writing tool must now include consideration of the in-line spell checker, that grammar checker that instantly analyzes every sentence for poor structure, and the very fact that the words themselves appear sequentially on the screen as an artifact of thought that is anything but sequential. Placed in combination with the computer’s ways of processing and presenting information, the result is some hybrid way of thinking, not computerized, but no longer completely human either. Tufte, (2003) examines PowerPoint as a cognitive mechanism; something that puts limits on the directions we are allowed to think. The sequential presentation of information inherent in PowerPoint (and PowerPoint-like presentation structures such as web pages) may have additional components relative to the affective
dimensions of how we use computers in education, and in other areas of human involvement. We are simultaneously limited and expanded by the tools we choose and the tools we use. The next logical step is to see how this affects learning. The next sections will examine research conducted in these areas.
Educational Foundations

This section of the review examines research that has been conducted regarding information presentation, structure and delivery medium, with a focus on educational usage.

Much of what has been considered to this point has been a speculative or theoretical discussion related to the topic of adult and computer based education. As the entry point into the discussion of actual research, it may prove beneficial to examine some of the writing on instructional information design and move from there into the research.

Lohr (2000) directly addresses the issue of information design in the specific context of a computer based instructional interface. He describes a methodology for designing the instructional interface that places it in the context of an instructional system design process. This process consists of an iterative Analysis-Synthesis-Evaluation and Change model, a model that contains three related elements of message design, graphic design and information design. The instructional designer is faced with the dual challenge of meeting the baseline requirements for good human factors interface design, as well as the additional challenges imposed by the context of the instructional environment.

This separate focus on instructional software design as a field different from software design is necessary because most of the published research and findings are the result of work done by software designers. These sciences, covering such fields as human
factors, human-computer interaction, cognitive science, graphic arts and technical communications, but all addressing the needs of the software environment. The difference between a software environment and an instructional environment is the desired result. The desired output of software such as word processors or spreadsheets is some document. The desired output in a learning environment however, is more difficult to achieve and to measure, since it is a cognitive change on the part of the user.

One aspect of the new literacy (see earlier section) is the concept of the personalization of information. Maule (1998) cites numerous developments in current computer language development and technology that have been and can be used to personalize the environment that a learner interacts with. Most easily demonstrated by commercial websites such as Amazon.com which remember user preferences and reading habits, this personalization can be extended and become as narrowly focused on such individualized preferences as either a primarily text or primarily graphic interface. It may eventually extend into the way individuals develop and model an understanding of how things work. This personalization can be incorporated into such things as computer conference software, chat services, and bulletin boards to present information to a user in the way that he/she is most comfortable with. “The success of representations, whether graphical or textual, depend on not only whether the information meets the users needs, but the degree to which the representations fulfill the user’s information acquisition requirements and are appropriate to the user’s task. A goal of the designer to assist users in the construction of their mental models (p. 6).” This mental model may be something that is shared between the human and the computer, residing completely in neither sphere.
Further consideration of this concept is given by Hewitt and Scardamalia (1998), who discuss the concept of ‘distributed cognition.” Their use of the term distributed does not constitute something that is divided up as much as something that is spread over, echoing the ideas presented previously by Card et al to discuss external cognition. The example cited here is that of a classroom with textbooks, notebooks, rulers, organization of furniture and the contents of blackboards/whiteboards and bulletin boards that are used to distribute the cognition over them. With this as a base, the authors discuss the concept of a CSILE – a Computer Supported Intentional Learning Environment. This environment can be described as one in which every member of the class has a window into a shared idea space and takes part in constructing a shared understanding of a concept. Each member of the class is given the opportunity to contribute in a variety of ways, such as inserting a new term along with a base understanding of it, commenting on or adding to previous understandings, or searching a database for shared and related concepts. The resulting understanding of a topic is something that has been built and shared through a collaboration built with the assistance of the community of learners, facilitated by the computer. This has not been possible prior to the development of this particular piece of information presentation technology.

One aspect of the profound “newness” of these technologies is demonstrated by a series of articles. Hill, Hannafin and Land (1997) describe an Open Ended Learning Environment (OELE). Hill (1999) reports research on an Open Ended Information System. Hill and Hannafin (2001) describe a Resource Based Learning Environment (RBLE). Although the labels are different, the concept seems the same – the World Wide Web provides a learning environment in which there are no “correct” answers, merely
vast resources. Students need some support in navigating this informational space in order to make meaning.

The Open Ended Learning Environment is described as providing tools and resources that allow students to immerse in a simulated but genuine context of problem solving. The learning experience was structured to provide the information necessary to grasp the problem in a way that would simulate real world methods of data gathering, i.e. the information necessary to solve a problem was placed in virtual student folder. Those participating in the learning experience needed to find the file and read it to understand the problem. The goal is to use the environment to extend thinking and learning away from descriptions and into direct experience. The Open Ended Information System is described as a virtual space where users can construct their own meaning. The Resource Based Learning Environment is described as one that provides tools for: searching, to enable the location of resources; processing, to provide cognitive support in such activities as organizing and generating information; manipulating, to allow for users to test beliefs and theories; and finally, communicating, to enable the sharing of ideas in a variety of forms. What becomes apparent in these articles, in addition to the explicit content, is the attempt by the authors to make meaning for themselves of a rapid expansion of information and informational resources. That seems to take place in several different ways, including the evolution of the name used to describe the concept.

One of the problems in reviewing research on the effectiveness of information presentation lies in the definition of information presentation itself. Reiser (2001), in reviewing the history of instructional media, points out that much of the comparative media research studies, those who have attempted to measure how much students learn
after being taught with a particular medium, have failed to reveal any significant differences. This was the focus of much post-war research, but those efforts were mostly abandoned in the mid 1970’s due to the inability to attribute any differences in results to the media themselves, and not any confounding factors. It is only recently that interest has again risen in the concept of comparative media, this time from the pure media comparison to media comparison in context, that is, in the research of such fields as attributes of media, how media influence learning, or how instructional methods use media. The research documented in this section focuses on how information culled from the web is used by students to foster understanding.

Mayer (1989) reviews research conducted in his learning laboratory that addressed the ability of learners to creatively solve problems based on the use of a conceptual model. The theory tested was whether students who were given a conceptual modeling could engage in systematic problem solving. Conceptual modeling is useful in helping learners to build a mental model of the system being studied. Since the findings indicate that significantly improved performance results from the use of these conceptual models, it is relevant to the topic at hand to review in some detail what makes a good conceptual model. The qualities that define a good conceptual model are:
**Complete.** Good models contain all of the essential parts, states, or actions of the system as well as the essential relations among them, so that the learner can be able to see how the system works.

**Concise.** Good models are presented at a level of detail that is appropriate for the learner. Rather than provide so much detail that the student is overwhelmed, good models summarize and epitomize the system they seek to explain…

**Coherent.** Good models make intuitive sense to the learner so that the operation is transparent; the model or analogy used is a logical system that contains parts and rules for how the parts interact.

**Concrete.** Good models are presented at a level of familiarity that is appropriate for the learner, including physical models or visual models.

**Conceptual.** Good models are based on material that is potentially meaningful, that is, on material that explains how some system operates.

**Correct.** Good models correspond at some level to the actual events or objects they represent. The major parts and relationships in the model correspond to the major parts and relationships in the actual object or event.

**Considerate.** Good models are presented in a manner that is appropriate to the learner, using learner appropriate vocabulary and organization. (p. 59-60).

If these guidelines are followed, conceptual models can be used to guide attention and build internal and external connections. In one sense it might be argued that this chapter is an attempt to develop a good conceptual model of the idea of the various components and interactions of a computer based learning system. Mayer worked with
many static graphic models in his research. Of specific note is his observation that the addition of interactivity in computer graphic simulations can be a powerful conceptual modeling tool.

Hill (1997) continues the exploration of this theme, studying how users interact with both traditional electronic information systems such as card catalogs and electronic databases and the newer open ended systems such as the World Wide Web. Noting that in some respects providing users with a conceptual model of the system simply perpetuates an old style systems view, i.e., the user is just another component passively adapting to the system and becoming just another component of the overall input-output system. Instead she proposes that navigating within an open ended system is more in line with the system view that will be used in this research and with a concept described as “ecological psychology.” Ecological psychology places the user clearly within the system, making the individual and the environment interdependent. Those elements that can be considered as part of the user: their behavior, the objects they use and the skills, knowledge and ability to use them; and the setting, those things that comprise the environment and force the individual to adapt to it, are part of the same entity.

In examining the results of conceptual models on users’ ability to navigate through the World Wide Web, one issue of note relative to the specific topic of this paper was the need by Hill to create a conceptual model for the purpose of reporting on how users moved through the World Wide Web. She writes:

Therefore, it was important to select a shape to communicate the clearest message of the activities occurring in the OEIS information-seeking process. Circles tend to convey predictability and reliability, straight lines convey stability and linearity
of thought and time (Weed, 1989), all characteristics more aligned with static, closed systems. As a complex, ever-changing environment, an OEIS does not inherently support the characteristics of predictability, reliability stability or linearity. As such, the model is represented as a spiral to depict the ever-evolving and infinite nature of the information-seeking process in an OEIS (p.11).

In discussing the actual findings of her research, several issues are revealed. Although both instructional designers and information scientists have addressed the problem of working within their particular environments, neither has addressed open-ended environments and the need for users to create structure without hampering creativity. While some models have been proposed, they have not yet been fully researched, and an ongoing problem affecting users has been disorientation within the environment.

It is this attempt to provide some conceptual model useful for organizing the idea of moving within a computer space that prompts the research of Colle and Reid (2003) into three dimensional graphic displays. Building upon the initial research of Robertson et al (1999) done as part of the development efforts for the TaskGallery product by Microsoft, they adapt the traditional two dimensional desktop motif familiar to any computer user to a three dimensional gallery of computer desktops. Each of those desktops has been customized for a specific task. Within the gallery, the variety of task specific desktops appear as pictures. Each of the pictures can be moved to the center of the space and activated. By placing the desktops in a three dimensional space, the theory was that the procedural and spatial knowledge used in navigate through real
environments could be invoked to prevent users from becoming lost within an electronic environment. Their findings indicate that the strategy is successful, that objects placed into rooms become grouped by something referred to as the boundary effect, that is, objects become organized in space, even if the boundaries are simple lines drawn upon the floor. Of note to the discussion of the presentation of information is the observation that squeezing more information into the visual display does not also squeeze that information into the mind of the viewer, but that arranging that information into a three dimensional display, an alternate way of increasing the amount of information in a finite space, may allow other mnemonic devices to be brought into play.

Jelfs and Whitelock (2000) add one more element that will be expanded as part of the learning system to the concept of this virtual space, that of “presence.” Presence addresses the informational need of users in virtual worlds to determine their location within that world. The world that the user is part of is clearly the computer mediated world, and for the designer of that world, there is the difficult chore of creating an interface that is intuitive but also invisible. The conundrum is that the greater the intrusion of the interface, the less the sense of presence, and conversely, the greater the sense of presence, the less intrusive is the interface. The elements that Jelfs and Whitelock (2000) found most important as a result of their study were ease of navigation and some form of audio feedback, echoing findings from the discussion of media.

The implications of these research findings are intriguing by themselves, and each of the authors has made suggestions for further study within the context of their particular research. However, since many of the authors have made note that the overall work of designing an instruction interface or instructional environment crosses many of the
traditional boundaries of study, the overall implications will be considered further in the discussion section of this chapter, after consideration of the available research on problem solving, and graphics and presentation.

**Solving Problems**

One measure of the successful use of computers in education is the ability to solve problems in the real world as a result of the use of some computerized instruction. Herrington and Oliver (2000) address the separation of knowledge and application in an attempt to define the requirements for a situated learning environment. In a research study that addressed the definition, creation and assessment of a computer based situated learning environment, they first extracted from the research, debate and discussion on situated learning a model of instructional design that specifically addresses the situational aspects of the design. They then used those principles to design an instructional package. For the purposes of the study, the instructional package consisted of a CD-ROM to be used to teach assessment strategies for mathematics teachers of grades K-12. The third part of the study explored the student perspectives on the use of the CD-ROM as an instructional tool.

Herrington and Oliver (2000) list nine specifics of a situated learning environment, many centering on the creation of an “authentic” environment, authentic in this context meaning something that preserves the complexity of the real life settings, with no attempt to fragment or simplify the experience or activities relevant to understanding it. Of particular note is their use of the environment to provide expert thinking in the modeling of solutions, in addition to viewing situations from multiple perspectives. In order to achieve these goals, the CD-ROM presentation included video
clips of multiple viewpoints, such as teachers using various assessment techniques, teachers then commenting on those techniques, children’s comments on the techniques, and experts providing the theoretical background. Additional text based resources were also included on the CD-ROM.

The actual study of the efficacy of the program, conducted using a qualitative methodology, revealed a number of interesting details, several extremely relevant to the current research topic. The problem the students were presented with was ill-defined. Students were given a copy of a letter of complaint from a parent and asked to propose a plan of action. Media elements were available in the form of elements placed in a filing cabinet; they could view the problem from multiple perspectives by opening different drawers. Additionally, the concept of “views” was extended beyond the multiple perspectives contained on the CD-ROM itself by requiring students to work in pairs, thus adding multiple views to the discussion. A significant finding of the research relative to the presentation on CD-ROM was that the context of the presentation eliminated the need for the program to anticipate every possible response from the learners. The use of authentic context, activity and assessment allowed the program to be used as a research tool, rather than a simple presentation tool. Herrington and Oliver (2000) conclude that this model, based on situated learning, is effective as a substitute for the traditional instructional design model. This speaks directly to many of the assumptions of computer based instructional model. As they state:

A further implication of the research is that the findings undermine the wisdom of the wholesale replacement of lectures and tutorials with individual interactive multimedia work. The inappropriate adoption of flexible modes of delivery, on
which such private and lonely work is predicated, may ultimately sacrifice effective learning for convenience (p. 43).

Bandy and Young (2002) study the impact of Computer Supported Collaborative Work (CSCW) systems. These are technologies that facilitate collaborative work efforts. Of interest to the current discussion is the second research question stated by the authors, “Does use of a collaborative technology within group discussion impact the structuring of group discourse (p. 12)?” The study was motivated by research conducted by Senge and Kim that suggested that the use of a shared computer mediated communication model facilitated the transfer of mental models from one member to another, and by observations by Shedletsky (1993) that addressed the possibility that the use of a computer mediated communication method was likely to shift learning from a lower level response to a higher level one. The research examined three different methods of communication, oral, chat, and a fully developed group support system. Users of the chat system produced the most communication, however, the Group Support system, which employed a number of tools to focus discussion and to allow the reuse of content between the tools produced the higher level of task-focused communication.

Research on Graphics and Presentation

Uncovered in the literature searches for actual research conducted against an educational background, Lohse, Biolsi, Walker, and Reuter (1994) reinforce ideas developed in the initial theoretical sections of this review. Their study attempts to categorize systematically the various types of educational graphics. The reason for their
research was their view that “visual representations are data structures for expressing knowledge (p. 37).” The use of an appropriate data structure can assist in problem solving and understanding. Subjects of the research were presented with 60 different types of graphics and asked to sort them on a variety of phrases, such as spatial/non-spatial, concrete-abstract, conveys a lot of information-conveys little information, etc. The targeted outcome of the research was to develop a taxonomic classification of graphics. That taxonomy consists of 11 elements: Graphs; Graphical Tables; Numeric Tables; Time Charts; Network Charts; Structure diagrams; Process diagrams; Maps; Cartograms, Icons, and Photo-Realistic pictures. One of the more significant findings in their work however, was the discovery that photo realism, often used to judge graphic quality, may be of little use. As they state, “subjects in our study characterized photo-realism images as conveying the least amount of information of all categories in our classification” (p. 46). An additional suggestion resulting from their research affects the direction of future comparative media studies. Addressing the tendency to interchange graphs and tables, they suggest that future research should focus on how effective graphics express knowledge, rather than which media is the most efficacious.

Although it is not stated explicitly by the authors, it is this search for how knowledge is expressed in graphics that links the studies in this section. Cochenour, Jung and Wilkins (1996) examined the effectiveness of image maps as information display and navigational tools. An image map is that entity born with the World Wide Web and web browsers, that permits a graphic image to act both as information presentation in its own right, and as a linking device to multiple other, presumably related, informational resources. Their research focused on three elements of the
interface design: visual characteristics, that in addition to being visually appealing, the map should provide obvious clues that it is a linking device; navigational characteristics, among other things that the map should aid in the construction of a mental model of the interrelationship of informational resources, and adhere to good navigational principles, i.e., navigation back to the origin should be both easy and obvious, and finally; practical characteristics, it should not take an excessive amount of time to load, should link the original map and its related resources. Cochenour, Jung and Wilkins (1996) report that if the primary use of the image map is as a link to other information, then simplicity should be the primary factor driving design. Artistic images tend to be too difficult to navigate, reducing their effectiveness as linking tools, and taking too long to load, negatively affecting their practical considerations.

An interesting variation on this theme is reported by Nygren, Wyatt, and Wright (1998). Although not explicitly related to education, it does provide useful background in how people use information. Studying how and why clinicians search medical records, they found that the reason a clinician searches a record may affect the most efficient presentation of information on that record. The three most common reasons to search a record were as a way to gain an overview of a specific patient, to search for specific details concerning that patient, or to test hypotheses about the patient. Physical or paper records, due to the placement of information in specific locations, facilitate a record search method that allows for skimming on the part of the clinician until relevant information is discovered, at which point they switch to a detailed reading, after which they return to skimming until the purpose of the search is realized. The information in the record is arranged in patterns that the clinician can survey. Computerized records, on
the other hand, often result in a “pattern-dead” presentation that acts to impede the search for information, requiring that doctors take more time to review computerized information. They offer a number of suggestions most targeted at the organization of paper records that may help to organize those records in a way that will facilitate information retrieval for the varied purposes of the records.

Another view of the power of effective information presentation is given by Elting, Martin, Cantor and Rubenstein (1999) in a study that examined information presentation in clinical trials. Clinicians were shown the results of a hypothetical clinical trial framed as a table, a stacked bar graph, a pie chart, and an icon display. They report several significant findings, the most important in general and also in relation to the hypotheses currently under examination being that the method of displaying information influenced the accuracy of the resulting decisions, and that the method preferred by the clinicians did not result in the most accurate decisions. Specifically, the study found that the most accurate method of presentation was the icon display, although this display method was not the presentation preferred by the clinicians. These results are of note when placed against studies such as by Wright, Jansen and Wyatt (1998) which reports that errors can arise when the presentation of data differs from what viewers expect.

Although the idea of expressing ideas graphically has run through many of the articles reviewed at this point, the idea of a cognitive map as an explicit expression of content is used by Cossette (2002) to present the management ideas of F.W. Taylor. He analyzes the importance of concepts appearing in Taylor’s work by measuring the frequency of the words used in describing them. He then uses that analysis to create a graphic display representative of the researchers thinking about the thinking of Taylor. In
the resulting graphic, “every concept that exercised a direct real or possible influence over another concept was linked graphically to that other concept by means of a line ending in an arrow (p. 170).” Additional rules are imposed that describe the creation of the graphic. When viewing the resulting graphic, those ideas that are “central” to Taylor’s thinking are obviously so because they sit at the center of a web of linked concepts.
Educational Framework

This section of the review considers ideas and literature reviewed by Tallent-Runnels, Thomas, Lan, Cooper et al (2006). This continues the focus on research begun in the last section, but considers several more recent studies, and the meta-research conducted by Tallent-Runnels et al as part of their literature review.

To this point in this review a number of issues have been raised that relate to education, but the task still remains to situate the proposed area of research within a broader and more clearly defined educational context. Fortunately, a framework for this task has been established by Tallent-Runnels, Thomas, Lan, Cooper et al (2006). They review the current research literature on teaching courses online and it is of value to this effort to examine their review in some depth.

In addition to the actual work of reviewing the literature, their review provides a useful framework for organizing the current research in online teaching. They posit four major categories or themes they use to define online education:

- Course environment
- Learners Outcomes
- Learners Characteristics
- Institutional and administrative factors (p. 96)
As a logical construct of the various elements of online education, using these four general areas as organizational tools provides a good starting point to a formal examination of the relationship of a more traditional educational focus and the topic of the proposed research. After a brief discussion of Tallent-Runnels et al general outline, a more detailed examination will be considered for the two topics of direct import to the research.

The first area defined by Tallent-Runnels et al, the term “course environment,” is used as “an overarching term that includes classroom culture, structural assistance, success factors, online interaction, and evaluation (p.96).” This is of immediate interest as all of these constitute significant components of the education system that will be described in the next section of this review.

When Tallent-Runnels et al use the term structural assistance it is a term that describes things such as scaffolding and external systems that assist cognition. Previous discussions of visual thinking again prove their relevance. Additional links to matters of concern to this paper are provided by Tallent-Runnels et al relative to their review of recent research. Their discussion of research by Mayer, Heiser and Lonn (2001) found concurrent narration and animation to be less effective as an instructional methodology, most notable because learners who were forced to split their visual attention retained less. As they note, “It seems that when the cognitive load is high, understanding of complex concepts is hindered (p. 97).” While they do not mention him by name, this brings McLuhan’s observations about media directly into the discussion of electronic learning in a way that allows us to question how the presentation of information affects the construction and retention of information.
The literature on success factors presents the OLES (Online Learning Environments Survey) as a specific and final object, but preliminary research of the term indicates that it is rather a concept that is under development. The reader is referred to the methodology section of this paper for further discussion.

The general topic of “interaction systems” is used as a departure point by Runnels et al for a consideration of the nature of online knowledge construction. This topic forms the basis for the deeper discussion of two research projects that construct taxonomies of online learning. They cite Kanuka and Anderson (1998) who posit a 5 stage process for learning that ranges from a simple sharing of information at stage 1 to interacting with others on the basis of newly constructed knowledge in stage 5 and also Thomas (1998) who also posits a 5 stage taxonomy of engagement. Of note is that while both studies use different terms to describe cognitive engagement, they find on-line learning remains at the preliminary levels.

This section of the review is helpful apropos the proposed the research that is the topic of this effort because, while the results of the research they cite are of interest, the methodologies of knowledge organization and questioning methodology are directly relevant. They cite Blignaut and Trollip’s (2003) taxonomy of instructor participation, “administrative, affective, corrective, informative, and Socratic (p. 102)” and Christopher, Thomas and Tallent-Runnels’ (2004) rubric to assess the nature of thinking in online discussions.

Learner outcomes are considered separately in the cognitive and affective domains. This distinction will prove helpful when evaluating the experiences of subjects during the proposed research. When viewing research in the cognitive domain, Tallent-
Runnels et al revisit the previously noted difficulty in comparing cognitive outcomes based on different media. Alternately, they define the affective domain as being comprised of student attitudes, satisfaction and perceptions. While both of these areas are of import to the research, it is the result of the interaction between the cognitive and affective domains that may provide the interest in the system under review.

The third broad category that Tallent-Runnels et al note as a theme of the literature is the general study of learner characteristics. They cite Shrum (1995) as exploring the “interplay between design, delivery and user characteristics (p.109),” something of immediate interest since it hints at a system view of on-line learning. Another cited study that hints at this system view is Graff (2003) who examined the relationship between cognitive style and on-line learning. Cognitive style is classified on as ranging from holistic to analytical, with results that suggest that matching presentation to cognitive style can have positive results. In summarizing the research on learners’ characteristics, they preview the systems view of on-line learning:

Much of the early research on online instruction focused on the impact the delivery system had on the efficacy of student learning. Recently, researchers with concerns about the design of online learning have shifted focus from simply investigating the effect of different delivery systems to a more sophisticated investigation of the synergistic relationships among the learners, the design of instruction, and the constraints of the delivery system (p.112).

The final category identified by Tallent-Runnels et al concerns institutional and administrative aspects, further subdivided into matters of institutional policy, institutional
support and enrollment effects. There is little here that bears on the subject of my research.

In their overall conclusions to the literature review Tallent-Runnels et al confirm personal observations that

… found no comprehensive theory or model that informed studies of online instruction. We also found few conclusive guidelines from the studies that we reviewed. Though several of the reviewed studies pointed to the need for a more sophisticated approach than merely moving text-based courses to the Internet, they simply recommended use of new technologies and sound pedagogy as models. Very few areas of inquiry about online courses were supported by multiple studies (pp 115-116).

The one area that may benefit from multiple studies is that of media comparison, and in this area the research confirms that there is little difference between the results achieved between on-line and traditional classes. The researchers recognize and note that the literature does illustrate differences in the cognitive processing between delivery methods and challenge future researchers to identify and use those features of the on-line environment. Of note in their comments on future research is the following passage:

However, research needs to be conducted to determine which format provides the highest level of interaction and the most effective learning experiences for various kinds of students. In addition, future studies need to show which format best fits a particular pedagogy used by instructors. More important, future research needs to examine the kinds of instructor and student roles in online interactions that
enhance class discussions and encourage critical thinking and construction of knowledge (117).

This may be perceived as a description of a system, and a request to study this educational system. The existence of this system and the need to study it is the subject of the remaining section of this review.
The Educational System

This final section of the review presents literature that considers the classroom, whether traditional or electronic, as a system. The elements that comprise the system and nature of their interactions are considered.

Since there are so many ideas that can be described with the phrase “educational system” the first task is to limit the discussion to the specific meaning of interest here.

What is under discussion is clearly not any kind of administrative or formally organized bureaucracy used to deal with registration of students or hiring of teachers. Rather it is the interaction between the elements and participants in a learning system. It is the nature of the interactions that become the subject of study.

The first view to be presented here of the this type of system is one in which the author does not use the word system to describe what the topic under consideration, although it soon becomes clear that what is implicit in the learning perspectives being described is a system view of education. Pratt (1998) conducted research with over 250 adult educators in an effort to find what it means to teach. From their answers, the authors identified five distinct perspectives, defined as “an expression of personal beliefs and values related to learning and teaching” (p. 16). While the specifics of each of the perspectives is of interest, of more and significant interest is the description of each perspective as a “complex web of interdependent beliefs and commitments” (p.215). Each of the perspectives addresses the interaction of four elements: teachers and students interacting with the content; and with the ideals and beliefs carried into the learning
environment. Pratt distills the ideas derived from the research into five formal perspectives of teaching, each of which expresses a different balance of elements in the interaction between the groups and ideas.

The five identified perspectives are described as *transmission*, focused on the effective delivery of content and most easily identified with the traditional view of the role of teacher and student; *apprenticeship*, described by Pratt as focused on modeling ways of being, and most familiar as a traditional method of teaching craft skills; *developmental* and *nurturing* perspectives, both of which are more focused on the development of the learner rather than the transmission of content; and a *social reform* perspective, which seeks as its primary focus a change in society.

Pratt’s purpose in writing the book is to provide educators with a conceptual framework for understanding and articulating their teaching perspective. The “clusters of actions, intentions, and beliefs” (p.16) that comprise perspectives will ultimately determine how teachers plan, implement, and determine results. The ability to conceptualize one’s teaching perspective, therefore, has implications for teachers, learners, and those responsible for evaluating teacher performance. More importantly apropos the topic of this chapter however, is the idea, not only that teachers, students, content and ideals interact to shape the learning environment, but that teachers and students can become aware of and react to the nature of those interactions.

The idea of the interactions between elements of a classroom comprising a system is made explicit by Dron (2002). Starting from a point which considers the key element of the system to be the learners, Dron considers how those learners interact with school staff such as teachers and administrators, and with various school resources, such as
libraries and books. They participate in actions, such as lectures, tutorials and seminars, and take advantage of school provided learning support structures such as classrooms and laboratories. In addition:

There may be a host of other factors which affect its dynamic progression. The word education refers to some kind of interaction where there is an involvement of the educator, the learner, what is to be learnt and an environment. In a word, it is a system. It is composed of many interacting subsystems, the libraries, resources, curricula, social demands, political initiatives, geography, educational theories, teachers, students, administrators, institutions, employers, the academic community and so on. The interactions of these different subsystems form the character of any given educational system (p.21).

It may be of note that while Pratt would consider the system to be comprised of teachers, learners, content and attitudes, and Dron would expand that to include a wider variety of materials, in light of the comments and literature that comprise the first sections of this review, it is not a distant leap to suggest that a significant component of the system would be the presentation of material. That is, not only the content, but the presentation of that content via some medium, and the reaction of the human participants in the system to that presentation. Dron explicitly adds this consideration of the human element:

It is not enough for communication to take place, but at least some f that communication has to be affective. Systems are constituted in the relationships
between their elements. If elements do not affect each other, we are not looking at a system but at a set of discrete parts (p.35).

The problem that has troubled people with various comparative media studies has been the difficulty attempting to reconcile the lack of significant different derived from comparative media. Dron’s system view provides an answer to this dilemma in the core concept he seeks to examine in his thesis, the tendency for systems to self-regulate. Dron states that the “most significant part of what shapes education systems will be seen to be the mediator or manager of learning, a role most commonly embodied in the teacher.” The affective interaction of the parts of the system capable of it may thus be the confounding factor long searched for.

As an example of this self regulation Dron, cites Moore’s theory of transactional distance as illustrative of the systems nature of distance education. It may prove helpful to review that theory, and to expand upon it in the interest of this research.

Moore and Kearsley (1996) state the systems nature of the distance education system quite succinctly:

Selection of a particular delivery technology or combination of technologies should be determined by the content to be taught, who is to be taught and where the learning will take place. Design of the instructional media depends on the content, the delivery technology, the kind of interaction desired, and the learning environment (p.13).
Moore and Kearsley describe learning as a transaction that occurs between a teacher and a learner. Even when both are co-located in a traditional classroom, there is some communicative distance, but that distance becomes an explicit part of the distance learning transaction:

What is normally referred to as distance education is that subset of educational events in which the separation of teacher and learner is so significant that it affects their behaviors in major ways. The separation actually dictates that teachers plan, present content, interact, and perform the other processes of teaching in significantly different ways from the face-to-face environment (p.200).

Moore (1991) describes the details of transactional distance to the interaction of two variables, dialogue and structure. Dialogue refers to the interaction between teacher and learner, whether that dialogue occurs face to face or via some long distance communication medium. Dialogue varies in the degree to which it is possible in various media. Structure is the way the course has been assembled so that it can be delivered. Structure varies between extremes of rigidity and flexibility.

The idea of transactional distance is useful in envisioning the systems nature of the electronic classroom, since in one view, it places transactional distance as a measurement of the effectiveness of the system. A system with little discourse and little structure has a great transactional distance, and one with corresponding opposites of much discourse and structure has a smaller transactional distance. That there is more to the system becomes clear however, since Moore (1991) addresses this directly:
Thus, there is a relationship between transactional distance and learning style, since the greater the transactional distance, the more autonomy the learner has to exercise. Thus it can be argued that while transactional distance is a characteristic of every educational program, and that programs differ in transactional distance according to the extent of dialogue and structure within them, there is also variability in the transactional distance between teachers and learners within each educational program, resulting from the interaction of dialogue, structure, and the characteristics of each learner (Paragraph 8.)

This explicit addition of a consideration of the characteristics of the each learner as part of the transactional distance equation re-expands the topic to include the previously mentioned components of the system that have been the topic of this review. It also makes obvious one aspect of the learning system that a concept such as transactional distance cannot address.

Galimberti and Riva (2003) speak of on-line communications specifically, but with words that apply to many aspects of the system in discussing a term they call “cyberpsychology;”

Communication was once seen as a process which can be switched on and off at will, an alternation of action and reaction or a series of actions performed in an inter-subjective vacuum; now it is seen as the outcome of a complex, coordinated activity, an event which generates conversational space with within intertwined personal and social relationships. Thus, communication is not only – or not so much – a question of the transfer of information, but rather the activation of a
psychosocial relationship, the process by which interlocutors co-construct an area of reality (p. 5).
Discussion

Each section of the review has examined some aspect of the proposed learning system. There have been several smaller discussions embedded in the sections and specific to the narrower topics discussed. This section concerns itself with the more global discussion of the total learning system.

This review has ranged over several related yet different topics. The hope is that the connection between each of those topics is so integral, and the relationship between each element and the complete system so clear that simply placing them in sequence will create the connection in the mind of the reader. The learning system that is formed through the interaction of learners, teachers, content and delivery medium will become a reality and recognized as an object of study. It is hoped that this review will cause the reader to review and reflect upon personal experience with such learning systems, and in so doing, to see the relevance of the proposed research. The purpose in this section is to put forward some of the questions that arise based on the literature, and consider some of the possible directions those questions suggest.

The initial discussion that started with visual thinking becomes a persistent concept, whether expressed by Arnheim, Tufte, or Card. Yet each treats the communication of knowledge as a deterministic phenomenon, the success of the graphic as a communication tool dependent solely upon the skill of the graphic designer. The ability of the viewer to decode the graphic is assumed. That this might be an acquired skill has not been considered – the graphic itself held the key. The first thought that this
might not address the issue completely came during a course of study at Johns Hopkins University.

From 1995 to 2000, after a hiatus of 20 years away from higher education, I attended Johns Hopkins University in a program in Information and Telecommunications Science. What was most immediate and obvious in all of the classes was the omnipresence of PowerPoint. Class lectures were conducted and presented based on PowerPoint. Student presentations were equally dependent on this technology. At first it seemed to be a good thing. Class notes came in a single handout that matched precisely what the instructor had placed on the screen during class. This eliminated the need to take handwritten notes and avoided their inherent imprecision. It was not long after however that something began to feel wrong.

At about the halfway point in the Hopkins program the difference between figure and ground changed. I stopped watching the figure, the actual content, and began looking at the ground, how the information was being presented. By not writing my own notes I was eliminating the first step in the personal information processing I would need to do to internalize the class content. The PowerPoint presentation, however convenient, was stuck in a forever “now” mode, where all that mattered was the current slide. In previous classes, when blackboards and chalk were still the presentation method of choice, the evolution of ideas and the development of the current discussion was present on the board, in a visual record of the recent past which everyone could follow and with visual artefacts proving how the discussion had evolved. In Hopkins the use of PowerPoint had transformed the classroom lecture from a passive learning experience into something far different, a practically unconscious learning experience without conscious notice,
because of the adoption of a new technology that was having unanticipated consequences.

As stated in the introduction and carried through the entire review is the theme of the learning system, and the affect upon students, teachers and content made by the presentation of information in computerized education. However, in locating and reviewing literature which addressed this presentation of information, one thing noticed is how amorphously the boundaries of that topic are drawn. Many authors felt compelled to define explicitly their own boundaries to the field, and many have extended the area of concern beyond the obvious fields of instructional or visual design, into cognitive psychology, ecological psychology, distributed cognition, human-factors engineering, ergonomic research, computer science and editorial design. The effect of this is profound because it defines a new field of research, one that has roots in multiple disciplines, but one which needs to be given its own measure. One problem is that of determining which field the research applies to.

The effect of not having an overall conception of the topic takes several forms. To illustrate, I would like to look back at several of the studies that were part of this review, and two others that were not included. Lohse, et al, (2002) find that images act as data structures for knowledge. However, Cochenour, Lee and Witkins (2002) do not address this aspect of the image when they studied the use of images as navigational tools. While computer technology can allow an image both uses, as both illustration of concept and navigational tool, how effective is an image that is used in such a way? It might be less effective, if the users simply click through the image to get at deeper content, or it might be more effective, if the users have a conceptual model reinforced through an
examination of the graphic to find the deeper content. Within the context of this
discussion, the image can be educational, provide a cognitive map of process or context,
or it can be dismissed as mere decoration, providing nothing but fluff. It will be
interesting to see how this stands as a research question and how the subjects of the
research answer the question.

Another aspect of this lack of definition in the field, and one that may be the
single strongest motivation to develop a systems view of the electronic classroom
involves studies that address some specific aspect of computer usage, but in doing so,
ignore other documented byproducts of the interface. One such study was conducted by
Jonassen and Kwan (2001). The explicit purpose of the study was to examine the use of
the computer as a communicative conduit for problem solving, however, in the course of
describing the computer conferencing system used in the study, the authors make the
observation that, “Computer conferencing for purposes of case analysis had not been
used previously in the course; however, all students were experienced electronic mail (e-
mail) users. The computer conference was similar in form and function to e-mail” (p.38).

The over-simplification inherent in this view can be seen in comments by
Hermann Maurer (2002) writing specifically about the differences between e-mail and
discussion forums and the hidden complexity of learning environments:

Innocent looking words like "discussion forum" are really like the mythical box of
Pandora: once you start to seriously use a discussion forum with a sizeable group
of users the number of issues arising is mind boggling: from questions of the
levels of anonymity, to tools for structuring a discussion, to the issue of meta-data
for contributions (!), to the issue of active notification of users, to the fact that any
large discussion forum has to provide a substantial number of different views of the contributions, to tools for "positive" and "negative" filtering, just to name a few examples. If more complex collaboration tools are to be involved (and they should be) all issues surrounding computer supported collaborative work (CSCW), now discussed in entirely separate conferences, start to be important. (p.3.)

One additional problem noted in a number of articles that were excluded from this study is a tendency to revere technology for its own sake. One example of this type of study examines the use of presentation graphics in business and industry. In a study that purports to examine how presentation graphics software is used in business and industry the author states that “it is apparent that more educators and business professionals need to be encouraged to learn presentation graphics software” (Alexander, 1998, p. 35). Based on the object of the study, the methodology employed, and the results reported, it is not clear why educators and business professionals need this encouragement. In fact, Tufte quotes a study by Shaw, Brown and Bromily (1998) showing that one of the most frequently used elements of presentation software, the bullet list, promotes laziness of thought in three specific areas: it is too generic, it cannot express relationships between items, and it forces presenters into an arbitrary selection of one of three presentation methods: sequence, priority or simple membership (Tufte, 2003, p.5).

A concept that needs to be expanded upon is that of an updated and current definition of literacy. When Heath (2000) attempts to expand the definition, he is actually addressing a question raised by Elkins (2003) within the field of visual studies. Elkins
was considering Mayan artwork, but his description echoes current use of graphics in web design. Content consists of text, hypertext, simple graphics, navigational graphics, video, audio, animations and additional graphic elements that are being developed and embedded without instruction into web pages. While we may no longer be able to define literacy, we do seem to have discovered the tools to contextualize the Mayan images described by Elkins (2003). The questions that flow relative to the current research are many. How do our current understandings of literacy affect how people view web content? Is everyone equally “literate,” or are there degrees of literacy? Is it culturally based? Do the various sub-literacy’s increase equally for everyone, or are there people who are more visually literate, those who are more textually literate, and how do we now define the difference? Most importantly, how does this affect the use of the web as a learning tool? These questions are not addressed by Elkins, or find a home within the context of the discourse of Visual Studies. They do remain a concern for those who wish to use the computer as an educational tool.

In reviewing the literature on the use computers, there is a persistent focus on the visual aspect – what does it consist of, what is contained in the frame, how does it communicates information; how does it obscures information. Kerckhove moves the online experience from something visual to something tactile and auditory. One of the often unnoticed aspects of Internet Explorer is that Microsoft has built into the software an audible “click” that occurs whenever the mouse is clicked. It is of note perhaps that pages which can auto update, i.e. news related webs sites with time sensitive content, issue a “click” when they update the page. Thus web surfing becomes a combination of seeing,
hearing, and touching the interface. The user becomes connected to the computer on more than just a visual level. How can this connection be measured?

The question of the psychological effect of hypertext has yet to be adequately addressed in the literature, despite a large number of articles on the mechanics of hypertext. Links can lead from one page to the next, from one place to the next, but also to somewhere unrelated, and from there to yet another unrelated page, mimicking the stream of human consciousness. How much of this “multimedia” aspect is consciously and deliberately included or excluded in computer based education? In thinking about work related computer based training, the training occurring within a very scripted progression of pages. The most dominant memory is one of being annoyed by having to click on something – a click that interrupts reading and thinking. And yet CBT authoring guidelines will include discussion of buttons and the necessity to include user control. Unfortunately, in much of current computerized content there is nothing to control – in most cases each button click leads inevitably and inexorably to the next page. Additionally, the various content packaging guidelines, while not discussing presentation specifically, do specify CBT packaging guidelines that make it easiest for the developer to make each “next page” looks just like each “last page.” These will look just like all of the other pages before and predict all the pages that will appear after. Have users been conditioned, by the often unanticipated consequences of web surfing, to expect something new, different, and potentially unrelated when they click the mouse, or when the mouse is clicked for them? Is the unanticipated consequence of web surfing that we are now inured to Computer Based Training, and instead, unknown to the course designers, engaged in a massive collective effort that is unintentionally changing the way
we think? Kerckhove uses the term “psychotechnologies.” The question that becomes immediately apparent and immediately of relevance to this project is how do students see the internet? More importantly how does it affect learning?

The final point to raise here concerns the view of learning implicit in the views of many of the educational writings reviewed in this chapter. A recurrent theme observed in the writings on the web as educational tool is a presumption of a constructivist view of knowledge. As an element of the proposed learning system it will prove useful to be aware of a large scale philosophical tendency on the part of the learning community. It is something to be probed in the attitudes and beliefs of the subjects of the proposed research.

**Conclusion**

This purpose of this chapter has been to examine the several streams of thought that run together to create a learning system from the interaction of students, teachers, content and presentation. The studies documented in this paper have been culled from a wide variety of diverse sources and subject areas. The next step in this exercise must be to define the boundaries of the proposed research, suggest an appropriate methodology to approach the subject matter and participants, and determine a suitable reporting structure.
Chapter 3
Research Design and Methodology

The purpose of this study is to examine the interrelationship of teachers, students, content and media in a completely on-line higher education class. I focus on the specific consequences of using computers as teaching aids, and explore the factors that may lead to those consequences. I explore the idea that far from being a passive information delivery and communication tool, the computer adds to, subtracts from, and changes the nature of information presentation, comprehension and communication. That change can be situated in the nature of the medium itself, in how the students and teachers interact with that medium, or in the teachers and students themselves. Hopefully, this study will lead to a more careful consideration on the part of educators of how, in the best of circumstances, the computer has been incorporated into education as a useful research and communication tool, and in the worst, of how education has been compromised by the indiscriminate use of computers. Looking forward it is my hope that this research can serve to guide practice within the evolving field of educational technology.

I seek answers to the following specific research questions:

- What role does the presentation and communication of information on a computer screen play in how students and teachers interpret and react to the information?
- What happens to the learning system when teaching and learning transaction is filtered through the medium of the computer? Specifically, what happens:
  - in the content of discussions?
- What role do student and teacher background attitudes, personality type, information processing style and self-perceived computer competency play in how those students and teachers perceive discussions, conceptualize knowledge, and perceive purpose of education?

**Research Paradigm and Rationale**

In considering an appropriate research paradigm for an exploration of this nature, the first broad decision that needed to be made was between a quantitative and a qualitative approach. Trochim (2006) locates the traditional differences between the approaches as one of purpose. Quantitative research is generally seen as confirming and deductive, qualitative as exploratory and inductive. A similar point is made by Creswell (2003), who cites additional elements descriptive of qualitative research in general. The one that is perhaps most salient, and the most relevant to the current purpose, is that this study is not seeking to confirm as much as to explore. While more can be made of the differences, this general idea of dividing the paradigms by purpose can serve well here as the initial distinction.

At the moment the concept of the system that I have proposed to exist is only suggested by the literature. There seems to be a general consensus that on-line classes are not the same as those taught face-to-face. The form is different. The presentation of the content is different and this may result in the perception of the content being different. The
nature of student interactions is different. While any number of these issues has been subjected to research, their interrelationship as a system has not. What is not needed as the next step is another quantitative study of a small part of a system that misses the fact that it is a system.

In the literature review I considered a number of interrelated themes that develop the idea of how people learn graphically with or without computers, and the general topic of computerized education, including a number of quantitative studies. These studies have proven to be inconclusive, perhaps because the nature of electronic learning, specifically the interrelationship between teacher, learner and material, is too fluid and adaptable to be atomized effectively. While it might be bold to say I have selected this approach, in truth, the approach has been selected by a recognition of the interlinked nature of the topic and of the method of inquiry. Again citing Creswell (2003) on the nature of qualitative research, I believe that only by providing a richness of detail regarding the participants, the environment and the material can the themes that exist in this system reveal themselves. From this, useful quantitative lines of inquiry may develop in the future. Therefore, this research was an interpretive consideration of the nature of the interactions in an adult course delivered entirely on-line.

In reviewing the literature, a number of studies were cited that linked content and presentation, content and thinking, delivery and presentation mechanism, and reactions to delivery and presentation based on culture and personality. While each of these studies document valid relationships within the subjects under the direct scope of observation, it is only when the studies are placed in close proximity to one another that an overall pattern becomes discernable. The students in an online environment, interacting with teachers and
each other in that environment, and dependent on that environment for the sending and receiving of their instruction and communication, form a system. The most appropriate way to study and understand the various interrelationships and dependencies within the environment is to use a systems approach to understanding the system. Indeed, anything less would tend to raise the individual elements into false relief and distort the conclusions because of a focus too narrow.

**Research Design**

The object of this research is to explore the electronic classroom, specifically to consider the interrelationships that may exist between the various participants and elements in that classroom. These interrelationships may be between teacher and students, student and student, or students or teachers and media. Each of these interrelationships may further interact with or be influenced by teachers, students or material. The research design needed to be sufficiently robust to discover these influences or interactions.

To achieve this end two complementary research strategies were used; one a method of analyzing and interpreting the data collected, the other a systematic way of collecting sufficient and diverse data to ensure the depth of detail needed for analysis. These two topics are related, and while it would be natural to first discuss data collection, then move to data analysis, in truth, the method selected for analysis not only determines how to interpret the data, but also what data should be collected. For this reason it is discussed first in overview, then in detail in the data analysis section of this chapter.
Two ideas for analyzing and interpreting data were taken from the qualitative literature. The first, adapted from Carspecken (1996), provides a five step method for working with the actual data collected during the research. The initial stages of his method provide for the collection of detailed research records, which he calls the “thick record,” and then for a systematic analysis of this information. In the final stages of his method Carspecken analyzes the data as part of a social system. This systems view bridges both analysis and interpretation and therefore, it is considered appropriate to move to a systems view in interpreting the results. Therefore, the second tool used to understand the data is the systems approach described by Patton (2002). This provides a unity between method and philosophy that should address overall issues of reliability and validity of the study. The specifics of how these tools are used to interpret and analyze data is addressed in the section on data analysis.

In order to provide a sufficiently thick record for analysis, the following elements were examined as potential contributors to the learning system:

Students

Personality (via P.E.T. instrument)
Learning styles (via Gregorc instrument)
Attitudes and reactions to on-line education (via interview)

Teachers

Personality (via P.E.T. instrument)
Learning styles (via Gregorc instrument)
Attitudes and reactions to on-line education (via interview)
Philosophy of education (via interview)
Materials and Media

Course Content (case presentations, course discussions, illustrations, other)

Course Presentation (Web interface, Usability)

Each of these elements of the classroom system was collected with as much detail as possible to provide the thick record necessary to analyze the environment. Student and teachers were interviewed to uncover feelings, attitudes and perceived abilities using the computer, and perceptions of students and teachers in the class. Two test instruments were administered to probe the nature of participant information processing. On-line class discussions and presentations were examined to compare actual performance with the perceived impressions of performance. Finally the learning interface itself is examined to determine if it adds to, subtracts from or is a neutral element of the class discussion, presentation and learning. The discussion of how these are analyzed will be held until the data analysis section of this chapter.

One element that should be addressed in this section is the selection of the personality instruments. The information about the students and teachers that was gathered using the two test instruments is related to the cognitive and informational processing domains and how this may interact with learning. The two instruments were chosen because of their ability to probe two complementary aspects of this personal information processing. James and Blank (1993), in discussing learning style instruments, break them into three broad categories dependent on the general area of measurement: information processing, perceptual modality or personality factor instruments. The instruments are used in a descriptive way only; the research questions
are not formed to address quantitative questions and there was no effort to correlate the information with other data.

The first such instrument proposed is the Personal Empowerment through Type (P.E.T.) survey, which was used to obtain information on the participants relative to their attitudes about the world and how they prefer to function in the world. This instrument is derived from psychological type theory and is related to the Myers-Briggs Type Indicator. It is based on Jung’s theory of psychological type preferences and consists of two core attitudes (introversion and extroversion) and four functions of living (thinking, feeling, intuition and sensing). Lin, Cranton and Bridglall (2005) describe these relationships:

- Introversion is an orientation to the self or inner world, whereas extraversion is a preference for the world external to the self. The two attitudes form a continuum; that is, any one person can be more introverted, more extraverted, or somewhere in between. Jung defines two judgmental or rational functions: thinking and feeling. The thinking function uses a logical, analytical process for making judgments, and the feeling function relies on value-based reactions of acceptance or rejection. In addition to judging, we also perceive the world around us, and Jung describes two opposing strategies for that process: intuition and sensing. With intuition, a person follows hunches, images, and possibilities rather than focusing on concrete reality; with sensing, a person uses the five senses to gather information about the world. The four functions of living, when combined with the two attitudes, form eight patterns of personality or psychological preferences, namely, introverted thinking (IT), introverted feeling (IF), introverted intuition, and...
Lin, Cranton and Bridglall (2005) used the P.E.T. instrument to study the interaction of personality and electronic environment, specifically course related asynchronous written dialogue and find “interesting and meaningful connections between personality type preferences and individual differences” in the online environment. Since my research focuses on the online learning environment as a system, it is hoped psychological type analysis, in combination with the interview results, may provide some additional insight into the participants and prove relevant to my research.

The Gregorc Style Delineator (Gregorc, 1982) is the second of the two tools selected to provide additional background information on the learning styles of the research participants. It probes actual information processing preferences. The basic premise of the Gregorc instrument is that the mind has channels thru which an individual receives and expresses information. Termed “mediation abilities,” they express power, dexterity and capacity of the individual’s perception and ordering of life’s experiences.

The Perception channel describes a continuum that ranges from Abstract to Concrete. The Abstract quality enables one:

…to grasp, conceive, and mentally visualize data through the faculty of reason and to emotionally and intuitively register and deal with inner and subjective thoughts, ideas, concepts, feelings, drives, desires and spiritual experiences (p.5).

while the opposite pole, concreteness, enables one to:
…grasp and mentally register data through the direct use and application of the physical senses. This quality permits you to apprehend that which is visible in the concret, physical world through your physical senses of sight, smell, touch, taste and hearing (p.5).

The second channel measured by the Gregorc instrument, Ordering, concerns the arranging, referencing and disposing of information. The Ordering channel describes a continuum labeled Sequence at one end and Randomness at the other. The Sequence quality disposes the mind to:

…organize information in a linear, step-by-step, methodical, predetermined order…to naturally sequence, arrange, and categorize discrete pieces of information (p.5)

The converse quality within the Ordering channel, Randomness,:

…disposes your mind to grasp and organize information ina nonlinear, galloping, leaping and multifarious manner. Large chunks of data can be imprinted on your mind in a fraction of a second…This quality enables you to deal with numerous, diverse, and independent elements of information and activities. Multiplex patters of data can be processed simultaneously and holistically (pp. 5-6).

The channels and abilites revealed through the use of the Gregorc instrument are reported as 4 distinct transactional abilites:

Concrete/Sequential   CS

Abstract/Sequential   AS
Although each individual possesses all four qualities, the predominant qualities revealed through the instrument indicate an individual’s orientation to life. In the more specific purpose of this research, it is believed that the transactional ability channel information reveals the individual’s orientation to learning and to computerized information presentation. In combination with the other information revealed through the various data collection methods this presents a more robust view upon which to attempt to understand the educational system. The specific relevance of this instrument to this research is the work done by Ross and Schulz (1999) to correlate character types and preferences in computer assisted instruction. Their research has found that some types do better than others when learning is moved to the computer. It is believed that the Gregorc instrument, in combination with the P.E.T and with the participant interviews revealed a more robust understanding of what is taking place in the electronic classroom.

Gallagher, Bridgeman and Cahalan (2002) have noted gender based differences in results between tests administered on computer as opposed to the same test administered using paper and pencil. Although in this instance there were no gender issues that were of concern, it was still prudent to have avoided administering an instrument designed to probe attitudes toward the computer on a computer. Because of distance issues, the personality instruments were administered by mail and returned to the researcher. The teacher also completed the personality and cognitive style inventories.

The final element that needs to be discussed as part of the research design is that
of the course delivery mechanism and materials. In order to assess the content and interactions with students several components were documented concerning the materials.

**Data Collection**

Data collection for this project consisted of three discrete components. The first was the administration and compilation of the personality instruments. The second was interviews with class participants, and the final component was the collection and analysis of the content, graphics and interface that comprise the on-line class environment. Each of these components presented a number of challenges related to the collection of data which shall be considered here.

The study consisted of four students and the course instructor. Each participant was interviewed twice. The interviews were administered at two points in the semester. The first was held close to the start of class and had as it goal the determination of how students and teacher viewed the upcoming class in terms of expectations and possible apprehensions. The second was conducted shortly after the conclusion of the class and was used to assess how students perceived the class, and their own learning within the on-line class structure. Interviews were conducted by the researcher and were audio taped.

The collection of online data was accomplished using several different methods, since the data is analyzed in two different ways. The content of the class discussions was extracted from the interface and converted to text, which was then examined in much the
same way that the interview data that was reviewed, that is, it was analyzed using only the researcher’s ability to extract pattern and theme. After examination of the data, it was determined that this was sufficient and no Computer Assisted Qualitative Data Analysis was used.

The collection of data for the analysis of the computer interface also required screen captures of specific pages of the website, and of the navigational structure as it existed in a given time. The form of the class was preserved relative to the content. That is, if a student discussion takes place in an on-line forum, the screen geography, layout of graphics elements and what the student or teacher saw and how they interacted with the environment was preserved. Included in this was a record of when in the course the interactions took place, i.e. was this discussion at the beginning, middle or end of the semester. The actual layout of the screen while various functions of the learning management system are invoked was recorded, for example, how the screen was organized when creating a new contribution to a discussion list, or reviewing a previously posted discussion item in context. This was included when considering whether such items as how the students read discussion contributions, as stand alone text documents, or as “threaded” contributions to a larger entity? In order to preserve these elements, screen shots were taken of the Learning Management system in action, for example, if an in-progress discussion had multiple threads with multiple contributions. The class was monitored and captured for later analysis, along with good metadata regarding time and context. Fortunately, this was recorded as part of the discussion threads, so it was part of the record anyone can see when they audit the course. This resulted in a great deal of data, however, while it was anticipated that the learning management system would
provide the mechanism for capturing the course information in a usable format, such was not the case. Discussion data was rendered without any breaks or indentation, a feature that worked against both the students who wished to print the discussions and me.

A final component of the data collection for this part of the research was conducted during the participant interviews. How a person accesses the learning management system was considered as part of the total system. By this was meant the technical details of the computer, i.e. processor speed, memory and monitor size and type, and of the network interface, i.e. dial up access at 56Kbs or broadband access at >640Kbs. The details of the computer and network equipment were probed during the interview process, as well as any user definable settings that might have altered or affected how the system worked, or how it was perceived by the student.

Participants

The criteria for selection of participants for this study were in large part already defined by the nature of the study. They will be reviewed here. A learning system presupposes that all components, the students, teacher and material, contribute to the overall system, therefore each of these elements presents selection criteria that need to be considered to benefit the study. The overall consideration is that the clearest and cleanest way to obtain a view into this system view would be to study these components within the same online class. Once this decision was made, the following criteria presented themselves within that class.

While to this point reference to either faculty or students has referenced both
groups, when considering the selection of participants there was at least one difference that must be drawn. The faculty member was experienced in teaching an on-line course. There was simply too much that was dependent on the faculty member’s ability to manipulate the environment to have considered a novice on-line instructor. Technical inability on the part of the instructor would have seriously compromised the validity of the study.

On the other hand, no such requirement of experience existed for the students. In fact, to have placed such a requirement on students would have served to compromise the validity of the study from the opposite direction, pre-selecting only those who were comfortable with on-line learning. One desired criteria for the selection of participants for this research was physical and geographic accessibility. This would have made them available for those portions of the study that require face to face contact. However desirous this may have been during the design of the study, the nature of this on-line class made it impossible. The size of the class was small and the hoped for selection of 5-7 candidates was reduced to four as the number of volunteers was not forthcoming. That subset was geographically inaccessible. This was something that could not have been determined prior to the start of class. Since a suitable pool of local students was not available, the interviews were conducted by telephone, and the learning instruments were distributed and collected by mail.

The third element of the system was the course material. While the details of the presentation of that material were a matter of concern, it was assumed that the selection of a course management system was beyond the scope of this selection process. Such decisions are usually University-wide and therefore larger than any single course. The environment that is used may be modified by the instructor and while such modification
were noted, the course management system did not play a role in the selection of course. The concern was for the selection of a suitable course of study. The selection criteria for the ideal course for analysis was for one in a topic that was concrete, somewhat technical but not computer related, and a course that had been developed and refined over time so that the materials benefited from some refinement. The justification for a concrete topic was that it would be simpler to assess the effectiveness of graphics attempting to explain some real object or process, as opposed to a philosophical construct. The reason for the exclusion of computer related technical topics, such as computer programming or electronics repair, was to avoid accidental selection bias based on technical proficiency or desire for technical proficiency.

A course that met these requirements was sought from the World Campus on-line learning division of Penn State University. While in theory any on-line class from any institution of higher education could have displayed the system characteristics, the selection of a local institution facilitated the communication and administrative aspects of the research. For example, there was no concern about conflicting administrative requirements for protecting the research subjects. A faculty member of the world campus was found to take part in the study and in consultation with him a suitable class was selected.

Data Analysis

It takes little imagination to realize that analyzing the data that was collected in a project of this type was a complex and daunting exercise. Each of the different data sources needed to be analyzed first as an independent entity, and then in relation to possible
interactions with the other data. While a large and difficult task, however, it did benefit from the methodology proposed originally by Carspecken (1996). This methodology, in combination with Patton’s (2002) system view provided both a method of analysis, and an interpretive framework to view the data. I first consider the large issue of a framework for interpreting results, then describe the smaller details of the actual data analysis.

Carspecken (1996) proposes a five step methodology under the umbrella of critical ethnography. While this study was not posited to use critical ethnography as an underlying philosophy, this method did provide a way to integrate the various data sources into a single coherent entity useful as an object of study.

Carspecken (1994) has developed a methodology for conducting qualitative research that addresses many of the issues that this study would encounter. While Carspecken is firmly grounded in critical theory, with its implicit call to action and political viewpoint, many of his observations about the holistic nature of this project, the validity of data collection and the preliminary interpretation of results are apropos to a study of a system:

The contexts of action and experience, moreover, are holistic: they are not in essence a set of secrete terms readily translatable into “variables.” If they were, then the problem of context could be reduced to the examination of how many variables “interact” with each other. A number of statistical methods have been developed to explore variable interactions. But very often the holistic quality of action contexts simply cannot be captured through a model of interacting yet discrete factors. The factors are simply not discrete by nature, so making them
discrete conceptually can greatly distort our understanding of what is taking place (p. 25).

It is of note that Carspecken describes his method as critical ethnography, and while there are some incidental observations that may relate to critical theory, this study is firmly grounded in systems theory. This apparent mismatch is discussed later in the chapter.

These aspects of the class selected for study were selected based on the need to illustrate the system postulated to be in play in the typical on-line class. Those elements are the three general areas recognized as present in most classes: students, teacher and class content. Each of these general areas was further expanded. Students were interviewed to determine their qualitative view of the class content, on-line learning and subject matter. They also provided responses to two personality/learning instruments to consider how their core “learning personality” reacts to online learning. The class instructor was interviewed to determine their qualitative view of the development and delivery of materials, on-line learning and general subject area. He was provided with the same two personality/learning instruments to consider how his “teaching personality” works within an on-line environment. A further area that may be unique to this study is a consideration of the content of the class, with that content further divided into two elements of actual on-line instruction, and the course management system that provides the delivery mechanism for that instruction.

Carspecken (1996) considers the first stage in his methodology as the building of the primary record. He describes this as a “thick” (p. 44) record, in that it contains the
detailed and objective observations of the subjects of the research within the environment. These detailed observations provide both the detail necessary for further analysis and a record that can be described as valid and unbiased. The data collected over the course of this project approached this thick description from a new angle in that in an on-line course all interactions can be recorded and reviewed at a later data. The challenge was to organize this data in a useful manner.

The second stage of the methodology is described as the preliminary reconstructive analysis. The researcher begins to add low level inferences to the primary record and to begin the process of reconstructing meaning from recurrent patterns in the primary record. The benefit, and challenge, of the wealth of data sources in this research was to keep within the field of view all of the data, to allow for the interaction of this data and to observe and note the patterns that formed. At an early stage in the research the researcher had access to student and teacher psychological instruments, actual class presentation system and course materials, actual and detailed class interactions, and the preliminary student interviews. In this stage of the research these materials began to coalesce and themes to emerge.

The third stage of Carspecken’s methodology is described as dialogical data generation and in the context of this research is something of an adaptation of the methodology. Carspecken would place the qualitative interview after the initial data collection and preliminary data analysis. Here, one of the elements of that primary data collection was the initial interview with the participants. This was not perceived to be a problem, however, since the initial interview, conducted early in the class, was clearly in the context of compiling an additional component of the thick record. The second interview, conducted shortly after the end of class, more complied with Carspecken’s view
of the qualitative interview as a method of democratizing the research process and allowing the subjects to challenge and comment upon the observations of the researcher.

This second interview was open ended and designed to explore how the students and teacher viewed the course. This required careful attention to the questions in order to avoid biasing the research into confirming the initial observations of the researcher. As Patton (2002) has noted:

The purpose of gathering responses to open-ended questions is to enable the researcher to understand and capture the points of view of other people without predetermining those points of view through prior selection of questionnaire categories (p. 21)

The goal of these participant interviews was to understand how and why the people involved in this system of on-line learning experience and view this particular class and how it fit with their ideas, conceptions and experiences in other on-line classes. The questions here were created and framed as a result of an initial data analysis, yet be open enough to allow the subjects to present contradictory data if they so perceive it.

The final stages of Carspecken’s theory move clearly into the analysis of the classroom interactions discovered in the previous three stages as a system. Carspecken describes it thus:

Stages four and five concern the complex relationship existing between the social site (or group) of focal interest and various other social sties (groups). These relationships have to do with system factors. In stage four the idea is to discover specific system relationships, such as relationships between a school and its
surrounding community, or a youth culture and the popular media. In stage five
the idea is to consider one’s findings in relation to general theories of society,
both to help explain what has been discovered in stages one thru four and to alter,
challenge and refine macrosociological theories themselves (p. 172).

Several items are of note, since they move this from the area of critical
ethnography, where Carspecken would situate the methodology, into a more general
systems theory, which this paper is positing. Carspecken views the system in the macro –
as something that extends from the school to the community – while this paper takes a
micro view – that the system exists within the classroom, and is formed by the
participants and the media they use to communicate. Patton (2003) expresses this as:

…a whole that is both greater than and different from its parts. Indeed, a system
cannot validly be divided into independent parts as discrete entities of inquiry
because the effects of the behavior of the parts on the whole depend on what is
happening to the other parts. The parts are so interconnected and interdependent
that any simple cause-effect analysis distorts more than it illuminates (p.120).

He further, and perhaps most relevantly to the current project observes, “At the
system level…there is a qualitative difference in the kind of thinking that is required to
make sense of what is happening (p. 122).

One final note should be made here regarding the move from Carspecken’s to
Patton. Implicit in the use of the word “critical” in his methodology is an implication that
the system to be discovered is somehow unbalanced or unfair. Such a view of the system
here would be inappropriate since we did not yet know the relationships within this system, how they interact, or if they are beneficial to the participants.

What remains to be discussed in this section is some description of the various low level data analysis, that is, the actual mechanics of interpretation. The analysis of the personality instruments was the most straightforward. The selected instruments were easy to score, and the vendors provide validity. The participant responses were therefore analyzed based on the criteria supplied by the test vendors, which provided the first point of analysis, the raw personality inclinations of the various participants as to how they process information and their general personality type. This proceeded based on the norms of the selected instruments, but in the case of one of the instruments, with the additional help of the test author.

The analysis of the initial interviews took a longer time based on the previous discussion of Carspecken’s methodology. The interviews were transcribed by the researcher as part of the initial analysis. The same process was followed with the second interviews, however this second interview was considered more carefully, since it contained reaction to the completed course, and the reaction of the participants to questions based on some of the initial interpretation of results. All initial interviews were transcribed prior to the transcription of end term interviews.

The final component of the system under consideration was the data collected from the computer, that is, course materials, discussions, and other interactive aspects of the class. The dual components of this data were subjected to multiple methods of analysis. The first involved reviewing the content of the discussions, the second the form. The analysis of the content of the discussion was conducted in a manner similar to the analysis
of the interview data. The analysis of the on-line components of the learning system, the
screen layouts and logical progression through the course was conducted according to
criteria based in part on the published work of Kordel (2007), a work which synthesized
much of the literature discussed in chapter 2, including Tufte (1990, 1997, 2001), Nielson
(1998), Flanders (1999), Yale University Center for Advanced Instructional Media (2002),
as well as additional works from the fields of information design. In summary, a system
was developed to analyze the readability of web pages that is a corollary to the readability
index of a text passage.

It is necessary for the purposes of this dissertation to move these general guidelines
and observations to a replicable process. An extensive description of the actual data and
initial analysis is included in Chapter 4 of the dissertation. In chapter 5 these initial
observations are synthesized into the system. For the purpose of this introductory
discussion of data analysis a brief overview is provided here. The first stage in the
analysis of a page was to assess those components that are part of the static infrastructure
of delivery, for example the computer operating system, the browser application, or the
learning management system. The second stage was a consideration of the actual course
content, those items that comprise the lesson presentation or course interaction.

To make this clear, and as we will see in the next chapter, the Angel course
management system used by Penn State consists of a static frame that borders the course
content. This course content consists of the actual content contributed by students and
teachers, including any graphics, text, and illustrations. The most common elements
found in this category are the syllabus, downloadable document files, class
announcements and discussion threads.
The infrastructure of the page consist of the inherited elements of the interface, the untouchable components of a page and those things which the normal user accepts as unchangeable. Among these is the placement of the standardized navigational elements, such as the links to the Penn State homepage and library system on the course login page, the fact that there are often multiple links to the same site in different locations on the screen, best described as navigational synonyms. Relative to this layout, some attention was paid to Heath’s (2000) updated definition of literacy: text can be both content and hyper-link; graphics can be both graphic interpretation and navigational map. Multiple content levels result from the presence of multiple hyperlinks and it cannot be assumed that everyone can decode everything with equal facility. The analysis of the readability/decidability of a learning oriented web page is examined in terms similar to those used in assessing the readability of a text passage.

There are additional elements that need to be included in the analysis of the passive components of the screen. Tufte (2003) points out that merely rendering content in PowerPoint changes the content, reducing complex relationships to ones of membership, sequence or hierarchy. The resolution of the screen limits the complexity of graphics rendered there. McLuhan (1964) has explored the changes in scale that the introduction of any new media has on content. A consideration of these elements was included in the final analysis.

An additional concern that must be considered is that the environment may consist of two different categories of objects, those things that can be and have been changed by the instructor to create a more hospitable learning environment such as color palette, choice of graphics and labeling of links, and those things that cannot or have not been changed,
such as login procedures, sub-menu location and structure and discussion thread presentation. Some care was needed to keep these two subjects separate when appropriate, but also to consider the idea that the interaction of content within environment may effect the overall perception and effectiveness of the class.

The Learning System

Some narrative may help to illustrate the envisioned interactions between the various elements. The common and unifying element is the course content. It is why the members of the class have chosen to associate themselves. Students and teachers both approach the content of a class through the filters of their cognitive style and personality type. Presumably the students are there to learn and the teacher to communicate some subject area expertise; however this is not a direct interaction. As has been noted, each person has a particular learning style, and a preferred method of processing information. Each medium of communication filters the communication that passes through it. So both students and teachers must approach course content through the multiple filters of personality type, cognitive style and communication medium, and each of those are
interacting with each other. As information passes from teacher to student and from student to teacher, both are filtering the information. This is a type of transactional distance similar to but not quite as described by Moore, but one that is more in keeping with the interactions that actually exist. Perhaps a better descriptor is “cognitive distance.”

The result is that a series of interactions flow from a student viewing a lesson on the web. If the student’s personality type and cognitive style are matched with well designed course material presented in the proper medium the student can learn. A mismatch in any of these areas will create a barrier to learning, a cognitive distance that must be overcome. The size of the barrier and the amount of effort needed to overcome it will depend on the amount of the mismatch.

Validity

There are several concerns that needed to be addressed in the design of this study. These centered on the collection of data and the reporting of results and they needed to be addressed in order to provide some measure of what is labeled validity to this work. Those concerns are the credibility of the research, the transferability of the results, the dependability and confirm-ability of the research. Hopefully each of these concerns has been addressed in the narrative and description that has been created to this point. In addition, validity is discussed by Carspecken (1996) as integral to the data collection and analysis methods of Critical Ethnography. However, each of these topics is addressed here in the specific.
Lincoln and Guba (1985) recommend several methods to ensure credibility. Among those that they recommended and which were employed in this study were the idea of prolonged engagement and triangulation of sources. This study was designed to explore the interactions of an on-line class over the course of a full semester. Data collection started shortly before the class began and ended after the final session. Data was collected from multiple sources, including personal interviews with students and faculty, on-line discussions and assignments by students and faculty, the content of on-line presentation of material, with corresponding screen captures of the actual presentation. Additionally, Lincoln and Guba (1985) suggest two methods of ensuring data credibility that are built into the dissertation process that define the purpose and structure of this document, that of peer debriefing and of referential adequacy. These duties are shared in varying degrees by the members of the dissertation committee.

The issue of transferability of this research is, from one view, a measure of the usefulness of the research. If viewed from the extremes, my research can be considered either the idle inquiry of a graduate student in need of a research topic, or the logical next step in considerations of the computerized classroom and of how people use this tool to facilitate learning. Fortunately, Lincoln and Guba (1985) remove the onus of making that decision from my shoulders and place it squarely on those of the potential appliers of my research. The responsibility that is on my shoulders is to provide as much detailed information as possible to address any concerns that may arise regarding transferability. It is hoped that the scholarship demonstrated to this point provides some guidepost that assures that future related scholarship is of sufficient quality to address the concerns of
transferability, and that the wealth of related data on the system under consideration
provides an adequate backup to address the same issue.

The issue of dependability of data is interrelated with the credibility of the data
(Lincoln and Guba, 1985). To ensure the dependability of the data it was necessary to
keep detailed records of the research. As has been noted, this entailed a large amount of
very diverse data: recorded interviews, interview transcripts, personality instrument
results, discussion group transcripts, class presentations and web site navigation and
screen shot records.

In addition, a good working relationship with my dissertation chair and other
committee members provided a good background to the research and interpretation of the
results, and thus contribute to the dependability of the study.

Lincoln and Guba (1985) recommend adhering to the Halpern Audit trail as a
method to ensure confirmability. That method consists of maintaining six different types
of data:

1. Raw data
2. Data reduction and analysis products
3. Data reconstruction and synthesis products
4. Process notes
5. Materials relating to intentions and dispositions

As has been noted above, the sheer volume of data that needed to be
recorded and maintained required some method of organization. Initially, a database
system seemed necessary, but as the research progressed it became clear that the varied
nature of the data allowed for organization within each type. For example, the audio recordings were maintained on tape and as digital files. The transcripts were maintained as text files. This organization by type, and the inclusion of the data in the reporting of the results provided much of the data suggested by the Halpern audit trail. In essence, the presentation did become an integral part of the research. I believe the multiple examples of how data was interpreted within the text of the dissertation to prove the points being suggested. In other words, the nature of the research required that I “show my work” to address not only issues of confirmability but all issues that may arise that question the validity, reliability and relevance of the research. This was done.

Summary

This chapter has focused on the nature or the research, participant selection, data collection and data analysis. The goal of this chapter, and of the overall paper to this point, has been to present the system under discussion as a system, worthy of research and analysis as a critical component of the modern educational environment. It is important to keep in mind however that this system is a collection of discrete components that are able to be analyzed independently; in fact, without a constant mindfulness of this dual nature of the subject the task might seem too large and too daunting. Instead, the view should be that while conceding that it is large and daunting, the system view is essential for a complete understanding.
Chapter 4

Research Results

Overview

The purpose of this study is to examine the consequences of using computers as teaching aids and to explore the factors that may lead to those consequences. It tests the idea that far from being a passive information delivery and communication tool, the computer adds to, subtracts from, and changes the nature of information presentation, comprehension and communication.

The research questions that define the boundaries of the research are:

- What changes occur for teachers and students when the learning transaction is extended onto the computer? Specifically, are there changes:
  - in the content of discussions?
  - in the conduct of discussions?
  - in how students and teachers conceptualize knowledge?
  - in how students and teachers envision the purpose of education?

- Does the presentation and communication of information on a computer screen affect how students and teachers interpret and react to the information?

- Do student and teacher background attitudes, personality type, information processing style and self-perceived computer competency
affect student discussions, conceptualization of knowledge and the perceived purpose of education?

The answers to all these research questions are viewed as being inter-related and part of a complete system. The challenge is to probe the subjects adequately and in a way that will reveal the inter-relationships.

The methodology guiding data collection is adapted from work done by Carspecken (1996). The primary element borrowed from Carspecken’s work is the idea of the “thick record,” a detailed compilation of the raw observations and detailed interactions of multiple facets viewed within the environment under study. In addition to the somewhat mundane aspect of simply making sure enough of the environment has been adequately observed, the method addresses aspects of the overall validity and verifiability of the research.

The three foundational elements of the class to be studied are the students, the teacher and the course materials. These elements are further subdivided in the following ways to enable the creation of the thick record:

Teacher

Initial Interview

Learning Style Instruments

PET

Gregorc

On-line observation
Post-Class interview

Students:

Background

Initial Interview

Learning Style Instruments

PET

Gregorc

On-line observation

Post-Class interview

Learning Materials

The Learning Management System

Interface Content

Presentation

Class Materials

Content

Presentation

Each of these elements is examined in this chapter and includes sections on:

- data collected on the components

- an analysis and interpretation of the independent elements

The evaluation of these data elements that comprise the thick record are conducted using several methods. Initially each element is interpreted in isolation from other factors. During this phase for example, responses to the
personality/learning instruments are coded using the interpretive keys established for each instrument. The various interviews and class interactions are then considered using a qualitative inquiry to determine individual themes and ideas held by members of the class. While these interviews with student participants revealed several common themes, these themes are initially be presented as independent observations prior to being synthesized as part of the larger system.

The in-class material, both on-line content and the form of the learning interface, is analyzed using criteria developed by the author (Kordel, 2007) and included as Appendix B of this study.

A final section of the chapter presents a preliminary synthesized analysis of the elements. Further discussion of this synthesis will be undertaken in the final chapter.
Teacher: A–

Background and Initial Interview

The teacher of the course selected for study, one of the advanced classes in the turf management program, is A–. He has taught this class for more than 10 years, both as a traditional course delivered on-campus, and as part of the distance education offerings of the world campus.

The purpose of the initial interview was to get a feeling for how the instructor viewed on-line learning and his general reaction to the differences between traditional courses and on-line/distance courses. As a general overview to the interview and in order to give the reader a feel for that emotional component of the interview that cannot be adequately conveyed, the tone of all the answers was thoughtful, but also enthusiastically positive. A– likes what he is doing and it shows, not only in the content of his answers, but in the delivery.

One of his courses became the first presented as a distance learning alternative at the World Campus. As he explains:

The reason why my course was the very first one on the world campus was I had developed all the learning resources beforehand. All of my instructional modules, all of my decision cases were already developed and so putting them into the Course management system was a relatively simple affair. Initially we used WebCT, now we use our own system, Angel. But it
was simple a matter of taking what I already developed and subsuming it within that course management system.

A– initially describes the differences in teaching between on-line and in-class as something the reader might anticipate:

Like most people I basically tried to mimic what I was doing in the classroom on the web. But what I discovered over time was the web is different than the classroom. There are some things you cannot do on the web that you can do in the classroom, then I discovered that there are some things you can do on the web that you can’t do in the classroom. So, in other words, each arena had its advantages and disadvantages.

Among the differences noted by A– is that on-line, both students and teacher are not time constrained, but more importantly, resources can be developed that more closely match the students interests and abilities. What becomes apparent in talking with A– however, is that the previously conceived of distinction between the two types of instruction is fading. He notes that there is now an on-line component to most classes. As an instructor he views this is a good thing:

… in the classroom to an increasing extent (I) use on-line learning resources to enhance the quality of the classroom instruction. Because it enables you to personalize it, to reach those students and address his or her needs in a fashion far better than we could historically, and yet still preserve the excitement of the classroom interactive experience. So that’s what has made me so excited about it, about being a teacher again, the web
has given me the opportunity not only to extend the reach of my teaching to people who are location bound, but to enhance the quality of my resident teaching by adding those resources that help those students who can benefit.

One change that A– notes is the way instruction is targeted. Previously, without the enhancements offered by the web, it would be necessary for the instructor to find the intellectual center of the class, that place that was in the middle between the quick and the slow, the bright and the not so bright and recognizing that such a methodology has inherent drawbacks of overwhelming those at the bottom, and underwhelming those at the top:

On the web I can create learning resources that don’t necessarily aim at the middle, but can reach a broader diversity of students by the way I’ve created that resource. And then begin to incorporate those now into my instructional modules by incorporating loops into the modules, by taking them in another direction if they need that as a clarification to understand a difficult concept.
Learning Style Instruments

PET

Based on the interpretive guidelines for the instrument, the first thing that becomes apparent is that A— seems to be more extraverted than introverted. This is determined by comparing the right and left sides of the results graph. The bars exhibit a definite preference for extraversion. Using those same guidelines, this time comparing the top graphs with the bottom to determine whether A—
processes information predominantly judgmentally or perceptively, we see that the judgmental is pronounced, although in this case the split is far less pronounced.

Further exploration of the results from the instrument reveal a learning type whose dominant function is Extraverted Intuition and whose auxiliary function is introverted thinking. Using these results for the narrow purpose of understanding how A— will interact in an on-line class presents the necessity of extrapolating several of the characteristics in an attempt to see how they interact.

A—‘s dominant function is that of Extraverted Intuition. Several items stand out as characteristics of this function when considering A— as the teacher of an on-line class and as expressed in the initial interview. “These are the people who see what can be done with the old dilapidated house, what will come into fashion…They are constantly on the lookout for new opportunities to exploit and new fields to conquer (p.9).” The words used to describe them are initiators, promoters, visionaries, and champions of causes.

The thinking function adds to this a view of the world that considers it a rational and logical place, and one that allows theories and models to work well on that basis within the real world. One descriptive sentence is that they “continually work to establish order in their personal and professional lives (p.3).” One caveat based on type is the thought that they might be more interested in thoughts and ideas than in their students.
The Gregorc Style Delineator shows A—to have as dominant the Concrete Random (34), and Abstract Sequential (30) channels. These two channels are at opposite ends of the graph, and their characteristics will be considered relative to those traits of note in an on-line instructor. That A—teaches the class in both the on-line and resident modes is also of interest.

When describing how the dominant Concrete Random orders the world, an image is created of three-dimensional patterns. Although events may occur in a linear fashion, numerous outside variables can affect those events. The perception of those events may be significantly influenced by intuition however:

The Concrete Random’s thinking processes emphasize intuition and instinct. The instinctual processes are used to register the concrete world as
a starting point. Then his primary ability, intuition, is used to see into and beyond objects in the concrete world to try to identify their nature and possibilities (p. 35)

The result of this may have a direct affect on the CR’s thinking processes:

…his mind can make the transition from fact to theory with amazing speed, making “intuitive leaps” in exploring unstructured problem-solving situations. This same uncanny ability manifests in making the transition from theory to fact and can leave the concrete Random unable to explain his intervening steps or the source of his solution (p.35)

**On-Line Observations**

Of the several motivating thoughts that occurred around the observation of class interactions on-line, one of the primary ones was that on-line interaction would give a good example of how people came to understand one another. In considering A—‘s contribution to the online aspect of the class, it quickly became clear that he viewed this aspect as something relatively “hands-off” during the class. Each group was required to submit 4 cases, and for each member of the group there would be a personal and public critique of the case material. One such sample is included here:

Re: revised Blue-green algae case study

by A-- at 10/29/2007 1:07 PM
Dear D——: In the Blue-Green Algae case, I wanted you to understand the relationship between various environmental conditions and turfgrass species on the incidence and severity of algal formations and the associated damage that occurs. The Netherlands is in a temperate-oceanic climate with mild winters and cool summers. Colonial bentgrasses can do fairly well in this climate; however, fine fescues generally don't persist and annual bluegrass is likely to invade and eventually dominate the turf, especially where drainage is poor and sunlight intensity deficient. In this particular case, internal drainage is not very good, due to the finer-textured sand layer resulting from topdressing, and the temporary water table at the base of the California-Style green that may result in higher moisture in sections of the green between the drainage pipes. Also, sunlight intensity is limited by the proximity of trees nearly surrounding the green, resulting in the kinds of unfavorable growth effects seen in the Oak Hill case. The intense traffic to which this practice green is subjected causes especially severe wear on this rather delicate turf. While selected trees can be removed to improve light intensity and airflow, an appropriate series of corrective measures are needed to effectively deal with the textural layering caused by topdressing with finer-textured sand. One might employ intensive HTC, removal of cores, and backfilling with coarser sand to provide bypass channels through this troublesome layer. In your answer, you covered many of these points but didn't point out the effect of topdressing with a finer sand on infiltration. You have been awarded 44 out of 50 points for this case. A——
As will be seen in the consideration of most of the research subjects, the on-line discussion forums were almost single-mindedly focused on the topic of the class. While this is worthy of consideration as an overall component of the system, it does not merit extended or detailed citation of the actual class interactions. This is especially true in the case of the instructor, since in this particular case it was both intentional and a strategy discussed during the post class interview.

Post-Class Interview

The purpose of the post class interview was twofold. On one hand it offered the opportunity to probe deeper in to the thoughts and beliefs of the subject in light of the personality profiles, and it was a chance to explore some of the issues that came up in the actual class discussions.

The first item of note relative to this study, and to the previously cited literature on concept mapping related to the actual inclusion of concept maps in the class curriculum. When asked about how and why he used them, A—explained:

I don’t use those in my resident courses because I have the ability to walk them thru the analytical process and the process of decision making. But on-line I had to come up with some vehicle that could help them structure an analysis and delineate the various decision options. So some years ago I began using concept maps as a way of structuring an analysis. Then the written analysis is simply a reflection of what the map says. By the same
token the selection of strategies and the implementation of them in the
action plan is a reflection of what the decision tree does.

In considering the role and function of the discussion groups in the class,
which were actually the primary instructional methodology and means of
communication, there were several interesting points revealed in the interview.
First, although several students noted that they printed the discussion forums in
order to review them later, A—was not aware that such an action in the Angel
course management system would remove all line spacing and convert any
discussion text to a single large block of text that might span 2-3 pages without
pause. When asked about this, he responded:

No, because the discussion forums are really designed, not so much as a set
of notes for later, although one could do that, but designed as an action
vehicle that binds the teams together day by day thru the course of the
semester. In other words, you have a problem, you attempt to solve it, you
then look at what your teammates have done, you pose questions, you
answer questions posed to you, and based on that discussion, you come up
with a final answer for my critique and evaluation. So it’s a very much in
your face dynamic day to day thing. And if one wants to document that
after the fact that’s fine, but that’s more a set of notes for later reference
rather than of key importance during the instructional process itself.

In the discussions themselves, A—maintained an intentional distance from
the students. This was intentional; he did not regularly participate in the middle of
the discussions, preferring to wait, to comment on the various student contributions
to the case studies. However, in considering this procedure in the larger and more general sense, he opined:

What I’m going to do this semester and in the future is in the middle of the discussion be a questioner myself. Because in some cases the quality of the questions is pretty good, and other cases they’re so simple and unoriginal and lacking so much in substance that I feel that I need to model how to ask good questions. Rather than try to figure out on a case by case basis how to do that I thought I would just routinely participate in each one. So every time we get into the discussion phase I will pose a question. I have standard stock questions available to do that. That way I just grade them on the response to all of the questions, including mine. I decided that’s a change I need to move to because this semester I was sort of light in terms of my involvement in the discussion. I decided that’s not a good thing. I need to be more intimately involved but in a more routine way rather than an especially structured way.

Perhaps the most interesting point raised in the interview was the overall view of on-line instruction. When asked if he would like to have face to face access to his students for some period of time, whether a single day, or perhaps a few days, the following response was forthcoming:

I always feel that way...always feel that way. The thing is when you do on-line teaching you come up with ideas that you employ to some extent in your resident teaching. So if you’re always enriching your resident teaching
with things that you learn from the on-line experience then the on-line is always the second best. Even though it may be quite effective, it’s still the second best. So if I had my druthers I’d always love to have them in for a week, or for a few days. But that’s just the reality of it, I can’t so I have to make the best of it.

When probed on this issue of distance learning being second best, the response reconfirmed the initial statement:

As a general response I’d say no, because, simply because anything that you use on-line you can provide to your resident students. So, if you’re talking about really good learning modules, like some of the ones I’m experimenting with that are non-linear and very complex, you can provide that to the resident students as well, as an adjunct to what you do in class, or to obviate the need to do as much lecturing and so on. So on-line can never be better than resident, because in resident you can employ anything you employ on line.

Summary and Findings

The second stage of Carspecken’s methodology is to consider the elements that comprise the thick record and to consider what they mean, and if any of them
inform the others during that analysis. When one considers how all the information collected on A—begins to interact, some basic ideas begin to coalesce.

The learning style instruments provide a starting point for this consideration. The PET described him with words such as “initiator, promoter, visionary, and champion of causes.” This comes through clearly during the first interview. Although not directly relevant to this study, the initial interview elicited the following comment on the role of older faculty:

The beauty about online teaching is that I can continue it into retirement. I will continue to do this for years after I retire. …Older faculty do have something to contribute, they have insight, they have perspective, and if you can hold onto them, and other people can benefit from them, despite the fact that they have moved into retirement, that’s going to improve education.

That same interview also strayed into the role and nature of the university. While the comments themselves are of note, what is actually more of interest to this study is that those topics were broached as the result of an “intuitive leap” during a discussion of distance education. This ability was noted in the interpretive instrument for the Gregorc Learning inventory:

…his mind can make the transition from fact to theory with amazing speed, making “intuitive leaps” in exploring unstructured problem-solving situations. This same uncanny ability manifests in making the transition
from theory to fact and can leave the Concrete Random unable to explain his intervening steps or the source of his solution (p.35)

The personality instruments may provide a window into why A—feels that on-line education is second best. His natural tendency and ability to make intuitive leaps may be suppressed in favor of an introverted thinking style that is more conducive to online education, however inhospitable it is to his information processing needs. There is no indication that this has hampered his ability to teach however. No students noted any inability to follow his logic, nor were any such unfathomable intuitive leaps entertained in the class discussions. If anything, the analysis of case studies became simple explanatory exposition, “this case was about…. I wanted you to note…..You did the following components of this case analysis well...”

It is during the second interview after the conclusion of class that a certain tension begins to manifest itself within some topics. In the conversation about questioning, after noting that some questions were good, others unoriginal, he then says that he will model how to ask good questions, but will use stock questions to do it. He then concludes,

“I need to be more intimately involved but in a more routine way rather than an especially structured way.” The question becomes what could be more structured than contributing to every discussion from a pool of stock questions?

Perhaps the most curious thing to arise from the second interview is A—‘s opinion of on-line learning. What is one to make of the fact that one of the
founding members of the Penn State World Campus considers on-line learning to be “second best?”
Student B—

Background and Initial Interview

B— has been working in the golf industry for 3 years and has taken a number of courses on-line. He was attracted to the convenience of on-line learning and the ability to access material flexibly and within his schedule. He notes that the tradeoff is a loss of direct interaction with the professor. The change of classroom setting from live to on-line has several implications.

The discussion forums are typically, relatively speaking, an informal situation. It’s not like writing a formal paper, a research paper or something like that. But from my past school experience and my work experiences, etcetera, when I sit down to write something it tends to take on a more formal tone.

Ultimately, while B— says that he prefers on-line learning, his statements display an ambivalence toward the concept. While he notes that it is possible to schedule time conveniently within the limits of his work schedule and to attend Penn State, although without an on-line alternative that would have otherwise been impossible, he also describes the discussion forum this way:
The discussion forum, the exchange between members of the group of students that you’re working in … it’s a big chunk of the grade. I think it’s a good learning experience – it forces you to dig into the material a little deeper sometimes and that kind of thing. The only downside to it at times, without that face to face contact and being able to read body language and that kind of thing that we do when we’re communicating with somebody – stuff tends to get lost sometime I think. Not that you can’t resolve it. Sometimes it just takes a little longer to get everybody on the same page.

Learning Style Instruments

<table>
<thead>
<tr>
<th>PET</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Judgemental Nature</strong></td>
</tr>
<tr>
<td>Extraverted</td>
</tr>
<tr>
<td>Thinking</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>Sensing</td>
</tr>
<tr>
<td>Extraverted</td>
</tr>
</tbody>
</table>

P.E.T.
Personal Empowerment through Type
Type Profile
B--
Based on the interpretive guidelines for the instrument, the first thing comparison is between the extraverted and introverted. In that comparison, it would seem that overall B—is well balanced on that split (48 vs. 55), slightly favoring introversion. When comparing the top (judgmental) against the bottom (perceptive) to determine whether B— processes information predominantly judgmentally or perceptively, we see that the judgmental may be pronounced (60 vs. 44).

Further exploration of the results from the instrument reveal a learning type whose dominant function is Thinking, equally distributed between introverted and extroverted, and with an auxiliary function is Extraverted Sensing. Using these results for the narrow purpose of understanding how B—will process information presented in an on-line class requires some interpretation of the instrument results, since the distribution is shared in this manner.

The base characteristic that stands out for Extraverted Thinkers is a focus on the external world, and the rational and logical manner in which they approach it:

ETs use either facts or ideals to guide their thinking. They tend to have strong principles by which they judge all things and people. They know what is “right” and what is “wrong” (p.3).

In what might be considered a direct prediction of how they will behave in an on-line discussion, the type is further described:

The thinking of ETs is positive and productive. They are sure of themselves, their ideals and their principles. ETs continue to pursue their
ideals in the face of opposition. They are strong and logical, and their world is ordered and clear (p.3).

Equally in use in the processing of information will be the Introverted Thinking function, and this may provide an interesting balance to how B— might process information. Logical thinking is again a key component, but the focus is less on the external world and more on the internal recreation of it, “ITs prefer to live in an inner world of thoughts and ideas. Their thoughts are less dependent on what they perceive or experience than on the development of their own ideas (p.4).

Added to the qualities of the Extraverted Thinker might be the strengths of the Introverted Thinker:

Their strength is not in the originality of their ideas or their ability to persuade others. They are able to take the ideas of others; integrate, synthesize and clarify them; and present them in a logical fashion. ITs can be surprised if others do not value this quality, and they may become stubborn or annoyed if they are not understood (p. 4).

The complement to these dual Thinking functions will be an auxiliary perceptual function. In the case of B— this is Extraverted Sensing. While in general giving them a good sense of the reality of their environment as derived through the senses, in B—this may reinforce the Extraverted component of this Thinking orientation. Extraverted Sensing provides a view of the world where holders:

…orient themselves by concrete facts and actual experiences. Other may seem them as rational, but they go by what “makes sense.” What they
perceive with their five sense- not what is rational or logical-- is their basis for making decisions. ESs have little patience for the abstract and theoretical; instead, they prefer reality and actuality. They are punctual and neat (p.7).

Gregorc

In the Gregorc Style Delineator, B— had the same score in the Abstract Sequential and Concrete Sequential channels. Thus his primary method of viewing the world, and of processing information about that world should be considered Concrete. The results showed that either of the Random channels were not as significant in B—‘s information processing. While the descriptions for the information processing styles are rather robust, and cover a wide range of information, in this section I attempt to extract those that relate to how he might
process information either expressed on a computer screen, or needing to be expressed on a computer screen. I look first at the Abstract Sequential channel, then at the Concrete Sequential. How this might affect his interaction in class will be deferred until I discuss the data about the class and how this information processing related to the classroom system under study.

The foundational belief of those using this information channel is that reality is absolute. The words and graphics that appear on the computer screen will represent real objects in a real world. This real world will be ordered by the AS thinker in a tree-like manner, with relationships starting from and relating to a common core.

Several of the characteristics that would be expected to reflect directly on how B—interacts with class material would be the evaluation of information:

Judgments are based upon criteria which are acceptable to tradition, scientific convention, and/or the intellectual atmosphere of the present time or academic community…Using his analytical faculties, the Abstract Sequential mentally outlines, correlates, compares and categorized data in a manner unsurpassed by any other style.(p.23)

The AS will be able to convert these abstract ideas into spoken or written communication that transmit his knowledge graphically. He will tend to weigh all data prior to coming to any conclusion and will delay that conclusion as long as possible. Of particular note relative to an on-line class, it is suggested that the AS
will work best in solitude. Further, they will sometimes have difficulty discerning subtle non-verbal cues and innuendos.

General considerations of what the AS dislikes or disregards:

- hazy or sentimental thinking which leads to loose or inaccurate conclusions
- ideas and claims which do not meet his rational test of logic or approved test of validity
- metaphors and emotional stimulants in sounds and gestures, and,
- boisterous activity and excessive rules and regulation. (p.25)

The information processing in the Concrete Sequential mode complements the Abstract Sequential characteristics noted above. Not only might S— view the world as a real thing, but he could be able to perceive it in that manner in an extraordinary fashion through all his senses. Describing those who function through the CS mode, he:

…is able to link successively-connected parts and divide facts and figures into categories and subcategories. His ability to organize logically produces a linear organizational capacity unsurpassed by any other style. (p.19)

A significant aspect of how the CS will interact in class is their relation with the role of the instructor. In addition to confirmation of truth through the use of their own senses:
Validation is also made via authorized and credentialed experts who have had accredited instruction and training PLUS professional experience and background (p.20)

The dominant CS channel expects that he will receive specific directions and need to know exactly what is expected of him prior to beginning work in a particular lesson. He will also expect some external reward for his efforts. In the large picture this may be an expectation of money or status for his work, but in the immediate classroom related environment it may be an acknowledgement from the instructor for a lesson or report he considers well done. The work he hands in will be workmanlike, eschewing florid verbal enhancements in favor of functional and direct language. This will also be exhibited in a dislike of academic discussions which do not related to the real world, or the direct application of the subject matter of the class.

One final observation related to the CS and how they approach their own class work class work is the observation of the CS parent. As parents they would enforce a rule which says that homework is to be taken seriously, done on a regular schedule and which places the teacher as “always right (p.22)”

On-line observations

When considering the on-line participation of the class, the primary focus was on the discussion forums, which constituted the major interactive medium of the class. It is of note that very few of the interactions observed in this, or any
group deviated from a strict question and answer on the topic of Turfgrass and the specific case under consideration. While this topic focus has been observed in the class interactions and noted in this paper, it has not been documented extensively. It is of note because it is unusual in my experience. For example, the following is the introduction, and the only post that does not reference a case file, by B—

Hello

by B— at 9/4/2007 3:04 PM

My name is B—

I am a spray tech / crew member at A— Golf Course in V--, Michigan. I look forward to working with you.

He is however, one of the few members of the class who explicitly notes and comments on the structure and form of the class. In this post, after questioning a specific turf problem, he speculates on the nature of the discussion forum itself and the problem solving process:

D—, Why does poor air circulation compound disease problems? You mention meetings / newsletter articles to help explain the need for changes in traffic patterns. Do you think it would also be helpful to use these forums to explain the effects of shade and the need for tree removal? B—

One of the items noted during the discussion forums was the formatting imposed on the discussion by the Angel system in specific, and the most on-line
discussion systems in general. The comment has been included with the introductory material that appeared with it:

    Re: Re: Re: Re: Re: Re: Re: Re: Re: Re: Re: Re: Blue Winter
w/attachments

    by B— at 10/5/2007 5:03 PM

T--, Yeah, this is taking up a lot of time isn't it. But I've enjoyed the discussion. I hope you don't feel that any of my posts were ever meant to be argumentative or confrontational - I just wanted to defend my positions and clarify yours. If anything I posted came off badly I apologize.

    Thanks B—

There are twelve “re’s” that indicate antecedents to this post. The content of those posts are unavailable for easy and contextual review. They do not necessarily follow sequentially; there may be other comments that reference other threads of the post interspersed with these. On both the printed copy this discussion and the on-line view, the comments spanned multiple pages and could not be placed easily in context.

**Post-Class Interview**

The first element that stands out from B—’s consideration of the class is his observation as to the nature of the instruction:

    I guess the thing that stands out is the case studies and the practical application side of it. Being given a set of circumstances and having to go
solve the problem, as opposed to maybe some other classes, where maybe it’s more just memorizing lists of things here and there and…

The aspect of the class that appeals to him is the real world experience of trying to solve problems in the field based on previous class work. The class is not so much a presentation of new material as much as an opportunity to demonstrate newfound skills and knowledge.

The actual sequence of considering the case also reveals something that will become a common theme among the participants:

Normally it was starting with the, well, first of all going thru all the case material. In addition to that there was some readings, background material and technical information and similar cases. So, it was a question at that point of going thru that and then identifying what the exact problem was. That was the main thing for me first was spelling out for myself what exactly the problem was so that I could do the content map and decision tree, and that served as an outline for my report.

Since this exploration of the case material is inextricably linked to their presentation on the computer screen, it is of interest to consider how that presentation is perceived in the following exchange:

In a couple of the cases I did you’d go to…you’d link to a screen on background information and there’d be a few links within there that you had to go to, so that maybe a little cumbersome sometimes, but overall it
wasn’t too bad, cause I usually just printed everything off, and then I was able to organize it how I wanted to.

R: You printed the whole case with all the various pictures and things?
B: Not necessarily the pictures, just because I don’t have a color printer, so I wasn’t getting a good quality picture, but I’d print out the text.

R. Pardon me if I pursue this, but this is one of the things I find fascinating. When you printed out the screens, how did you organize the printed pages? By necessity, you’re going to be organized slightly differently on paper than you would be on the computer screen.

B. Right. What I would typically do is…say I’d print out the introduction screen that had the background information and then I’d go to the first link there, and then that would be typically I’d print that off, and so that would go back behind the background information, and then any links that were within that first link would go behind that, so I guess I would usually organize it in the way it was laid out on the web page essentially

The absence of face to face communication was also noted as a component of the on-line learning experience, the various visual clues of context and inflection missing, but without replacement by any on-line equivalent. This reduced the judgment of a variety of personal elements to content alone, “I guess I just based it on the content of their postings relative to my idea of what was correct or what I had in my mind in terms of additional points that could be made.”
The one additional component that could be used to evaluate the other student members of the discussion group was punctuality:

I guess my understanding the way things were laid out was that we had a week to post our report, then a week for the discussions, then a week to do the final and it was pretty common for people not to post any questions or anything else until the last day of that second week. For me, trying to stay on a schedule and stick to a schedule and keep things planned out, it got frustrating sometimes to wait for people to answer the questions, and then I’d have to turn around and handle all that.

The aspect of the class that touched upon both instruction and materials was in the consideration of the class materials:

**Summary and Findings**

In considering B—‘s pre-class observations, learning style, on-line activity and post class observations, it becomes clear that these things relate to one another in ways that are at times subtle, and at other times not so subtle. Early in the first interview he notes that the on-line format adds a level of formality to discussions that is not present in face to face interactions. He prefers the face to face interactions, an idea which is confirmed by his extraverted scores on the PET. On that same instrument his strong score in both introverted and extroverted thinking imply that he can synthesize knowledge and act upon it. The Gregorc reveals a
preference for sequential presentation, in both abstract and concrete areas, which
implies that he will be able to express himself well, which returns us to the on-line
discussions.

When considering some additional aspects of learning style that are
revealed in his interviews and his personality instruments, we can see the
interactions that are occurring. His concrete sequential score indicates that:

Validation is also made via authorized and credentialed experts who have
had accredited instruction and training PLUS professional experience and
background.

When asked how the course might be improved, he states:

The only other thing would maybe be, if the professor were to maybe jump
in on the discussions every once in a while, say when there is a
disagreement about an issue. I think to a certain extent he tried to stay out
of that just from a standpoint of letting people resolve it on their own but
just from a …not necessarily from a standpoint of trying to prove I’m
right and somebody else is wrong or the other way around, but just so I
know going forward, if I was wrong, then…you know…

This Concrete Sequential view also extends into his evaluations of other
students. B—wants to know what is expected; when asked to describe how he
evaluates other students. One aspect used for that evaluation, lacking the usual face
to face characteristics, is their punctuality, which is something that goes directly to how they respond to “what is expected.”

I believe that all of this points to a certain joy in problem solving, which was the major mode of learning in this class. The aspect that might have assisted the learning is the ongoing validation of having his views echoed by the instructor in a more timely fashion.

A central piece of this work, and one that remains a question, is the role of information presentation, and specifically, the computer presentation that comprised this class. We have noted that B— has already considered the discussions to be more formal. While not noting any significant problems with the material or the interface, B— did take the time to navigate through the case study structures and print all the pages. The piece that remains curious is why.
Student S—

**Background and Initial Interview**

S— has worked in the golf industry for 10 years and has taken several online classes related to his turf grass studies. He currently works at a course in the Washington, DC area. He feels that because of his extensive background in the industry he is getting a great deal out of his college education. As he puts it, “I go to the quote unquote ‘classroom,’ and then I come out and I’m right in the field.”

Several things stand out in speaking to S— about his on-line study. He is in the enviable position of being able to attend to his school work during the workday. While he cites what has become a standard notation of convenience, within his response is an ambivalence about the experience:

I do have access to it virtually whenever I want – so I’m able to go to class whenever I want. A lot of that has to do with ….I do have the ability to access and do school work at work…so I can continually do it. And that’s the other thing – one of the down sides I have is that I am constantly doing it. Mostly because I have the ability …I can do that. Sometimes other students like a lot of classes are interactive and you have group and you ask each other questions. And if they’re not going as fast as I am, or …you know keeping up the pace, (and I understand that they might not have the
ability to do it as much as I can) it kind of holds me back. So I like it because I can keep going at it as much as I want.

S— also speaks explicitly about one perception of the nature of learning on line:

Yeah, I think opinion is out of it…there’s more opinion when you’re live than when you’re on-line. So sometimes it’s harder to grasp what the teacher is asking…or what the teacher or professor is trying to portray than when you’re right there in front of him or her.

It is of note that S— would prefer to attend an on-campus class than a distance class. Although the enticements, the convenience, Penn State reputation for turf grass studies and the ability to obtain a Bachelor’s degree on-line, are considerable, and at the moment are the actual motivation for taking the classes on-line, there is still a feeling that something is lost when attending a class on-line:

I think that I would honestly prefer the live class, the normal class setting…it’s just not convenient for me. Just because I can have that continuous interaction between the…not only the professor, but with the other students too. I do have interaction obviously, but it’s not at a conversation pace, it’s at an email pace.
Learning Style Instruments

PET

Based on the interpretive guidelines for the instrument, the first thing that becomes apparent is that S— seems to be more extraverted, and may be the most extraverted of the participants. This is determined by comparing the right and left sides of the results graph. The bars exhibit a definite preference for extraversion, with the scores for the extraverted/introverted difference being 75 / 47. Using those same guidelines, this time comparing the top graphs with the bottom to determine whether A— processes information predominantly judgmentally or perceptively,
we see that the judgmental is favored, although the split is far less pronounced (64 / 58).

Further exploration of the results from the instrument reveals a learning type whose dominant function is Extraverted Thinking and whose auxiliary function is Extraverted Intuition. Using these results for the narrow purpose of understanding how S— will interact in an on-line class presents the necessity of extrapolating several of the characteristics in an attempt to see how they interact.

Extraverted Thinkers focus on the real and external world, and approach it in a rational and logical manner. They use facts and ideals as guides for thinking, and use them to create the principles by which they judge the right and wrong in people and things. In what might be considered a direct prediction of how they will behave in an on-line discussion, the type is further described:

The thinking of ETs is positive and productive. They are sure of themselves, their ideals and their principles. ETs continue to pursue their ideals in the face of opposition. They are strong and logical, and their world is ordered and clear (p.3).

S— has an auxiliary function of Extraverted Intuition and several items stand out as characteristics of this function. The words used to describe them are initiators, promoters, visionaries, and champions of causes, and “they can peer beyond what is visible. They can have insights into what is hidden, what is about to emerge, or what is just beginning (p.9).
It is further noted that they “do not merely perceive or envision; their mind stays actively creative by seizing and shaping their perceptions and visions (p.9). This tendency, were it not tempered by the primary function of Extraverted Thinking function, might actually interfere with on-line learning of the type needed here. Other cautions noted are a tendency to start things they do not finish, primarily because they become bored with projects that take too long.

Gregorc

In the Gregorc Style Delineator, S— was had the same score in the Abstract Sequential and Concrete Sequential channels. Thus his primary method of viewing the world, and of processing information about that world should be considered Sequential. The results showed that either of the Random channels
might not be as significant in S—‘s information processing. While the descriptions for the information processing styles are rather robust, and cover a wide range of information, in this section I extract those that relate to how he might process information either expressed on a computer screen, or needing to be expressed on a computer screen. I look first at the Abstract Sequential channel, then at the Concrete Sequential. How this might affect his interaction in class will be deferred until I discuss the data about the class and how this information processing related to the classroom system under study.

The foundational belief of those possessing this information channel is that reality is absolute. The words and graphics that appear on the computer screen will represent real objects in a real world. This real world will be ordered by the AS thinker in a tree-like manner, with relationships starting from and relating to a common core.

Several of the characteristics that would be expected to reflect directly on how S—interacts with class material would be the evaluation of information:

Judgments are based upon criteria which are acceptable to tradition, scientific convention, and/or the intellectual atmosphere of the present time or academic community…Using his analytical faculties, the Abstract Sequential mentally outlines, correlates, compares and categorized data in a manner unsurpassed by any other style.(p.23)

The AS will be able to convert these abstract ideas into spoken or written communication that transmit his knowledge graphically. He will tend to weigh all data prior to coming to any conclusion and will delay that conclusion as long as
possible. Of particular note relative to an on-line class, it is suggested that the AS will work best in solitude. Further, they will sometimes have difficulty discerning subtle non-verbal cues and innuendos.

General considerations of what the AS dislikes or disregards:
- hazy or sentimental thinking which leads to loose or inaccurate conclusions
- ideas and claims which do not meet his rational test of logic or approved test of validity
- metaphors and emotional stimulants in sounds and gestures, and,
- boisterous activity and excessive rules and regulation. (p.25)

The information processing in the Concrete Sequential mode complements the Abstract Sequential characteristics noted above. Not only would S— view the world as a real thing, but he should be able to perceive it in that manner in an extraordinary fashion through all his senses. He has a formula for dealing with the world and he

…is able to link successively-connected parts and divide facts and figures into categories and subcategories. His ability to organize logically produces a linear organizational capacity unsurpassed by any other style.

(p.19)
A significant aspect of how the CS will interact in class is their relation with the role of the instructor. In addition to confirmation of truth through the use of their own senses:

Validation is also made via authorized and credentialed experts who have had accredited instruction and training PLUS professional experience and background (p.20)

The dominant CS channel expects that he will receive specific directions and need to know exactly what is expected of him prior to beginning work in a particular lesson. He will also expect some external reward for his efforts. In the large picture this may be an expectation of money or status for his work, but in the immediate classroom related environment it may be an acknowledgement from the instructor for a lesson or report he considers well done. The work he hands in will be workmanlike, eschewing florid verbal enhancements in favor of functional and direct language. This will also be exhibited in a dislike of academic discussions which do not related to the real world, or the direct application of the subject matter of the class.

One final observation related to the CS and class work is the observation of the CS parent, which may apply when considering how the CS views their own schoolwork. As parents they would enforce a rule which says that homework is to be taken seriously, done on a regular schedule and which places the teacher as “always right (p.22)”
On-Line Observations

The only participant in the study in S—‘s discussion group was S—himself. This is a shame, because this entire discussion group was curious in that there was almost no off-topic discussion, and the discussion that was there was specific to turfgrass and to the questions that arose from the posted case studies. Additionally, the questions and comments were very terse, consisting of very brief two to three sentence staccato conversations of the nature:

Wow that’s a lot of plugging. Was this a sudden infestation? Seems like a course like Winged Foot would have preventative measures in place. What about fertility, what that adjusted any? Did you alter your watering practices at all?

This would typically be followed by a response equally short and to the point. Case studies were posted as file attachments.

Post-Class Interview

S—‘s post class interview offers a second opportunity to consider how the students view the class, and he offers a confirming view of the summative nature of the experience:

The case studies class was the generalization of everything we’ve learned, I guess …because you had to apply everything not just one specific…not just
entomology, or soils or disease, you know what I mean, it was the broad spectrum of everything. It’s different in the fact …it was a different format I guess the first that that comes to my mind. It wasn’t your typical, for me typical- do the lesson, take a quiz, take a midterm, do some more, take a final. It was broken up into four individual cases.

When asked about the mechanics of the decision trees and concept maps that seem to be one of the key components of the presentation of materials however, he presented a different view:

I had a very difficult time with it because…we had to do the decision tree and the concept map and I couldn’t stand those. Only because to me they were a tool for brainstorming. So, essentially, he was telling me how I should brainstorm. I didn’t like that format.

This dislike may trace to a mismatch between the course’s information presentation requirements and S—‘s actual internal information processing as predicted by this ET/EN combination. He is being forced to use a thinking tool that does not address how he thinks. This is revealed in his answer when probed on the actual mechanics of how he did the assignments:

I always did the decision tree, the brainstorming tools last. I worked backwards because I couldn’t stand those things...because for me they weren’t a good tool. That’s not how I brainstorm. I just had a hard time with it. I kind of have my own way to going about things….
An additional cause of concern around the use of the decision trees was their inter-relationship with an assumed level of computer expertise, which was not necessarily true, and as expressed by S—, not the actual subject of the course:

The biggest problem I had with it was that I’m not a computer guy, so I could draw it up…I still didn’t like the format, but I could draw it up on pieces of paper…it took me three times as long to do it on the computer. …it’s kind of like, the purpose of the class was to do a case study, but I was spending more time on trying to figure out how to make boxes on a computer screen, not really the material I was going to be spending my time on. I understand this is where everything is moving…it’s already moved to all computers. Maybe superintendents are a little slower in getting there, I just didn’t want to do that in this class.

When asked about the Angel system, S—did not have any specific problems with the format of the screen or the placement of contents, but did express a concern that the system was always down from 5AM to 7AM, which was one of the times he was able to do his coursework. Although this was not an “interface” problem, as has been considered in the discussion on graphic presentation, it was a low level mechanical problem with computer access.

The student interactions were regarded well by S—. Since the case study format was dependent on student interaction, the timeliness of that interaction was the subject of specific comment:
I’ve got to say this was probably the best interaction I’ve had as far as guys trying to keep up. I understand there’s times where they’ve got big tournaments, a lot going on, or whatever. I think for the most part everybody held their own.

The consideration of other students, relative to the tools available to judge their knowledge and expertise on-line brought up an consideration that was not mentioned by any of the other subjects, but which is worthy of note:

I think the first and foremost would be what course they’re at. I was proven wrong it seemed. And again, I don’t know these people. There was a guy in my group that was from Winged Foot, I’m sure you know Winged Foot. You get the impression the guy is…it’s just like with any business I guess… you get a bigger name you kind of assume they know what they’re doing, whatever. It was just the way he was writing, whatever, that you could tell that about a person, how they write. He just didn’t impress me at all.

Along these same lines S—offered the following description of another student:

Another guy who was from West Virginia…boy, he was fricken dead on. He was smart as a whip. I don’t know, West Virginia, the hills or whatever (I’ve got family from West Virginia so I guess I can say that). You just get impressions, but he was probably smartest that you could tell, that I could tell, in the course. He was just very well spoken.
The teacher, and more specifically the teaching itself, was viewed favorably. As with other students, the nature of the class was central to their consideration of the quality of instruction:

In something like this I guess it’s more of guidance than a teaching, because of the way the class is. It’s note anything specific that they’re teaching, it’s like here’s a problem, run with it. And he did a good job returning emails, explaining why you did …what your content…why your paper was good or why it was bad. Things of that nature… You don’t necessarily learn that 2 + 2 is 4, you learn “how do you add 2 plus 2?” How do you gather your information thru your resources?

Summary and Findings

One of the first ideas that comes thru when considering S—‘s comments is that on-line learning is significantly different from what occurs in a live setting. This difference may be perceived almost subliminally, but it is perceived, and when asked to give voice to the difference the only option is to describe some of the details and hope they make a picture. S— thus considers that on-line learning has less opinion, that it is harder to grasp what the teacher is presenting, or that conversation proceeds at “email pace.” Given a choice, he would prefer a classroom over a computer.

There is not necessarily limited to a negative view of on-line learning. He also finds some significantly positive aspects of the class. Consider his view of the
format of this class in comparison to others as not the typical, “do the lesson, take a quiz, take a midterm, do some more, take a final.”

Some of this may be predicted on the basis of his learning profiles. The PET survey reveals a strongly extroverted tendency in three of the four measures, with one, Extraverted Intuition, providing an explicit caution about perception and vision. How this is revealed may not be directly evident, but rather, indicated by one of S—‘s criteria for judging fellow students, what geographic region the golf course they work at is located. This may also be another reflection of an extroverted personality lacking the familiar basis for evaluation.

The Gregorc provides an even stronger indication of how some aspects of the class will be perceived. S—‘s survey reveals equally strong tendencies in both Concrete Sequential and Abstract Sequential channels, with both Random channels significantly less. The first indication of some influence is the idea that subjects strong in the AS channel have difficulty discerning subtle, non-verbal clues. Additional cautions are against “ideas and claims which do not meet his rational test of logic or …validity,” and academic discussions which do not relate to the real world. Consider one specific aspect of S—‘s reaction to the concept mapping:

I still didn’t like the format, but I could draw it up on pieces of paper…it took me three times as long to do it on the computer. … it’s kind of like, the purpose of the class was to do a case study, but I was spending more time on trying to figure out how to make boxes on a computer screen, not really the material I was going to be spending my time on.
It is also of note that S—is the second student who displays a strong tendency toward the sequential.
Student W—

Background and Initial Interview

W— has been working at his current golf course for 8 years and is familiar with the on-line curriculum, having been actively involved for a few years. That has resulted in some adjustment on his part, since he had been out of school for some time and needed to reacclimate to a school environment in general and to the discipline needed for on-line learning in the specific. He is comfortable with the convenience of on-line learning and enjoys the fact that the work is less structured. He does not think the curriculum is easier, but he finds it matches his learning style better.

I think I tend to respond a little bit more to the online just because it’s …

I’m kind of a fast learner…I I kind of lose interest when I’m sitting through an hour and a half seminar kind of deal, I 'm more of a give it to me all at once I adjust it by my own pace sort of deal.

Unlike several other on-line students who have commented on the lack of body language or other conversational clues in on-line communications, W— does not seem to be bothered by this:
I don’t think it has much effect you know I just kind of take the information for what it’s worth and the body language and the attitude it is given to me at doesn’t really effect me that much.

The result of this is that W— does not see a benefit to attending live classes.

You’re reading, taking notes; you know the same thing you would do on campus. I think it servers me better just because like I said you can do it at your own pace. The reading is there, you can refer back to the reading if you need help with any specific thing where if you on campus and you miss something the instructor says it is a little more difficult to go back to.

One item of significant note to this study is the conception of knowledge that W—brings to the subject.

I don’t know how to explain this quite right but Turfgrass is like a science type thing. It’s not quite like mathematics where there is one definite answer but I mean it’s close to that… where, if this is the problem, this is the solution type deal so it’s close.
Based on the interpretive guidelines for the PET, the first thing that becomes apparent is that W— has a dominate function of Extraverted Thinking. Using those same guidelines, this time comparing the top graphs with the bottom to determine whether W— processes information predominantly judgmentally or perceptively, we see that the judgmental is slightly more pronounced, (55 vs. 45). He also has an auxiliary function of Extraverted Sensing.

Using these results for the narrow purpose of understanding how W—will process information presented in an on-line class requires some interpretation of the instrument results, since there is also a strong Introverting Thinking score that
may influence the overall result. Looking at the dominant function first, the base characteristic that stands out for Extraverted Thinkers is a focus on the external world, and the rational and logical manner in which they approach it:

ETs use either facts or ideals to guide their thinking. They tend to have strong principles by which they judge all things and people. They know what is “right” and what is “wrong” (p.3).

In what might be considered a direct prediction of how they will behave in an on-line discussion, the type is further described as having thinking that is positive and productive, and based on being sure of themselves, their ideas and their principles. They will pursue these principles in the face of opposition. Overall they live in a world that is ordered and clear.

The complement to this function will be an auxiliary perceptual function of Extraverted Sensing. While in general giving them a good sense of the reality of their environment as derived through the senses, in W—this may reinforce the Extraverted Thinking orientation. Extraverted Sensing provides a view of the world where holders of it:

…orient themselves by concrete facts and actual experiences. Other may seem them as rational, but they go by what “makes sense.” What they perceive with their five sense- not what is rational or logical-- is their basis for making decisions. ESs have little patience for the abstract and theoretical; instead, they prefer reality and actuality. They are punctual and neat (p.7).
In the Gregorc Style Delineator, W— has the same score (34) in the Abstract Sequential and Concrete Sequential channels, echoing his Thinking orientation in the P.E.T. His primary method of viewing the world and of processing information about that world will therefore be considered through the commonality of the two Sequential channels first. The commonalities that relate to sequencing events are described, in the case of Concrete Sequential as:

The dominant Concrete Sequential views and approaches experiences in his world of reality in an ordered, sequential, rectilinear, and one-dimensional manner. He expresses concerns about “bottom lines,” “crossing lines,” and “deadlines.” Events are conceived as being joined in a successive and continuous manner like inks in a chain. Consequently, he thinks by using a “train of thought” which has a clear beginning and a clear end (p. 19).
In the case of the Abstract Sequential this logical sequencing of events is further refined. No longer one-dimensional, it is described now as two-dimensional:

He orders in a tree-like manner starting with a common core and branching into parts derived from the base. He also views the world in curvilinear forms through arch and circles consisting of parts which are “welded” to make a whole. From these “welds” and branches, the AS draws correlations, predicts next steps, and involves himself in their scope and sequence. (p. 23).

The results showed that either of the Random channels might not be as significant in W—‘s information processing.

The foundational belief of those possessing the Abstract Sequential information channel is that reality is absolute. The words and graphics that appear on the computer screen will represent real objects in a real world. This real world will be ordered by the AS thinker in a tree-like manner, with relationships starting from and relating to a common core:

Judgments are based upon criteria which are acceptable to tradition, scientific convention, and/or the intellectual atmosphere of the present time or academic community…Using his analytical faculties, the Abstract Sequential mentally outlines, correlates, compares and categorized data in a manner unsurpassed by any other style. (p. 23)

The AS will be able to convert these abstract ideas into spoken or written communication that transmit his knowledge graphically. He will tend to weigh all
data prior to coming to any conclusion and will delay that conclusion as long as possible. Of particular note relative to an on-line class, it is suggested that the AS will work best in solitude. Further, they will sometimes have difficulty discerning subtle non-verbal cues and innuendos.

General considerations of what the AS dislikes or disregards:

- hazy or sentimental thinking which leads to loose or inaccurate conclusions
- ideas and claims which do not meet his rational test of logic or approved test of validity
- metaphors and emotional stimulants in sounds and gestures, and,
- boisterous activity and excessive rules and regulation. (p.25)

The information processing in the Concrete Sequential mode complements the Abstract Sequential characteristics noted above. Not only does this suggest that W— would view the world as a real thing, but that view will be constructed in an extraordinary fashion through all his senses. He has a formula for dealing with the world and he

...is able to link successively-connected parts and divide facts and figures into categories and subcategories. His ability to organize logically produces a linear organizational capacity unsurpassed by any other style. (p.19)
A significant aspect of how the CS will interact in class is their relation with the role of the instructor. In addition to confirmation of truth through the use of their own senses:

Validation is also made via authorized and credentialed experts who have had accredited instruction and training PLUS professional experience and background (p.20)

The dominant CS channel expects that he will receive specific directions and need to know exactly what is expected of him prior to beginning work in a particular lesson. He will also expect some external reward for his efforts. In the large picture this may be an expectation of money or status for his work, but in the immediate classroom related environment it may be an acknowledgement from the instructor for a lesson or report he considers well done. The work he hands in will be workmanlike, eschewing florid verbal enhancements in favor of functional and direct language. This will also be exhibited in a dislike of academic discussions which do not related to the real world, or the direct application of the subject matter of the class.

On-Line Observations

W—’s class interactions fell into the same pattern repeated by all the research subjects. There were some brief and sparse non-Turf related interchanges
in the first week of class, after which almost all exchanges were related to the topic of the class. In the case of W—they numbered exactly three, before the discussion group he was part of focused on the topic of turf. All three of his non-turf remarks are reprinted here:

Hi there gents and ladies if there are any?? Im W— and i live just north of Philadelphia, PA. and i look forward to working with all of you... And

Brian i use to live about a hour or so north of you in hobe sound fla. are you familiar with it???

In response to a geographic question he replied:

i was only 13 when we lived there long before my golfing days but most of my family still lives in that area so ill get down there some day

And upon finding another student form Pennsylvania, he wrote:

WOW someone else from Pa!!! you may be the first guy in all the on-line classes i took that is actually from Pennsylvania

Of note is that there is some attempt to connect with other students on non Turf topics, but this was not very intense, nor was it sustained. Once these cultural acknowledgements were tended to, the almost single minded purpose was a focus on the topic of the class. One of these exchanges is placed here because it does illustrate the approach W— took toward the discussion.
i wish i could offer you some points but i think we are on the same page...
but something i didnt think of till now... i think re routeing the cart path
could help our traffic problem but as we all know the golfers drive where
ever they want anyway :) and that is another expence that the membership
will not want to put out... anyway i love the direction you are heading with
this!!! W—

Of note is the lack of capitalization where appropriate, the lack of normal
punctuation, but the alternate use of punctuation for emphasis, to indicate thought,
or to humanize bare text (via the text smile). There was also no use of spell
checking, despite the fact that this was available through the Angel discussion
forum interface. All these seem to point toward a view of the discussion forum as a
unique communication medium.

Post-Class Interview

W—‘s post class interview reveals some of the same impressions of the
class as other students, along with several new insights of the class. He considered
the most memorable part of the class to be the other students, and when asked to
name the most memorable part he did so without any hesitation or extensive
thought. Despite this however, he still does not “know” the people in his group:
You never strike up a personal relationship. I most likely wouldn’t talk to any of these guys again outside the class setting. I guess it’s the familiarity of what you’re going thru...you’re all going thru the same thing. You’re kind of all forced to work together. I wouldn’t say it was a friendship thing, but it was an association.

W—did express a desire to work with the group in some sort of face to face manner, however, he acknowledged that one particular aspect of the course would make that a practical impossibility, and that was the geographic distance between the students. In his particular group there were students from as far away as Ireland and Minnesota.

One consideration of the group learning experience that was probed was the knowledge level of the group itself, and how that was determined in an on-line environment:

W—: I think you can definitely see a little bit of a separation, not much, but a little bit of a separation, between the guys who’ve been in the field for awhile. I’ve been in the field for 8-9 years now. You kind of pick those guys out because they seem to ask more knowledgeable questions and questions that you wouldn’t really think of, as far as ...they would look at it from a different angle than somebody who was just reading it out of a textbook. Some of the younger guys that really haven’t been in the field that long...I guess it’s just an experience point of view, that would be the main difference. Everyone is pretty much there book smart-wise, but there
was a couple of guys who seemed like they had more experience in the field, and that helped them out quite a bit.

R: How did that come out?

W—: Pretty subtly actually, just …you could tell from some of the questions they were asking. You know, they would look at the problem in a different way and think of something, not necessarily a Turfgrass problem, but a problem you would have with management in the clubhouse or something along those lines. Dealing with the members and members of specific courses. Not really a book smart thing, more of a management type thing.

When asked about what he had learned, and if he could list that information easily, the response was similar to the other research subjects:

Not very easily. Most of the case studies I did, or that I was a part of, I’ve had experience with before just because I’ve been in the field for 8 or 9 years. I mean, I’ve learned a little bit more about Word, doing the discussion trees and stuff like that, but as far as the Turf case studies class, what I learned was minimal just because I’ve had experience in most of those problems already. And that benefited me obviously doing the case
studies. But, as for learning new stuff, I’m not sure how much...minor but...you know.

This prompted a question as to why he had taken the class, and the response was that it was necessary for career advancement in the industry.

Summary and Findings

Although several of the participants noted the convenience of on-line learning, most related that to the convenience of being able to attend class despite being geographically remote from the campus. W— was the first to relate to the distance learning aspect as being more in tune with his own personal learning style. Specifically, he did not feel that the lack of body language and other face to face clues was a special handicap. He preferred controlling the pace of his own learning, one of the benefits often cited as a positive for computer based education. Speaking to something larger than the day to day interactions of the course, he also stated that he believes the subject matter is a science-like, one in which there is one right answer. The interrelationships that are revealed between what has been stated by W— and what might have been predicted for him speak to a growing sense of confirmation of the system originally proposed.

W— has a task orientated personality style; he would be predicted to have little interest in form in forming friendships in class. This may speak to why he
does not miss the various interpersonal clues, and to why his evaluation of other students is based primarily on the content of their postings, and not a variety of other inputs that were used by several of the other participants as a substitute for the interpersonal. The Gregorc indicates a strong Sequential bias, in both the Random and Concrete channels, which is in keeping with the other students in the class and which may be indicative, not only of this student, but why all the students in this class are successful at distance learning. Of further note is the fact that although W— cites the other students as the most memorable part of the class, he neither knows them, nor seems to miss knowing them.

Addressing the actual learning content of the course, W— seemed to focus most two aspects of the course. The first, and perhaps primary, is that there was not a lot of new material learned as a result of the class, rather, it confirmed the experience of the real world, something that relates directly back to both learning style instruments. When considering the value of the class, the real value was not the knowledge, but the external requirement of job advancement.
Student D—

Background and Initial Interview

D– has been working at a golf course in Florida for the past 5 years and has moved from entry level employee to supervisor. Turf 436 is the 5th class he has taken on-line and is the final course in the first part of the Turf Grass Management Certificate. He is hoping that the completion of this course will open the door to the assistant superintendent position.

In his initial interview D– cited convenience and the ability to make his own schedule as reasons for taking the course on-line, although he did cite several mitigating factors that weigh against the convenience. On-line courses are “obviously not as personal.” Additionally, there may be problems if some teachers do not respond in a timely fashion:

It seems like they answer half your question. I’m sure they have a lot of people to deal with online, but when you are face to face it’s a lot easier just to say “oh, no…that’s not what I meant exactly.

This point is restated and emphasized later in the interview:

I tend to be the type of person that, I guess, reads a lot more off of somebody and if you know … I do enjoy that part of conversation that you can look at somebody in the middle of what they are saying and give them that look and “no, that’s not what I’m talking about.”
When asked specifically if there was some on-line substitute for live interaction, he said “no.”

Of interest in consideration of the on-line class specifically, two items stand out in D–’s interview. Both involve how the computer is used as an educational tool. One considers the specifics of information presentation:

I print everything up because I like to sit and read it like it’s a book…I don’t know what’s going on with that but if I don’t print it up and start highlighting stuff I get bored looking at the computer screen.

The other involves the specifics of learning interaction with the computer. The following information was volunteered:

Can I say one thing real quick? A lot of times, like I mentioned before, I’ll get bored with what I’m seeing. I’ll see something like you said, that seems strange and I just don’t get it, probably because I’ve been starting at the same screen forever, and I’ll try to jump out of that and just go on a google search and search for the same thing I’ve been studying and get like a quick explanation of it. Then I jump back and it’s just like that change of scenery if you will seems to help me out.
Learning Style Instruments

PET

Based on the interpretive guidelines for the instrument, D— has a dominant function of Introverted Thinking, with an auxiliary of Extraverted Sensing. It is of note here that the scores for the right and left sides of the chart, when all 4 elements are added, are exactly the same. When considering that same chart, this time comparing the top graphs with the bottom to determine whether D— processes information predominantly judgmentally or perceptively, we see that the perceptive is very slightly favored, although the different is so slight as to be practically equal (54/56). Thus, of all the test subjects, D— has the most balanced
distribution between the introverted and extraverted, and between judgmental and perceptive.

The primary function of Introverted Thinking will echo what has already been said about other members of the class, all of whom seem to have a strong reliance on thinking functions. The world is a rational and logical place, and allows theories and models to work well on that basis within the real world. One descriptive sentence is that they “continually work to establish order in their personal and professional lives (p.3).”

The auxiliary function here is Extraverted Sensing. The characteristics of the extraverted sensing type suggest an attention to the detail of their environment, and the ability to find those things that make the biggest impression on them. One description that might apply to on-line learning is:

ESs are well adjusted to reality and orient themselves by concrete facts and actual experiences. Others may see them as rational, but they go by what “makes sense.” What they perceive with their five senses— not what is rational or logical – is their basis for making decisions. ESs have little patience for the abstract and theoretical; instead, they prefer reality and actuality (p 7)

This learning style profile may allow D— to benefit from on-line learning, and to be aware that he is benefiting from on-line learning.
Unlike the PET, the Gregorc manifests D—‘s learning preferences as a strong tendency to use the Abstract Sequential channel. The foundational belief of those possessing this information channel is that reality is absolute, or in the view that concerns us here, that the words and graphics that appear on the computer screen will represent real objects in a real world. This real world will be ordered by the AS thinker in a tree-like manner, with relationships starting from and relating to a common core.

He orders in a tree-like manner starting with a common core and branching into parts derived from the base. He also views the world in curvilinear forms through arch and circles consisting of parts which are “welded” to make a whole. From these “welds” and branches, the AS draws correlations, predicts next steps, and involves himself in their scope and sequence. (p. 23).

Several of the characteristics that would be expected to reflect directly on how D—interacts with class material would be the evaluation of information:

Judgments are based upon criteria which are acceptable to tradition, scientific convention, and/or the intellectual atmosphere of the present time or academic community…Using his analytical faculties, the Abstract Sequential mentally outlines, correlates, compares and categorized data in a manner unsurpassed by any other style.(p.23)
The AS will be able to convert these abstract ideas into spoken or written communication that transmit his knowledge graphically. He will tend to weigh all data prior to coming to any conclusion and will delay that conclusion as long as possible. Of particular note relative to an on-line class, it is suggested that the AS will work best in solitude. Further, they will sometimes have difficulty discerning subtle non-verbal cues and innuendos.

General considerations of what the AS dislikes or disregards:
- hazy or sentimental thinking which leads to loose or inaccurate conclusions
- ideas and claims which do not meet his rational test of logic or approved test of validity
- metaphors and emotional stimulants in sounds and gestures, and,
- boisterous activity and excessive rules and regulation. (p.25)

On-Line Observations

As with the other student participants in this study, off-topic discussion in the class forums was extremely limited. One of the only references to anyone being sick during the class was presented as an explanation for some late work submissions:

Greetings, I apologize in advance. I know I am already late on the next case report. I've been sick with Strep throat since Saturday (I'd rather have the
Flu). I wasn't able to make a doctors appointment until Tuesday, so it got pretty bad. Antibiotics are working very fast, though. So, now that I am able to actually think again, I will work quickly to finish my preliminary report and turn it in. Thank you and I apologize again, D—

This is of note because it may be the only statement made by anyone, after the few introductory remarks during the first week of class, in which anyone makes mention of anything that is not directly related to or derived from the study of turf.

The next comment was actually not made by D—, but rather to him. Is was made by another student in the study, and is included here because it was one of the few statements that made reference to the decision trees. It is of note because a great deal of effort was made to make and publish the decision trees, and most of the students in the study either explicitly did not like them, or modified them to fit a personal definition that varied to some degree from their original intent. Here we see that someone did review this study tool:

D—, In your decision tree you mention the possibility of the old system causing additional problems around tournament time, but I didn't see it specifically mentioned in the report. Do you think this should be added in the report somewhere as an additional justification for installing the system before the tournament? Do you think another advantage of installing a two-row system is that it will make it easier to establish the intermediate rough areas the USGA is asking for? Thanks B—
The final comment of note is this exchange between B—and D—, which references the absence of requisite information in the case presentation:

D—, According to some info I have on grey leaf spot, damage is usually more severe when the grass is stressed due to compaction. Do you know if the affected areas are prone to compaction? Do you plan to reseed with ryegrass? Would you consider seeding with another grass that is not affected by grey leaf spot? Thanks B--

B—, I do not know if compaction is a problem. This information is not stated anywhere in the case report. However it seems likely problems could be worse in more compacted areas. I would definitely consider seeding with an alternate turf species. Since 10% of the fairways already consist of annual bluegrass this seems like an obvious choice. Reseeding the areas that were affected this year with this turf would likely prevent much re-infection the following year. This statement is under the assumption that the areas affected this year would continue to be the high disease pressure areas. D—

This is one of the few times that students in the class commented on the presentation of the case, rather than the case itself, and explicitly reference that some solutions are the result of assumptions about the case. While not indicative of any large scale perception of the class, it does indicate that the students might benefit from some more robust case presentation.
Post-Class Interview

In his post class interview D—brought up what has now become something of a shared observation, that the most memorable part of this class was the shared interaction of the on-line discussions, and the summative aspects of the class:

Actually I was probably more interested and I’ll probably remember this a little more, it had a little bit more discussion, it was pretty much the entire class…doing stuff,…the discussion back and forth…there really weren’t any lessons. It was just a broad coverage of everything we had should learned in previous classes. It was a lot of discussion, I really enjoyed that.

The students in the class were considered positively, as might be surmised from this general comment about the class, but when probed specifically about the students D— responded:

For the most part they seemed like knowledgeable and smart people willing to learn and wanting to try. Every once in a while you ran into somebody …myself included…I did the same thing a couple of time because I have a busy schedule…the one difficult thing is you might fall behind a little bit, and if somebody doesn’t complete their part of a discussion, then you naturally have to wait for them to do their part before you can continue on with the next section. The teacher seemed to understand that real well and not give any real penalties unless you were real late. As far as I can see,
really good interaction with everybody else, usually, if someone wasn’t
participated a bunch, they ended up quitting after 4 weeks or so.

When considering the interface and class materials, D—expressed no real
concerns with the ability to follow lessons, discussions or other navigational
requirements, however, he did offer some suggestions as to improvements of the
actual navigation thru the lessons:

The only thing I would say in regard to something like that is I don’t like it
when I have to go to one link and there’s another link to something else and
when you want to get back to the page you’re starting on you have to go
backwards three or four times every time. I mean, if there were links I wish
they were all like…related to each other on one page, where you could just
go…link to something go back, link to something else. I don’t mind the
whole scrolling down thing…I’d rather go to one thing, be able to scroll
down, read all the information, then jump back to the other one. Kind of
seems like it would be simpler that way.

Regarding the question of what was learned and how it was learned, D—
brought up the complementary interactions between students in the class:

With different case scenarios I learned a little bit about a bunch of different
things. I guess I could start listing stuff. For example, salt tolerances in soil,
how PH affects Turfgrass, different things about different species of turf in
different areas of the country.
R: Was this stuff you didn’t know before?

D: A lot of it was expanded upon because it was detailed information that people were giving me specific to their own experience. A lot of stuff I talked about, I tried to… when it was my turn to talk… I would obviously bring up the stuff that I had a stronger grasp upon that I knew a little bit more information about. I think the other people in my group, they brought up stuff that they knew a little bit more about and kind of…. everybody had a little bit of different strengths and weaknesses, and that kind of blended together to get a good round about learning experience for everybody.

**Summary and Findings**

One of the first things that D— referenced when asked why he was taking this class, and the Turf Grass program in general, was a desire to advance his career within the Turf Grass industry. While citing convenience as a reason for taking an on-line course, D— also acknowledged from the start that distance learning was something of a compromise that sacrificed some personal aspect of learning in return for convenience. At one point he notes that it is “obviously not as personal.”
D—is unique regarding one aspect of the study, and that is he is one of the few subjects that make note of the actual environment of the study. He makes explicit note of graphics that have been included in the assignments and of information that is missing from the case presentations. This is actually in keeping with what was predicted by the learning style instruments. In fact, the instruments do seem to predict certain strategies in how D—makes sense of the online materials. The strength in extraverted sensing would predict that he:

… reads a lot more off of somebody and if you know … I do enjoy that part of conversation that you can look at somebody in the middle of what they are saying and give them that look and “no, that’s not what I’m talking about.”

But more importantly, he prints all the cases. He orders them in his own way, and when he needs more information he uses Google on his own to obtain that information. When asked how to improve the class, his answer is, in essence, to allow him to order the information in his own manner and with his own rules.
Learning Materials

In the initial analysis of the system that is formed in an electronic classroom, there was equal consideration given to the students, to the teacher and to the computer based learning environment and class material displayed within it. Students and teacher have been viewed through the lenses of personal interviews, of learning style instruments, and of class interactions. The analysis of leaning materials also needs to contribute to the thick record documenting the system since it is through these detailed observations that the overall system may come into view. In order to present a balanced view of the environment, it will also need to be viewed in several different ways.

One problem with this is that a robust view that takes all of the varied factors for a graphic analysis of learning materials has not been done before. Kordel (2007) describes the background and history of the diverse criteria that will be used to evaluate the web pages that are used in this on-line class. These are summarized here:

1. Overall Graphic impression. -Do the graphic elements provide relevant information in a manner that clearly and unambiguously advances the educational purpose of the page? Do they assist in the creation of a mental model of the proposed topic?
2. Data Integrity - Is the user treated as intelligent and able to draw conclusions from the information. What percentage of the characters, lines, charts and graphics are used to convey information? Is the author of the page using page elements to obscure the message rather than reveal it?

3. Specific use of page elements - Is there an appropriate use of font, line, space? Is it easy to distinguish background from foreground in the page, and the information transmitted by it.

4. Usability - is this page “usable” for the purpose of education, that is, does the arrangement of navigational elements on the page facilitate the educational purposes of the page?

5. Learn-ability - does this page help people learn? Does the page presents new material in ways that take advantage of technology and encourage students to learn, or does it simply move previously developed materials “as-is” to a new delivery format. Does the page assist in the development of a mental model, or is it simply an aggregation of facts which leaves any hoped-for organization to the student.

In addition to the evidence presented by the web pages themselves, there was also some discussion with L—, one of the administrators involved in the
Angel system about some of the background and history of the Angel course management system used by this and all Penn State Courses.

Angel System Background

When this research was conceived the course content and the presentation of that content was conceived as an equal part of the system, able to shape and be shaped by both the students and the teacher in the class. In keeping with Carspecken’s idea of compiling as much background information about the subject as possible an interview was conducted with one of the administrators of the Angel system. The thought was that the other participants in the class had been viewed through several different perspectives, it was appropriate to get a view of the presentation system that was not just the view of the teacher or the students, or the researcher.

While it is not necessary to present a full history of Penn State’s on-line learning environments, there are several points that do need to be covered, and which mesh with student and faculty observations during the interviews. The most critical starting point for the purpose of this project is the view of the Angel interface that is held by the faculty and administration of Penn State. Perhaps the most interesting element revealed in the interview with A—about teaching using Angel was the thought that distance learning is just “second best.” This idea of the focus of the Angel interface was pursued with L—:
I would say it is without doubt built for a residence based format. That is what they will tell you when you read the literature. That was the structure, as were many of these systems, Blackboard and so forth. As on-line learning, totally on-line learning, came into its own in the last ten years, many of these learning packages that were designed or conceptualized as support tools for a face to face experience have had to modify. And they’ve made some adjustments. But I still say there are features in Angel, or in Blackboard, or WebCT that suggest that the learning experience is a face to face experience. I don’t know if you’ll ever get out of that. I think it’s just inherent in the design of these systems.

The thought that followed, and the question that arose from it then becomes the role of educational research specifically targeted at improving the nature of the on-line experience and the education system under direct consideration. Was there any research being pursued by the various schools at Penn State? This might include the various schools of educational, the World Campus, or other discipline specific institutions spread across the state. While acknowledging that there is a wide variety of users of the system, and a wide variety of development potential with the University, he cited one of the major difficulties to such development. On-line education is simultaneously a new and an old idea. While in computer terms it dates back into the late 1960’s and is therefore liable to be considered old and well developed, in terms of faculty involvement, it is not quite so clear. L—speaks of an in-service teacher he had:
he introduced this idea, I’m not sure whose idea it was, but it was the
degrees of adoption model. The first degree of adoption is we did what we
did before in a different environment and we call that a new thing. Second
degree of adoption is where we do stuff that is new that the old
environment couldn’t do. The third degree of adoption is when we do
things we couldn’t even conceptualize in the old environment. I always
keep that model in mind as I look at the faculty migration from the face to
face to the on-line environment, or somewhere in between that might be a
blended experience.

So the problem expressed is that in terms of faculty involvement with
Angel, or with any on-line learning system, for faculty who have had extensive
face to face teaching experience, on-line learning is still not subject to a standard
set of ideas, conceptions and uses. Instead it is being adopted, one by one, by a
variety of faculty members who are at different places on the degrees of adoption
scale.

The idea of a standard interface for Angel is likewise unstructured. While
the central Angel team maintains a variety of standard style sheets, there is still a
sense that individual modification, within limits, is a benefit. Most of the limits
seem to be determined by the system, not by the people using it. In terms of how
updates to the system are enacted:

There’s a formal process, actually. It’s multiple tiered, some formal, and
some informal. The formal processes engage a variety and level of input on
a regular basis. There’s an Angel operations team, and I think they meet weekly. There’s an Angel steering committee, I’m not sure of their frequency, so those are rather formalized groups that provide input and feedback and so forth. The informal, or perhaps ad hoc is a better term, processes they use are to, for example, there’s a survey going right now of gathering user input on the functionality of Angel. That’s the first time I’ve ever heard of it being used, although they may have done it in the past and I just wasn’t aware of it.

**The Angel System Student Interface**

One distinction that is drawn in this research is that between the Learning Management System, that is, the software infrastructure used to track where a student is and what they are doing, and the material presented upon it, the actual learning content of the subject class. In this section I review a representative sampling of web pages that a student sees when taking an on-line course. The first section consists of several screens that illustrate the Angel System only, the second is the actual course content presentation for XYZ. It is only through this kind of analysis that some of the assumptions built into the browser can be exposed.

The Learning Management system in use at Penn State University is called “Angel,” or “The Angel Course Management System.” It is the first screen PSU students see when they attempt to access course material, and it is the only way a
student can access any of that material. A detailed view of some of the interfaces to this system is needed to understand its contribution to the learning system.

The first screen that a student sees after typing in the URL of http://cms.psu.edu is seen below. What is immediately of note is the amount of information that is presented to students prior to their logging into the system. This information can be divided into two basic categories. The first concerns items that are generic to the presentation of information in the learning system and which will echo through every screen the student sees. The other is specific to the Angel system itself. Perhaps the most efficient method of examining this information is to examine the generic items first, understanding that what is uncovered here will be true for every screen the student sees in the course of his instruction.

The screen below is in some ways accidental. There has been no special preparation for this project, rather, it is typical of the way most users connect to the network, clicking their browser and accessing a web page.
While many elements of a detailed learning evaluation are not appropriate to this introductory screen, there are a number of items of note. There are roughly 34 lines of potential text on this screen (font size lends some amount of uncertainty to the count). Of that number there is a basic breakdown as follows:

7 lines are allocated to the browser/computer system itself

27 lines allocated to the Angel login page

This means that 22% of the available information space is dedicated to purposes that do not contribute to the specific reason this page is on the screen – logging into the Penn State system. This percentage remains constant throughout the entire learning session.
It is of note that the user name and password are not entered on this page, but rather, one pushes a button expressing a desire to enter user name and password. This seems to be contrary to what has become accepted use in most such situations.

It is the next screen that presents the most striking visual contrast to the previous. This page has one purpose, to obtain and validate user name and password, and there is only one function possible on this page, to enter username and password. The simplicity and elegance of this page should be remembered as the system is navigated.

Once the student login is confirmed and the student is granted access to the learning management system the screen they see below appears.
This is the central Angel screen which appears, with some personal variation, for all Penn State students who enter the system. There are a number of items of note, but several leap out immediately. First, the same 22% of the screen is still allocated to clerical tasks of operating system and presentation of the browser itself. On this screen, however, the actual content is different, although the visual clues that one is “in” the system rather than at the logon screen are subtle. The small text “logon” at the top of the first column has been replaced and there is a listing for “My Profile.” Below this, in white text against a blue background is listed “My Courses.” My name now appears in a small white box at the “top” of the actual learning system content where previously it had displayed “Guest”.

There are several curious and disorienting clues that remain in prominent positions on the screen, however. The most prominent feature of the page, the
banner listing broadcasting the Penn State Angel Course Management System remains in place, and continues to display links to various other Penn State locations:

- University
- LIAS
- Registrar
- Search PSU
- WebMail
- Portal

While several of these have obvious purposes (Registrar, Search PSU, WebMail), others are not quite specific. Does University take us to the Penn State Home Page? What is LIAS? What does the Portal permit access to? These additional menu choices are presented in a banner that is given approximately 10% of the screen, but the question becomes what do they contribute to the purpose of the page? When considered in the full context of the screen, that question becomes even more cogent – the various headers, OS components, static banners, etc. make up over 50% of the available screen space. Within that 50% there are a number of items, such as the 4 navigational icons on the far left of the screen that have questionable function. It may be safe to assume that the “?” icon is a help button, but what does the circular icon above it do? If the cursor is “hovered” over the button it reveals that is the log-off button, and it is only then that one realizes it is
the same icon on the power switch of the computer. Each of these icons hints at something that becomes explicit in the center of the screen.

One of the things that should be considered in any study of web based learning is the assumptions that are built into the system and how the students and system administrators come by those assumptions. An almost perfect example of this is in the center of the screen in a box marked “My Toolbox.” Within it is a link labeled:

My Bookmarks: Keep a personalized list of bookmarks for easy access to your favorite sites.

The first question to ask is why is this here? The browser itself, part of that static 22% of the screen dedicated to system tasks, offers to save bookmarks to easily return to pages. Why did the Angel administrators feel it necessary to offer what seems to be a redundant capability within the system? The answer to that question is that by placing it within the Angel system, it is possible to keep those bookmarks available when moving from system to system, as students often do when they use different computers in the library. The issue here however is not how or why this was done, or the relative benefits of doing it this way over another, but how did the student learn this? The larger issue of specific concern over time is how do new capabilities of the environment move from “unknown” to “specialized knowledge” to “common knowledge,” and what is the mechanism for communicating that, especially when it cannot be assumed that all users of the system are entering with the same level of expertise on the system. This disparity
in user ability has already been noted in the interview with S—, who complained about making boxes on a computer screen rather than learning about Turf Grass. How do neophyte students attain what is considered “common knowledge.”

The screens below are actually different views of the same screen as first seen in Figure x. Each has been scrolled down slightly to reveal more text. Two of these views are seen here, but more are possible, since we did not reach the bottom of the scroll bar/text. Several questions immediately present themselves. How much of this information does the student need? Depending on the answer to that question, the follow-up then becomes why is that information placed in such an inaccessible location?
Course Content

It is only after a student selects an actual course by clicking on it that they enter the course pages, and there is a large change in the look and feel of the environment. It is immediately apparent that something has happened. The color has changed. The generic banners are gone and have now been replaced by an explicit statement of the name of the course. At this point I would like to switch from looking at the environment to a detailed look at the course content.

The default view for students entering the course displays a number of interesting features, both positive and negative. On the positive note, the color palette of the screen is changed, which give an immediate signal that we are in the course. The generic and space-wasteful banner has been removed and replaced with the name of the course and a header row that is smaller and more task-
oriented. A negative however is that while the screen lists the discussion forums and other core class activities, it does so in a single column format, creating the need to scroll off the bottom of the screen to see discussion groups beyond “H.” Note that this screen could easily have been divided into three columns. Only one of those is used, and rather than distribute content across the three columns, the screen maintains a single column and forces the user to scroll to see all of the content.

While this may seem like a small matter, the reason to consider it in depth is the tension that it introduces into the understanding of the page. Consider for a moment the basic difference between a web page and a bound book. The book is obviously a sequential artifact; by its nature it must select a sequence of pages to present information. We have come to expect a certain order to that sequence, running in general from title page to table of contents, to chapter 1, and so forth. The general description of web pages considers them to be the opposite of this sequence bound presentation, with the most notable feature an immediate access and practically unlimited access to any page a person chooses to link to. Here we see the randomness demonstrated by the ability to go to the various discussion forums, but there is also a “table of contents,” a decidedly sequential concept, especially when tied to a display format that subconsciously amplifies the sequential nature of the page. This theme will run through most of the content pages of the course. Consider the Table of Contents seen below.
Once again the idea of random access to any of the case studies is in conflict with the very sequential idea of scrolling down the page to see all the cases. Immediately below the table of contents is a block of empty space that occupies the place where the eyes land when first viewing the page. Under that is the orientation case, followed by the generic rules for all cases. These features take up most of the screen. A small banner of something that is visible on the bottom of the page, and the scroll bar indicates that there is more content available off screen, and yet, the items that dominate the page are features that will only be used once during the orientation phase of the class. Once viewed, a student may wish to review them, but instead, here they are the central focus of the page. It is only
when the remainder of the page is scrolled do we see what that the “Table of Contents” at the top of the page references the cases that actually make up the bulk of the class.

The implications of this are explored more fully in Chapter 5 as the overall system is considered. It is only necessary to view a few more screens to confirm the trends that have emerged and which comprise the thick record being compiled in this section. One of those is immediately below, the landing page for the Oak Hill case, the orientation of the class.
Features that were observed on one screen are now seen to be typical of all screens. The content could easily have been arranged in several columns that would have eliminated the need to scroll down on this page to see everything. That was not done, reinforcing the sequential rather than the random access nature of the page. A new problem is now seen. The banner still reads “table of contents,” but we are no longer on the table of contents page. When viewed as a complete screen more than half that screen is irrelevant to the any educational purpose. It consists of detritus of the operating system, detritus of the learning management system, banners for pages we are no longer viewing, pictures or blank space the neither
contribute to the meaning of the course content nor arrange it in a way that helps create a mental model of the case. It could be argued that the page does list the essential elements of the case, the links in the center that start with the “background” and extend down. This is true, but the position of the scroll bar would indicate that there is a great deal that we cannot see. What is it and what does it contribute? Is the reason we cannot see it because the Angel system does not easily import text into columns?

There is one other item that becomes apparent after an extended consideration of the page, and that is the practical absence of any significant amount of textual information. The case-relevant “text” of this page consists only of the following:

Case Description: Oak Hill Country Club’s East Course is known for its small, “target-type” greens and impeccable tournament quality. All of the greens meet this loft praise, except for number 3. Surrounded by 60-foot tall oak trees and white pines, the green is moderately shaded most of the day. This is a “push-up” green with many years of accumulated sand in the top portion of the profile from topdressing. The membership is unhappy with the current situation and wants the green brought up to the level of the others comprising the East Course.

As the student begins to explore the case through the supplied links, the ability to navigate the case in an exploratory fashion begins to conflict with the actual layout of the case. As an example of this, consider that in the above page
there is a link to “views of the green.” Clicking on it does not lead to actual views of the green, but to a page with additional links to these views. Two of those views have been reproduced below to show the general layout of the screens on entry into the pages.

The layout of the hole consists of a graphic representation of the hole, but again, it is not possible to view the entire graphic on a single page.
Discussion

Kordel(2007) has developed guidelines for evaluating learning pages that consider a number of criteria, including Overall Graphic impression, Data Integrity, Specific use of page elements, Usability and Learn-ability. It is difficult to apply all of these measures to each of these pages, but with some effort a general impression can be derived.

When considering the Overall Graphic impression of the pages, the question is whether the presentation of information on the pages provides a student with relevant information in a manner that clearly and unambiguously advances an
educational purpose and assists in the creation of a mental model. While that is the intention of all of these pages, the problem with many is that there is a tension between what is seen and what would better present the content. The one item that easily illustrates this tension is the constant need to scroll down pages to see all of the relevant content, while irrelevant page headers and empty space are given the center of the presentation space. In terms of the overall environment, the presentation space itself is too small, consisting of what is left over after the operating and learning systems have levied their presentation tax.

The Data Integrity of these pages is a consideration of how the user is treated regarding his or her intelligence and ability to draw conclusions from the information. While it might be (and perhaps should be) argued that a greater percentage of each page should be used to convey information, it is clear that the authors of these pages, the instructor and the administrators of the Angel system, are trying to use the system as it exists to present learning information. No attempt is being made to obscure deliberately the ideas on the page, however, it is also clear that the learning environment does present some impediment to that presentation.

When considering the specific use of page elements it is some helpful that the actual course content is presented in a different color than the Angel landing pages. Unfortunately, there is also a definite breakdown in the use of a number of individual page elements on these pages. Pages are designed and displayed with vast amounts of irrelevant and background information highlighted while at the same time vital obscuring vital information. Consider the several pages that could
have displayed all information needed for both navigation and for the creation of a mental model of the information available on a topic.

When considering the usability of these pages for the purpose of education, several references to cited literature immediately come to mind. None of the students said they had any explicit problems with the pages, but there is Bermejo’s (n.d.) idea of psychotechnologies, which have effect even if that is not a conscious effect and Mayer’s (1989) idea of good mental models to name just two. The curious, and perhaps disturbing thought, is that web usability for the purpose of education often seems to follow a Nietzschean ideal, that which does not kill us makes us learn.

It is with the new measure of Learn-ability that some issue must be taken. One of the questions is whether the pages help people learn? Some of the specific questions are whether the page presents new material in ways that take advantage of technology and encourage students to learn, or does it simply move previously developed materials “as-is” to a new delivery format. Does the page assist in the development of a mental model, or does it leave the organization to the student?

I think that here with the idea of Learn-ability there is a definite breakdown. Several of the research subjects noted that they needed to print material, and yet when invoked, the print function removes formatting and prints pages of totally unformatted text. Discussion group contributions are presented with multiply nested “re:” headers that reference comments that are often pages away and which cannot easily be recalled and put into context. Most pages land on or highlight irrelevant background information rather than information that can be used for the
creation of a mental model. There are so many of these fundamental issues that consideration must shift away from the pages themselves and what they do or do not do to promote a learning model and move to the students themselves. In the interviews, students were all asked specific questions about the material and the interface, and all reported nothing at all, or only minor problems. The question that is relevant to this study is how the system reacts. This issue is one that will be addressed at length in the next chapter, which considers how these individual elements form that system.

Chapter Summary and Findings

The goal of this chapter has been to compile the thick record of the three major components that define the online learning system. Students and teacher have been interviewed both early in the class, and after its conclusion. They have been observed in class and have taken two instruments to determine their information presentation preferences. The learning materials have been examined in a way that reveals and differentiates the details of the learning management system and the course content, and that content has been considered in some detail as a means of conveying information. In addition some background has been provided about the administration and goals of the learning management system.

This thick record is the raw observations and detail on the interactions of the multiple facets of the environment under study. The goal has been to examine each of those components independent of the others, and some analysis of each
element has been added. This analysis has been limited to consideration of each element in isolation, that is, the multiple facets of each student’s record have been examined in an attempt to discover the essence of the student. The same consideration has been directed at the teacher. The learning management system has been considered as an information transmission and learning system.

What has not yet been considered is how these students and this teacher have worked within the confines of the learning management system and the course content to form a system. That task is addressed in the next and final chapter. In addition, in the next chapter, the implications of that system for future research and for current practice are addressed.
Chapter 5

Discussion and Conclusions

The purpose of this study has been to examine the consequences of using computers as teaching aids and to explore the factors that may shape to those consequences. It has tested the idea that far from being a passive information delivery and communication tool, the computer adds to, subtracts from, and changes the nature of information presentation, comprehension and communication. The interactions within a class form a system in which each element of the system influences and is influenced by other elements in the system. In order to conduct this study, and in compliance with Carspecken’s idea of compiling a thick record in order to provide the depth of data needed, I have collected and documented a variety of data on teacher and students, administrative and technical help, and also included observations on the structure and format of the educational materials. The task is now to use that thick record to address the questions that were raised in the first chapter of this work and which have motivated everything since.

The research questions that have been raised were:

- What changes occur for teachers and students when the learning transaction is extended onto the computer? Specifically, are there changes:
  - in the content of discussions?
  - in the conduct of discussions?
  - in how students and teachers conceptualize knowledge?
- in how students and teachers envision the purpose of education?
- Does the presentation and communication of information on a computer screen affect how students and teachers interpret and react to the information?
- Do student and teacher background attitudes, personality type, information processing style and self-perceived computer competency affect student discussions, conceptualization of knowledge and the perceived purpose of education?

Now that it is time to attempt to answer these questions, some manner of relating the data to the questions must be addressed in a way that treats the collected data with respect but also in a way that reveals what may be considered the fragile inter-relationships.

**A Further Consideration Of Carspecken**

The collection of data from the various sources has been undertaken with Carspecken’s (1996) five step methodology firmly in mind. By using this methodology for conducting qualitative research, many of the data collection and initial interpretive issues in this study were given a solid theoretical foundation. These included Carspecken’s observations about the holistic nature of the system under study, the validity of data collection and the preliminary interpretation of results.

Those elements of the course selected for study, and the aspects of those elements selected for study were based on the need to illustrate the system postulated to be in play in the typical on-line course. In the previous Chapter, I detailed the results that followed
the first stage in Carspecken’s methodology, the building of the thick record, and the second stage, the preliminary reconstructive analysis which begins to add low level inferences to the primary record and to begin the process of reconstructing meaning from recurrent patterns in the primary record. At that point, the meaning contained within the data began to coalesce and the larger system themes began to emerge.

The third stage of Carspecken’s methodology is described as dialogical data generation and it consists of a qualitative interview after the initial data collection and preliminary data analysis. As per the methodology, this interview was designed to allow the subjects to challenge and comment upon the observations of the researcher.

The final stages of Carspecken’s theory move clearly into the analysis of the classroom interactions discovered in the previous three stages as a system. Carspecken describes it thus:

Stages four and five concern the complex relationship existing between the social site (or group) of focal interest and various other social sites (groups). These relationships have to do with system factors. In stage four the idea is to discover specific system relationships, such as relationships between a school and its surrounding community, or a youth culture and the popular media. In stage five the idea is to consider one’s findings in relation to general theories of society, both to help explain what has been discovered in stages one thru four and to alter, challenge and refine macrosociological theories themselves (p. 172).

It was postulated that the system proposed for study here was the one that existed within the classroom and which consisted of teacher, students and media. Using Carspecken’s methodology was thought of as a way to organize and analyze what was
projected to be a large amount of interrelated data. The thought was that after this data was collected there would be a divergence from the methodology at stage four, since it became more explicitly “critical,” which was not the purpose here. The research itself has moved that divergence from the end of stage three back to the end of stage four. While still maintaining a primary focus on Patton’s (2003) micro system within the classroom, there are several aspects of the macro system outside the classroom which may have more influence on the classroom than previously considered. It will benefit our understanding of the complete system to add these elements to the model of the system used when going forward.

The system

Before revising the system, it will be useful to consider how the thick record that was recorded during the research fits within the initial presentation of that system. It is only by viewing it within that understanding that the shortcoming of that understanding will eventually become clear. In order to do this, it will be helpful to review the system diagram presented previously and move from the potential interactions proposed to the specific interactions observed.
Course content was proposed as the common and unifying element. It was the most direct explanation of why the members of the class had chosen to associate themselves; they had all viewed a course catalog and registered for this course because they were interested in the content. The teacher was contracted by the University to teach the course content. Because of this the content would be the clearest point to focus on when considering how both groups viewed and reacted to that content as it was presented within the environment. Students and teachers would approach the content through the filter of their own cognitive style and personality type, and that style and type would interact with the course content as presented by the learning management system. Assignments from the instructor would be filtered through the instructor’s cognitive style and personality type, and the responses from the students to each other and to the instructor would also be filtered in the same.

The term that was coined in this study to describe these interactions with the system was “cognitive distance.” It was derived from the idea of transactional distance described
by Moore (1997) but was intended to be more cognizant of the additional effects of the medium itself upon the content and the resulting transactional distance.

This will become clear as a simple lesson is traced. The instructor determines what needs to be communicated, and his or her personality and cognitive style shape what is proposed for the class. That proposed lesson is then shaped by the limitations and requirements of the display medium and presentation system that is to be used. As students view this lesson the meaning is then filtered by their cognitive style and personality type as it interacts with the medium. Corresponding responses are then shaped by the capabilities of the presentation system and the same personality factors.

If the student’s personality type and cognitive style are matched with well designed course material presented in the proper medium by an instructor who is also attuned in terms of personality type and cognitive style to the medium and the material, the student should experience no barrier to learning because the cognitive distance is the shortest. A mismatch in any one of these areas will create a barrier to learning, a cognitive distance that must be overcome. The size of the barrier and the amount of effort needed to overcome it will depend on the amount of the mismatch.

**System components**

With the system as described above firmly in view, the first of several iterative analyses of the data begins. The research questions that have been the motivation for this research will be kept in the forefront, but will not be addressed directly for a few more moments. It will be necessary to walk through several views of the research results in
order to arrive at an answer that displays the system, but it is hoped that as each of these views is exposed, each will contribute to an understanding of the interplay between the various system components. The ultimate goal is that the system that was created by the students, teacher and material in this class can be seen clearly as a system, the common features of which can be used to inform current practice and project future research.

The first such view is an attempt to find the commonalities of the students. The starting point for this discussion is the two learning style instruments. These are the easiest to see because they can be represented graphically, and have already been seen in the individual record of each of the research participants. It is now time to view them in the aggregate.
The PET Results

The four student PET graphs are seen here:

As can be seen, there are notable similarities among the students. All are primarily Judgmental, and within that they show similarly strong scores in Thinking.
Looking further across the charts similarities can be seen in the strong Sensing functions, and all have relatively low scores in the Feeling and Intuition functions, with the
exception of S whose intuitive preference is stronger than the others, but also undifferentiated from sensing. As a result, certain specifics noted for individual students can now be stated as generalities for all the students.

The base characteristics that follow from the extraverted thinking scores are a focus on the external world, and the rational and logical manner in which they approach it. They are grounded in facts or ideals, and a strong sense of what is right and what is wrong. Logic and order are the organizational principles of their world. From the introverted thinking ability comes the ability to create a private version of the external world based on their own synthesized version of what has been presented to them. In addition, when considering how these students interacted in the on-line discussions, the following description becomes even more notable.

ITs prefer to live in an inner world of thoughts and ideas. Their thoughts are less dependent on what they perceive or experience than on the development of their own ideas…Their strength is not in the originality of their ideas or their ability to persuade others. They are able to take the ideas of others; integrate, synthesize and clarify them; and present them in a logical fashion (Cranton and Knoop, 1995, p.4).

When this description is contrasted with the way the students conducted the on-line discussions, it becomes clear as to why they were so focused on the course content. Each was able to focus on the case description without hearing the noise of the presentation medium because that is the way they process information.
In addition to their shared strength in the thinking function, they also shared equally strong abilities in extraverted sensing. They make sense of the world by what makes sense – not the abstract or theoretical but what they actually observe. And it is at this point that the shared background of the test subjects needs to be brought into consideration. They are all actively working on golf courses and solving in their daily lives the cases that were the subject of this course. When viewed using the terms of a “system” the primary informational channel for these students to study the subject of turf management is not actually the computer, but the golf courses they work on every day.

The Gregorc Results

The following four Gregorc charts, when placed in proximity, provide confirmation of the observations of the PET results.
All four of the students exhibit a preference for the Abstract Sequential as their primary informational processing channel, with three of the students showing either an equal or complementary use of the Concrete Sequential channel as a secondary preference. The forth is equally balanced between Concrete Sequential and Abstract Random in his secondary preference. What does this indicate about how they process information?

The description of the Concrete Sequential channel reinforces what has been proposed in the PET. These students approach learning in an ordered and linear fashion, with problems conceived of as having a beginning which flows into a logical middle, which then is resolved in a logical end. The instructor will have an important role as the subject matter expert. They will also need to know exactly what is expected of them and for their good work they will also expect some external reward. In the large picture this may be an expectation of money or status for his work, but in the immediate classroom related environment it may be an acknowledgement from the instructor for a lesson or report he considers well done. This will also be exhibited in a dislike of academic discussions which do not related to the real world (Gregorc, 1982).

When the Abstract Sequential channel is also considered it also adds to the understanding, since now the sequence of events can take on a multiplicity of causes and motivations, but always with the goal of predicting the next step and forming correlations easily. The critical element of the Abstract Sequential channel here is that the words and graphics that appear on the computer screen will represent real objects in a real world, and those objects will be evaluated against criteria that adhere to convention scientific principles.
The AS will be able to convert these abstract ideas into spoken or written communication that transmit his knowledge graphically. He will tend to weigh all data prior to coming to any conclusion and will delay that conclusion as long as possible. Of particular note relative to an on-line class, it is suggested that the AS will work best in solitude. Further, they will sometimes have difficulty discerning subtle non-verbal cues and innuendos.

The Students

When viewed in the aggregate the results are quite remarkable. All the students seem to be similar in their information processing preferences. What does this contribute to the understanding of the system? In order to answer this question we must go backwards for a moment before going forward, and return to how and why this class and these students were selected for study.

When the research proposal was made to the instructor several classes were under consideration. One was an entry level class in the program, and the other was a more advanced class. The discussion at the time centered on the fact that the entry level class experienced a high level of attrition as students discovered that they did not like on-line learning. Given the original research proposal with its limited number of test subjects, it was felt that the more advanced class presented a more stable environment where those who were part of the study at the beginning would remain in the class through its conclusion.
The realization that has surfaced over the course of the research and as the results of the various data collection has begun to aggregate is that the students in the more advanced classes have more in common than simple fact of attendance in the same class. The external consideration that must be taken into account is the initial motivation for attendance in the class. As was discovered through the interviews, these students are adults working in the golf industry. Advancement within that industry is predicated on the possession of an academic certificate. To put this bluntly, one of the major motivations for these students is to get their ticket punched. In order to do that, they might be willing to overlook some things. During the interviews, several students did note that they would have preferred face to face contact, or that they missed having the ability to read the body language of other participants in the discussions, or the simply ability to say, “no, that’s not what I meant” in real time, rather than extending the exchange over several days.

The internal consideration is related to the fact that attrition is higher in the introductory classes. While this can be attributed to a variety of factors which will include those not related to learning, one of those factors will be that the students who remain in the program can meet the requirements of the program using the distance learning facilities that are provided. When the learning style and informational processing preferences are so similar and striking between the research subjects, some note must be made of this. Some attempt to place this in the context of the research and this class should be made.

To relate this back to the four student subjects who were involved in the research, we find a number of shared backgrounds and experiences. All are involved in the golf
industry, all wish to advance in their careers, all are in the turf grass program and all have taken multiple on-line courses as part of that program. The part that has been discovered through this research is that all have similar learning style and information presentation preferences.

The instructor

When considering the instructor, or more specifically, how the instructor interacts with the system, it is helpful to start with his comment about distance education being second best. The complaint centered not on any specific failing in the on-line environment as much as it did on the basic limitation of any communication medium. Anything not “live” would be second best. In this case it is computer based interactions, but the suspicion is that teleconferencing would also fall into this second best category.

In order to understand this, re-consider his learning style results for a moment:
Unlike the students, who were all of a type, the instructor’s preferences are distinctly different. The PET reveals a strong Extroverted Intuitive component to his personality, and unlike any of the students, the Gregorc reveals as primary channel the Concrete Random. When these two instruments are considered together the implications are interesting. In some ways the instructor is at odds with the system. On-line learning is conducive to introverting thinking, in structure and in process, and as demonstrated by the profiles of the test subjects. Yet, the instructor’s profile emphasizes his ability to use the concrete world that the students are most comfortable with as merely the starting point for intuitive leaps. By his nature he wants to see beyond the objects into their significance and possibilities, and can make the leap from fact to theory with great agility and facility. It is natural for him to see the on-line learning environment as second best because for him it very clearly is second best. The only thing that could be worse would be if the presentation system and learning materials themselves worked against his psychological and learning styles.

The Material

As has been noted and detailed in the previous chapter, in many of the pages that comprise the course material, there is a tension between content and presentation. The clearest illustration of this is the need to scroll down pages to see all of the content, and on many pages to scroll down in order to see the relevant content. On a very basic level this presents a mismatch between the assumed benefit of computer presentation, the ability to randomly access a variety of related learning resources, and the actual
implementation of the learning on a computer, which superimposes a very linear presentation upon that material.

One item that surfaced in the two interviews with the instructor and the Penn State Angel administrator is the feeling that on-line learning is somehow subordinate, or second best, to resident instruction. The material itself may foster this view because when the course content is viewed within the learning management system, as it must be by the student, it does indeed come after the needs of a variety of other systems. The primary presentation on the screen is the requisite details of the operating system, then the requisite details of the browser, then the requisite details of the learning management system. It is only after these details have been tended to that the course content can be viewed in what is left of the screen. This subordinate presentation space is the only area available for this, or any, on-line class. The on-line presentation of materials by its very nature makes those materials subordinate to other presentation requirements made upon the screen. In other words, it may be convenient, but is it good educational practice?

As the actual course content is viewed on the screen, it is clear that some effort has been made to distinguish the content of the course from the noise of the presentation. The most easily recognized is the fact that the course background is a light tan, as opposed to the blue of the learning management system. Unfortunately, the way the content pages load the information often leaves large areas of useless blank space in critical portions of the screen.

While all this may be interesting, the real and only issue is whether each page in this course helps students learn in the best way possible. Whether we label that as “learnability” or simply view the pages with a critical eye and questions mind, the answer must
be a “no.” There is far too much displayed on every page that does not advance the cause of learning. The logical next question must then be why does no one either notice or care? The answer to this question may lie in a combination of convenience, expectation or common usage on the part of the content developers, and the ability to look past an interface that in many ways presents information in a way compatible with their own particular learning style.

**Revising the System**

This secondary analysis of each of the elements proposed for the learning system leaves certain questions unanswered, and some interactions unexplained. When the computer screen was considered on any number of levels, the results are disappointing. Among other things discussed, there is too much clutter, not enough information and a mixed message in terms of how to access information. The problem is compounded by the fact that initially no one noticed, and then, when questioned about its shortcomings, no one seemed to care. In the literature review one area cited was the lack of any conclusive research in comparative media studies. Most of the research attributed this to confounding factors that were not part of the study (Reiser, 200x).

In this study I thought I had accounted for these elements, but when reviewing the data and attempting to organize it into a meaningful report, I realized that something was missing. This missing element was considered and reconsidered, and then reconsidered again. It seemed that if it could be addressed, if some rational reason could be found to
account for the lack of concern for the learning presentation the system would be back in balance.

I would like to propose here a slight change to the initial system diagram, based on Carspecken’s methodology. This change results from staying within his methodology fully until after stage four:

In stage four the idea is to discover specific system relationships, such as relationships between a school and its surrounding community, or a youth culture and the popular media. (p.173).

Here the system relationship that is proposed extends the system to consider what are labeled “external factors.”
This is not designed to be a catch all, or miscellany category, but rather to address specifically the inclusion of Stage four of Carspecken’s methodology. In this specific instance it is why these students registered for this class. As the research questions are addressed in the next sections, this reason for this addition to the system will become clear.

**Considering the System in Action**

The central point of this project has been to answer several questions concerning the on-line learning experiences of students and teacher against a backdrop of an envisioned system in which learning style, content, and media interact to form a system. By definition the system as experienced by the people in any instance of it will be unique for that group of individuals. It is also hoped, however, that some distinction can be drawn between the dynamic elements that make up any individual instance of the system, and those things that constitute the “constants” in the system, and from which knowledge can be extracted and used to benefit future practice.

It is now time to visit the questions that have motivated this project from the beginning. As each answer is addressed, it will be seen as having two components, the first which addresses the question directly, and the second, which attempts to determine what factors in the system may cause it to act that way in this instance.

The first question addressed in the research is:
What changes occur for teachers and students when the learning transaction is extended onto the computer? Specifically, are there changes:

- in the content of discussions?
- in the conduct of discussions?
- in how students and teachers conceptualize knowledge?
- in how students and teachers envision the purpose of education?

When the question was written it was not predicted that in this class the conduct of the discussions and the content contained within them would be so inextricably linked. The original thought was that these on-line discussions would parallel the normal discussions held in face to face classes, and would therefore justify being examined for content and for conduct. They could be used as a window into how people reacted to information presented on computer, how they interacted with each other as a result of that information and how they were able to process the information that resulted from class discussions. Such was not the case however, and because of this, those two elements will be addressed simultaneously.

In this instance while the record of the interactions is quite thick, it reveals little of the participants through the anticipated tangents, sidebars and digressions. As the research unfolded the most remarkable thing about the discussions was the almost single minded focus on the course content. This was not simply focused in one discussion group, or two, but in all three different groups where the research subjects participated. This was completely unexpected. In one case the entire student self introduction
consisted of the single word “hello” followed immediately by discussion of the preliminary case.

While this was surprising, it was also revealing. As I considered the various factors that could account for it in greater depth, and in conjunction with other elements of the thick record, several presented themselves as logical reasons.

One element that needed strong consideration was the learning and information style preferences revealed by the learning style instruments. All the research subjects revealed strong similarities. They each displayed long thinking lines in the PET, spanning both introversion and extroversion, and all displayed a similar strength in the Abstract Sequential channel in the Gregorc. While the individual results varied somewhat, the similarities linked them in ways they could not have anticipated. These students were all on the same page in terms of how they wanted to conduct their discussions. Each would be inclined to be concrete, specific, and able to consider the case as presented on the computer, however it was presented, as symbolic of the real problem. They would want to and be able to address it from their strength.

But this does not address all the similarities. There were additional factors that were not originally considered as part of the system, but which became clear during the course of the interviews. All the students work in the golf industry, and have been attending school for several years in order to advance within that industry. That advancement is predicated upon successful conclusion of the certificate program in turf management. These are not students who are interested in taking classes for theoretical or abstract reasons. They share a very utilitarian and pragmatic view of what they are doing
and why they are doing it. It is a shared background that is as much a part of the system as anything that was originally proposed.

There is one additional element of the discussions that was commented on by all of the research subjects and which may further illustrate how the students interacted within the bounds of the system both as originally proposed and as revised. The discussions were structured so that students would read and react to each other’s case descriptions and problem solutions. Questions would be posed in order to strengthen the proposed solution and the students understanding of it. Yet, these questions were often posted at the last minute, so much so that several of the subjects either complained about it directly or proposed solutions to the problem as a way to improve the class. These late responses were posted as if in compliance with an obligation. While within the discussions there is a definite feeling of adult learners working toward a common goal, this tardiness adds an undertone that speaks to more than busy schedules and obligations outside the classroom. Each and every discussion was commented on and commenting on the discussion was one of the criteria used for grading. This will be considered further in the discussions of the conceptualization of knowledge and the purpose of education.

**Concept of knowledge**

Pratt (2002) detailed five different modes of teaching and learning. His diagrams of the interactions between students, teachers and material form the foundation for the system as proposed in this research. As this research has been conducted, and as the
students and teacher have been interviewed, what has become clear is that although the
class is described as collaborative, and structured so that all students must participate in
constructing the knowledge that will result, all the participants in this class actually hold
to the transmission theory of education. The teacher is the final authority and the
students are there to learn how to do it the way the teacher has described. This is in
contrast to the constructivist principles detailed in Chapter 2 (Duffy and Jonassen, 1992;
Bednar, Cunningham, Duffy and Perry, 1992; Perkins, 1992) and ostensibly behind the
structure of the collaborative nature of the class.

There are several examples that demonstrate this transmission based
understanding. The teacher criticized several groups for not asking the right questions,
those that would reveal the lesson the case was designed to teach. Students were
appreciative of the feedback fellow students would give, but wished that the teacher
would comment (or comment sooner) so that they would know they were “right.”

There are several curious inconsistencies to this view revealed within the data,
and within the basic understanding all the students brought to the class. The most
elemental is that no matter what was discussed in the class, if the knowledge was
“wrong” the grass wouldn’t grow. All these students were working in the golf industry
and were, to some degree or another, responsible for making the grass grow and were
successful at it.
Purpose of Education

In addressing the question of the purpose of education, the revised system diagram becomes a necessary tool in understanding student attitudes. Both the interactions within the original diagram that address how the educational transactions are taking place during a class, and the addition of external factors that address why they are taking place are necessary for a full understanding of what is going on. While for these students it is the external factors that become the primary focus when considering the purpose of education, it is this in combination with their common personality type that provides a robust understanding of their conception of the purpose of education.

The external factors that provide a shared experience for the students are that they are all working on the same type of work within an industry that requires external certification as a prerequisite for advancement. The type of work they do lends itself to a certain level of scientific analysis; there is a shared language of plant biology. There is also a very strong external validation. Unlike some fields where results are difficult to assess or measure, for all these individuals, if they do their job correctly, the grass grows.

Coupled with this is a shared personality type that eschews the theoretical for the practical and links the students on an internal basis and the purpose of education becomes quite simple. It is to meet an external measure of competence by presenting the appropriate credentials at the appropriate time, for which there will be an external reward or money and status.
Affect of presentation of information

Whether the presentation of information has an affect on the students and teacher of this class will be the most difficult of the research questions to answer. This is not because there is a lack of affect, but because none of the principles can recognize the affect they are experiencing or acknowledge its importance. It is helpful to start with the question at hand:

Does the presentation and communication of information on a computer screen affect how students and teachers interpret and react to the information?

When asked directly during the both interviews students and teacher claim that the presentation of information in the learning system is not a problem or does not affect them. I believe this is because the computer and the web interface has become such a part of the general culture that it has already faded into the perceptual background. This does not imply however that its affect has in any way faded, or that the signal has managed to penetrate the noise. This may in part be an example of that “total lifetime of experience” derived from Arnheim (1969) and described in Chapter 2. This is translated into an understanding of the visual that is becoming part of our assumed cultural heritage. If anything our ability to measure this affect is in the early stages and is still waiting for the development of the appropriate tools. The original citation of Elkins (2003) about how Mayans parsed their visual communication becomes more cogent and worthy of reconsideration.
A scan of what has been discussed during this paper should be sufficient to address this research question directly. The most basic measure of the affect of the computer screen is the simple fact that two of the research subjects simply chose to bypass it completely and print the learning materials for review. Their learning style and information needs were so at odds with the presentation system that they opted out of using it as their primary method of study. One additional factor that flows from this is the fact that the discussion forums provide a button to print the discussion, but the act of printing will remove all formatting from the text, and print an unbroken block of un-indented text that runs for pages.

The more subtle consideration is the affect of the presentation structure of the materials. Pages present material that will be referenced once in positions of prominence, and material that will need to be scanned regularly in subordinate positions, often scrolled off the screen and un-viewable until explicitly searched for. In the literature review the ability of the computer to create a mental model of the information was discussed. Among others, Merrill (1992) was cited:

The construction of a mental model by a learner is facilitated by instruction that explicitly organizes and elaborates the knowledge being taught, during the instruction; – there are different organizations and elaborations of knowledge required to promote different learning outcomes." (p. 101)

It would seem that this ideal of the constructed mental model would be at odds with a presentation that scrolls critical information off the screen, presents incorrect labels for learning pages and forces the sequential access of information intended to be
accessed randomly. The sequential nature of the presentation was originally discussed by Tufte (2003) as an artifact of the thinking processes promoted by PowerPoint. The question however, is not whether this is so, but how the students and teacher react to it. The answer to that question is more difficult and on one level the study did not collect the information to answer it directly. However, a clear answer is suggested in the results and discussion of the final research question, which returns to the concept of the learning system.

**Background Attitudes**

The final question is the one that most clearly addresses the existence of a system of interactions in play in an on-line classroom. The question as stated is

Do student and teacher background attitudes, personality type, information processing style and self-perceived computer competency affect student discussions, conceptualization of knowledge and the perceived purpose of education?

The answer to this question addresses the reason for this research and I would say that the answer, as demonstrated by the students and documented here is a clear and unequivocal yes. Each element proposed as having the potential for interaction does indeed interact with each other element. This is significant for two reasons. In addition to
the specific comments relative to each of the research questions, it allows a number of
general conclusions that can be stated as results of this research.

Perhaps the most striking is that the system view posited and revised in this paper
has been validated. There is a system and it does exist within the direct elements in the
classroom and it is influenced by the factors outside the classroom. This becomes
significant when placed in the context of one of the issues raised during the literature
review. Reiser (2001) discussed the history of comparative media studies and the
consistent failure to reveal any significant difference between media, or any educational
benefit of using one medium over another. As an addendum to that existing literature and
to future studies of that type the existence of a system must now be considered. Discrete
studies of presentation media will be affected by the system context within which they
fall, and that system must become one of the factors.

An extensive discussion of information presentation was also contained in the
literature review (and supplemented in Appendix II). Writers such as Tufte (1990, 1997,
2001, 2003), McLuhan (1964) and Arnheim (1969) have argued for the ability of graphic
presentation to present ideas clearly, shape the message itself or structure it so that
concepts are presented in ways that facilitate learning. In addition to confirming these
arguments, this paper should act as a call to action. The people who use Angel as a
presentation method consider it to be second best and the unfortunate truth is that they
may be correct.

On-line learning as currently practiced is second best because the information
presentation practices currently in use make it so. Unlike previous computer based
educational systems that dedicated the entire screen to the task of learning, the Angel
system, and any system that allows the browser to be the predominate organizational and
method and presentation medium allows the presentation of the course content to be
subordinated to the needs of the operating system, the browser and the course
management system. Learning on the computer is not second best, but actually third or
fourth best. The sad thing is that after 40 years of practice in on-line learning and
information presentation the various related industries have not promoted excellence, but
rather, managed to package mediocrity in the pursuit of convenience.

Implications for Future Research

Several items that have surfaced during this research present opportunities for
further exploration. Some of these are extensions of the current research, and address
questions that arose during the study, but which were not part of the research design.
Others follow leads that have been suggested by this research and which would serve to
advance the general study of the use of computers in education. Others were considered
during the initial stages of the project as logical progressions from the literature, but were
not pursued in favor of this research.

One topic that flows as an extension of this research, and perhaps the most
intriguing question to address would be to conduct another study of an advanced class at
the world campus limited to personality type. It would be interesting to see the
distribution of type across an entire class and to see if the nature of on-line learning self-
selects one or two predominant learning styles. As a corollary, it would be useful to know
if learning style was a predictor of success in on-line education, and if the deciding factor was the learning style or the reaction to current presentation methods. A similar and related study would be a study of personality types across an incoming cohort in the world campus over the life of the cohort. One of the research questions in that study would be to see if there is a correlation of type with attrition rate.

Research that would be related to the current study would extend the system to include a course with both on-line and face to face components. The research would be designed to see how students reacted to the on line and face to face components and see if their reactions could be predicted based on personality type, course content and presentation method.

The class selected for study in this research was chosen on the basis of it being technical, but not computer related. The initial thought was that such a topic would require computer based presentation, and that presentation was examined in this research. Opening the course selection criteria to include diverse student populations and diverse course content would present multiple opportunities for related research. A course that used interactive computer graphics to explain basic concepts would be interesting as a way of considering how the creation mental models can be assisted using computer presentation. This could be done as a control study to see if presentation affects the creation of a robust mental model within the control group, and if such a model positively affects learning.

The idea of mental models suggests and additional line of research related to how class members related to different topic domain create and consider knowledge and how that consideration is reflected in the use of computers. The group that participated in this
research showed strong signs of a socialized concept of topic and a related use of
computerized tools. It would be interesting to pursue that across various topics and
professions, and include a consideration of how different types of learning are socialized
within professions.

These few suggestions are suggested as logical outgrowths of the current research.
I believe the study of on-line education and computer presentation has been advanced by
the current research, and will be extended by future research into the system that has been
under discussion in this work.

Conclusion

At the beginning of this project it was proposed that if the learning system could
be viewed as the interaction of students, teachers and content and presentation, then this
study would be significant in several ways. It would add to the understanding of the
interaction of those components and how we view the interaction of those components. It
would confirm just how far beyond the traditional boundaries of the learning transaction
many of the relevant factors can come, and in the process help point the way for inclusion
of those factors in future research. It would address why so many of the comparative
media studies conducted to date have failed to find significant differences as a result of
the delivery media of the education. Finally, and perhaps most importantly, it would
indicate some correlation of factors that might contribute to improving the practice of on-
line education. I would propose that these goals have been realized.
The interaction of the components and how we view the interaction of those components has been shown to be part of a system. Web pages not only display information, they shape information. That can be a subtle shaping, or it can be a heavy handed one, but however it is done, the fact that it is happening should be noted and cared for, both in research and in practice.

The traditional boundaries of the learning transaction do not include many of the factors that were brought into this study, some under the umbrella of image presentation, others as part of the study of learning styles and personality profiles. These things interact with each other, and with the larger system within which the learning transactions take place. The inclusion of those factors in future research may help address a number of issues that are currently observable through the research literature.

One of those issues that needs to be mentioned explicitly is the failure of so many comparative media studies to find significant differences as a result of the delivery media. This has been noted in a number of ways. The results here would suggest that there is a new line of research that relates personality to media, and both personality and media to the social position and reason for the education. This may be significant and worthy of pursuit.

Finally, and perhaps most importantly, it moves this from a study that illustrates what is, and provides a method would indicate some correlation of factors that might contribute to improving the practice of on-line education.

A significant limitation at the beginning of the study was the lack of a formal methodology to analyze effectively the content of computer screens. The prototype of a
tool that can be used for this purpose was developed during the course of the research and is included as Appendix 1 of this study.
References


design. In T. M. Duffy & D. H. Jonassen (Eds.), Constructivism and the technology of

Hannafin, M. J., Hill, J. R., & Land, S. M. (1997). Student-centered learning and
interactive multimedia: Status, issues, and implication [Electronic Version].
Contemporary Education, 68(2), 94.


authentic learning environments [Electronic Version]. Educational Technology, Research
and Development, 48(3), 23.

Knowledge Building Processes [Electronic Version]. Educational Psychology Review,
16(1), 75-96.

in open-ended information systems [Electronic Version]. Educational Technology.
Research and Development, 49(3), 37-52.

Hill, J. R., & Hannafin, M. J. (1997). Cognitive strategies and learning from the
World Wide Web [Electronic Version]. Educational Technology, Research and
Development, 45(4), 37.

environments: The resurgence of resource-based learning [Electronic Version].
Educational Technology, Research and Development, 49(3), 37.


Appendix A

Developing an Evaluative Instrument for E-Learning Presention

Richard Kordel

Penn State University
Published by Journal of the Research Center for Educational Technology

Abstract:
There is an understanding on the part of most educators that computers have become part of the learning environment. This environment may be centered in an institution of higher learning such as a college or university, or it may be centered in a corporate training environment. In many cases this understanding extends no farther than the local instructor’s need, the local institution’s implementation or the corporate IS staff’s ability. The computer environment “is” what it is, and no one questions what it does or how well it does it, or what it should do instead. The purpose of this article is to take a step back, understand just how pervasive that environment has become, and to look at the details of the computerized environment with an eye toward evaluating its effectiveness as a teaching and learning tool. To that end, it will provide a prototype evaluative instrument which may provide some criteria for criticism and, if necessary, modification.

Reach and Integration

A popular and widely distributed learning management system in use a number of large universities, including my own, provides facilities for taking part in on-line discussions. When a student or teacher desire to post a comment, a small link is clicked and the comment screen is opened. A small box, approximately 10% of the total screen area is opened for typing. The original post that inspired comment is no longer visible. There is however much navigation visible. Some of this navigation is at the top of the screen, artifacts of the browser in use. There are the standard and generic forward, backward and refresh buttons, although these are not guaranteed to work within the learning environment. There is also a link available to my favorite sites. Further down the
screen, inside the actual learning system, additional navigation is available. Some of it runs horizontally across the top of the window, others vertically to the left. At this point, approximately 50% of screen real estate has been used by navigation, and 50% is left for use by students and teachers. Below the space allotted for adding to the discussion are buttons relevant to the task of writing, buttons to invoke a spell check, preview the text, edit the text in HTML, and finally, a button to submit it. The remainder of the screen, approximately 30% is unused white space. If one takes too long in the composition of a comment the system times out and the entire comment is lost. There is no warning for this.

This screen seems dedicated to some other purpose than the stated one of adding to a class discussion. I am not sure what is more interesting, the poor design of the screen, the poor interaction of the computer system, or the curious reaction of users who are otherwise quite intelligent and demanding within their fields of expertise, but here simply shrug in acceptance when the poor design is pointed out.

This system for posting comments to a class is just one very small example of the many computerized functions a student will now encounter in higher education. If we start with registration, many institutions now offer on-line course catalogs and schedules, and provide for on-line registration. Once registered, students will find their class materials distributed via a centralized course web page. Typical features of this page include the syllabus, selected on-line articles, locations to “hand in” assignments, and some version of the previously noted interface for conducting discussions with the instructor or other students.
If the class in held on-campus the instructor may use PowerPoint to prepare lecture notes and provide students with copies of those notes to facilitate the class and so that students will not need to spend class time taking notes. In a fully on-line class all instruction may take place via some on-line presentation method. The instructor may distribute presentations, direct students to an alternate instructional web page, or provide links to instructional web pages prepared by some third party. In some cases video-taped lectures are included as part of the course materials linked to via these sites. When the use of the library is considered, it is now standard procedure for student and faculty research to be conducted with an electronic portal into the library system. Searches are conducted within various database systems and results are returned which often offer links to full-text page views of the relevant articles.

The computer has touched every aspect of the learning system. When considering how this integration of technology has become so pervasive, looking back at some of the history of the various “new” technologies may provide some useful background, but does not fully address the issue. Reiser (2001) provides a history of both the technology and the teaching methodologies that have been linked with each technology. Whether we consider lantern slides, educational television or immersive language labs, history reveals that prior to this new computer incursion, each previous “new” technology arrived with much fanfare and anticipation, only to be abandoned shortly thereafter, either discarded in disappointment or pushed aside in anticipation of the next “new” technology. It is only the computer that has broken from this cycle and actually changed the way people learn.

While many of these individual learning applications and transactions have been the subjects of study, those studies often treat computerized presentation of information
as unnoticed background environment, and the effect of the computer as something that occurs below the threshold of perception. When it is noted at all, it is noted as something that cannot be changed easily or at all, something that is just accepted “as-is.” The measurement instrument that is proved at the end of this article, and the need to look at the presentation of information on the computer were inspired by the need to evaluate web pages as part of an ongoing study of the effects of moving education onto the computer. The underlying assumption of the article is that web pages that are created to teach something can and should be evaluated on their ability to teach, but that ability is dependent on how well several previously unassociated and underlying components of educational presentation are woven into the page. While the details of that overall discussion will be contained within the study itself, this exercise comprises a component of that research, a proposed evaluative instrument presented to determine how well a web page addresses the needs of learners.

While many individual authors have contributed different aspects to the discussion, this paper will organize those aspects into four components:

**Graphic Excellence** – this evaluation will be based on the work of Edward Tufte and other design specific authors. It will seek to derive general principles regarding good design and apply them to the illustrations used by the course designer.

**Readability** – Inspired by Heath (2000) and others who note the new literacy, this evaluation will seek to develop a way to evaluate the readability of a page based on both traditional readability indexes, coupled with some
acknowledgement of the “new” readability, the ability for a user to decode and understand the various text and text links, the number of those links, the use of graphic hot spots, and other non-traditional methods of encoding information on the page.

**Usability** – Based on work concerned with the usability of web pages in general, this will evaluate the learning system interface on general usability principles, as well as educationally specific principles. It will consider how well the interface promotes the task of learning, and will consider such things as how easily a student can perform standard learning related tasks.

**Learnability** - Based on a variety of works by non-educational authors, including those of McLuhan (1964), Arnheim and Elkins, this considers how well the page promotes the art of learning and thinking, and concerns such areas as how people relate affectively to the content and presentation of a page.

This discussion has been conducted in discrete parts over several different venues, but this may be the first time it is being held in an integrated fashion. Rather than seeking to present these as in any way finished rules of composition, I would like to view this as the first step in a discussion that has been too long ignored.

The nature of this evaluation

The first thing that should be determined is what type of evaluation is under consideration. Reeves and Hedberg (2003) provide a good summary of the various
types of evaluation, along with the relationship to various aspects of the development process. They consider the full spectrum of evaluation, including components that occur during the planning phase of a project, although in this exercise it will only be necessary to consider those parts that can be applied to existing learning centered web pages. Three types of evaluation that might be considered relevant to the current discussion are:

- Formative Evaluation
- Effectiveness Evaluation
- Impact Evaluation

In each case there is some amount of direct relevance, but also a gap that leaves significant components unaddressed.

Reeves and Hedberg describe formative evaluation as occurring during the development phase of a project and serving the purpose of providing “information to guide decisions about creating, debugging, and enhancing an interactive learning system as various stages of its development (p. 60-61).” The evaluation that I am proposing may be considered formative as it relates to future projects that will be developed by those who use the tool, but the pages we will be looking at are already finished and static, so the description as “formative” is not quite accurate.

Effectiveness evaluation occurs in the implementation phase of a project. Their description of it is to determine “whether the interactive learning system accomplishes its objectives within the immediate or sort-term context of its implementation (p. 61).” While this sounds on the surface close to the purpose we are seeking, in truth, the descriptions they use place effectiveness evaluation within the purview of the program
developers and address questions most closely placed, in purpose and time, between formative and impact evaluation.

The final category of evaluation described by Reeves and Hedberg is that of impact evaluation, which occurs during what he describes as the institutionalization phase of a project, when the learning is examined to see if it results in any long term change in behavior. While this is probably the furthest from the mark in terms of the stated purpose here of this evaluation, the description does serve to allow us to maintain focus on the fact that learning web pages should have some focus on learning. As they state, the purpose is “to determine whether the knowledge, skills and attitudes learned in the context of instruction transfer to the intended context of use (p. 62).”

The purpose of including these descriptions is not to try to force a fit between existing categories of evaluation as much as it is to demonstrate that the currently proposed evaluation does not fit neatly into any existing category. Those that were noted, the formative, effectiveness and impact evaluations described by Reeves, provide a “best fit” within existing methods, but do not provide a suitable framework to allow existing web pages to be viewed as learning tools. It is hoped that the proposed instrument will enable the users of electronic learning tools to look at those tools as they are and to determine how best to use the things that cannot be changed, to adapt those that can, and to fit instruction within the environment provided.

Graphic Excellence
The inspiration for looking at the graphic design of learning materials is in the work of Edward Tufte. In his books on information design (1990, 1997, 2001) he uses the illustrative graphics of the past 500 years as his canvas, arguing passionately that clarity of thought and clarity of presentation are related. The timelessness, importance and media independence of this idea is demonstrated by the examples that Tufte cites. When logical thought and clear presentation are both present, ideas can be communicated. Tufte cites numerous examples to illustrate this point; perhaps the one most notably associated with him is Minard’s graphic illustration of the ineffectiveness of Napoleon’s attack on Russia, described as “the best statistical graphic ever drawn (Tufte, 2001, p.40). The alternative, the absence of logical thought and clear presentation, can result in disaster, as he describes in his analysis of the PowerPoint presentation used to make the decision to land the Space Shuttle Columbia.

The actual design principles that underlie Tufte’s work might be ascribed to common sense, if only they were not so uncommon. While there are many individual components that can add or subtract from a graphic, the one theme that remains consistent across all his observations and suggestions is that graphic design is a form of communication; anything that promotes better communication is good, and anything that detracts from it is bad. A number of general principles are proposed: we should consider the elimination of “chart junk,” the relatively meaningless detritus of graphic illustration, often composed of unrelated and un-illustrative decoration in graphic design, We should maintain a consistent scale in statistical graphics. Perhaps the single most important lesson from Tufte is simply the idea of keeping the intelligence of the audience foremost
in the mind of the designer. The consistent goal is to promote graphics that communicate accurate, precise and concise information.

Tufte’s books contain numerous examples of excellence in graphic design culled from illustrations that span centuries. It is not the purpose here to attempt to extract the concentrated essence of the books, but to use them as a guide as to how to look very carefully at what is being communicated through the use of graphics. Does there exist on the page a clear presentation of information that will provide the learner with a clear understanding of that information, or is the information muddy, and the graphics mere decoration?

Readability

It is within the context of instructional software and message design that Heath (2000) makes the point that the concept of literacy itself is expanding. The idea is worthy of extended consideration when looking at how web pages are used for teaching and learning. Reading was once defined as the ability to decode text, but on the web it is evolving into something new. Information is now coded in multiple layers, with content consisting of the standard text, but also expanded into hypertext: text that provides links to other documents or to other locations within the same document. These links can provide deeper, more robust explanation, alternate views or the personal web pages of cited authors.

On the page graphic images may exist as examples of their traditional use as illustrations of the text, or they may provide an alternate form of hyperlink to the
previous idea of deeper or most robust explanation. But graphics may take the form of icons, single buttons that provide a function, and which, while they strive to be clear, add elements of pictographic languages such as Chinese to the task of decoding the content of a page.

Within both of these ideas however, is another new idea that has not been considered within an educational literacy context, that of considering the state of something. A book exists as a static entity, the text and graphics wait to be read and understood. While the postmodernists among us may argue that the meaning of the text may change rather dynamically, none argue that the text, in this case the actual words on the page, is rearranging itself while the book is being read. On a computer screen however, there are a number of informative state changes that occur while a page is being viewed. The image of an arrow may change to the image of a hand, which may change to the image of a cursor, all of which are linked to the action of an external pointing device and which may have any of several meanings dependent on which button is pushed. In addition to the previously mentioned hypertext we must add things such as “hover text” – text that only become visible when a mouse is placed over a word that has a related link to text that becomes visible after a specified delay.

Within this already confusing array of symbols, text and actions, we must include the idea of media elements, animations, moving images, and audio that can be embedded within a page and whose actions can be triggered actively, by explicit action taken by the reader, or passively, simply because someone entered a page. Within this context, how do we define literacy? The challenge in the context of this article is to find a way to enumerate and evaluate the multiple forms a message may take on a web page.
Usability

There are numerous ideas of general web usability (Nielsen, 2000, Flanders and Willis, 1996, Lynch and Horton, 2001) and of specific learning centered usability (Horton, 2000). While the study of usability, often considered under the umbrella of human factors engineering can grow quite large and extensive, the purpose of this section is narrower and more focused. When a student views a web page, is that page usable? Can a student, without too much trouble and effort get to the pages that they need to get to? Can they do what they need to do once they get there?

Several notable red flags exist. Among them are the inappropriate use of color – does light text exist on a dark background? Can you read the text? Is the navigation clear and consistent? Does the author use what Flanders and Willis (1996) describe as “mystery meat navigation?” This is the use of unlabeled navigation that connect to sites unknown. The purpose of the navigation on an educational web site it to allow students to learn, not to demonstrate the misplaced creativity of the web designer. Does the page load in a reasonable amount of time? Students may not be accessing the page over a broadband connection. The overall purpose here is to view how well the site can be used by students for the purpose of learning.

Learnability
The final element that will be considered as part of the evaluation will also be the one most difficult to isolate. The computer as a learning platform has not been considered from the view of a media rich environment. This is more than the simple idea summarized by the use of the word “multimedia,” and is significantly different from the ideas suggested by the topic of usability. It is instead an attempt to consider the effect of these various types of media simultaneously presenting information to the learner. The consideration starts with the work of McLuhan (1964) and his work analyzing media. In reviewing work on learning with computers we start to find such terms as “external cognition” and “distributed cognition (Hewitt and Scardamalia, 1998).” A brief consideration reveals that neither of these terms are revolutionary – a pencil could realistically be considered an aid to external cognition, but when they are used in an examination of the problems and potentials of this new environment we need to open consideration into what might be the most important concept behind the technology, that “the medium is the message.” McLuhan writes, “For the message of any medium or technology is the change of scale or pace or pattern that it introduces into human affairs (p.8).” Consider the changes this medium has introduced into the reading and viewing habits of web users for just a moment before moving the focus to current educational processes.

Among the many places that consideration can extend, there are two threads that interweave and which are of interest to this exercise. The first is how people interact with other people across the net and the second is how people interact with computers and the information within the machine and presented on the screen. Lin, Cranton and Bridglall (2005) explore this first idea with an eye toward how the
environment interacts with personality type. Consideration of the second begins with McLuhan and extends forward into a consideration of the effect of the computer on the conceptualization and presentation of knowledge and information. While the study of these elements could easily become the exclusive focus of an analysis of web based learning, the purpose here is to examine the environment to see how it promotes learning. The challenge will be to look at web pages and determine whether they simply move previous pedagogical practice and materials from one medium to the next, without alteration, or if they take advantage of the unique features of the computer environment to encourage student participation and learning.
The Instrument

The instrument presented here incorporates each of the previously mentioned criteria and presents an opportunity to assess the overall usability of the page.

### Web Page Learning Assessment Instrument

<table>
<thead>
<tr>
<th>Overall Graphic impression</th>
</tr>
</thead>
<tbody>
<tr>
<td>First view the page as an integrated unit. Do the elements appear in balance</td>
</tr>
<tr>
<td>Are you left with a feeling that the page has a purpose or just that the page takes up space?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Page is well structured and balanced</td>
</tr>
<tr>
<td>4</td>
<td>Page is overall well structured but some items appear out of place</td>
</tr>
<tr>
<td>3</td>
<td>Page is neither good nor bad. It has information</td>
</tr>
<tr>
<td>2</td>
<td>This page leaves me with an uneasy feeling. I have information, but I am not sure of it</td>
</tr>
<tr>
<td>1</td>
<td>Page is unfocused, I can’t tell why things have been included or what I should know.</td>
</tr>
</tbody>
</table>

### Data Integrity

Next, focus on the specific information being communicated. Is the user treated as intelligent and able to draw conclusions from the information, or is the information “dumbed-down?”

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Data is intelligent, clear and concise. I can draw my own conclusions. Maximum use of</td>
</tr>
<tr>
<td>4</td>
<td>I can see the data, although there is a loss of focus – lines are too heavy, data</td>
</tr>
<tr>
<td>3</td>
<td>There is some use of graphic decoration, but overall I can still see the data</td>
</tr>
<tr>
<td>2</td>
<td>I am getting lost in the data. I can see, but must focus to get past the decoration to</td>
</tr>
<tr>
<td>1</td>
<td>There is much chartjunk, presentation is pointlessly complex, I do not know what</td>
</tr>
</tbody>
</table>
Specific use of page elements

Consider how various specific elements on the page are used. Is there an appropriate use of font, line, space? Is the background in the background, or does a bold primary color make it the most important part of the picture?

| 5 – The overall impression is that fonts are well chosen and appropriate, color is used well | 4 – Most of the elements of page design are used well, but one stands out inappropriately | 3 – There is nothing very misused, but the page does not feel right | 2 – Fonts seem to be chosen poorly, with serif and san-serif on the same page. Overall a feeling of sloppiness prevails | 1 – The page uses too many elements poorly. Colors are wrong, spacing is wrong, fonts are wrong. |

Readability - Content

This combines traditional readability indexes with web based indexes measuring a new type of readability. The first evaluation refers to the learning/lesson specific content of a page

| Flesch Reading Ease - Flesch-Kinkaid grade level | Text based links on page | Graphic based links on page | Total links on page |
**Readability - Environment**

This combines traditional readability indexes with web based indexes measuring a new type of readability. The second evaluation refers to the background and environmental content of a page.

<table>
<thead>
<tr>
<th>Flesch Reading Ease - Flesch-Kinkaid grade level</th>
<th>Text based links on page</th>
<th>Graphic based links on page</th>
<th>Total links on page</th>
</tr>
</thead>
</table>

**Usability**

Is the page “usable” for the purpose of education? Does it facilitate learning or does it get in the way of learning?

| 5 – The page is well laid out and. It is easy to see what to do and how to do it. | 4 – Overall the page is well laid out, but at some functions are confusing or difficult | 3 – The page is neither good nor bad. Some common functions are easy to execute, others are not | 2 – Overall the page is poorly laid out, but most functions can be achieved with difficulty | 1 – The page is difficult to understand, with navigation that cannot be determined |

**Learnability**

Does this page encourage students to learn using the web, or doe it simply move previously developed materials “as-is” to a new format.

| 5 – The page uses the unique features of the web | 4 – The page uses the unique features of the web | 3 – The page is undistinguished. It | 2 – The page simply exists. Previously developed | 1 – The page is dead. Previously developed |
| to promote new ways of learning and knowing | and tries to create new ways of learning, but something hampers the success of the effort | takes some advantage of the computer, but does not create any new way of viewing learning | material is moved without any acknowledgment of new media. This is undistinguished, but does no harm. | material is simply moved without any acknowledgment that the web may be different. This hampers learning |
References


VITA

Richard Kordel

333 Manor Avenue
Millersville, Pa 17551
(717)872-6678

Education:

2008– Ed.D. Adult Education
Penn State University
Concentration on computer-aided and computer-assisted education.

2001-Master of Science, Information and Telecommunications Systems.
Johns Hopkins University.
Concentration on Computer Based Education and Learning Management Systems.

1976- Master of Arts in Teaching.
Fordham University.
Graduate Scholarship in Division of Curriculum & Teaching.
Graduate Assistant to chairman of Division.

1975-Bachelor of Fine Arts.
New York University.
New York State Regents Scholarship
Kosciuszko Foundation Scholarship for overseas study.

1973 Jagiellonian University/ Cracow, Poland

1977-1978 Brooklyn College/
Graduate School of Computer and Information Science.

Work Experience

1993-2008 Verizon Communications

Computer Based Training development, learning systems deployment and administration, training evaluation. Responsible for training systems used by the entire footprint, consisting of over 400 classrooms, and 200,000 employees.