AN ANALYSIS OF NARRATIVE-BASED EDUCATIONAL SOFTWARE

by

DAVID NOAH

(Under the direction of Lloyd Rieber)

ABSTRACT

Instructional designers often rely on stories to structure interactive learning environments. There is little evidence that they bring contemporary critical theory to these designs, especially as it pertains to the narratological implications of a hypermedia environment. The use of stories in these designs raises issues about the relationship between learning, interactivity, and story. Interactivity undermines traditional narrative structures, diminishing their power as structural agents. However, it also creates constructivist affordances for the instructional designer. How are designers resolving this conflict? How are they using story? This research study examines the use of story and instructional design in selected educational CD-ROMs. The works of Propp, Campbell, and Gagne are used as models for the analysis of the stories and instructional events. The results indicate that instructional presentation in narrative environments is usually sequestered from the main narrative, though there is some relation between story elements and instructional design. The designers do use story to engage learner attention, though there is little consistent correlation with the story models chosen for this research. Character transformation, important in narrative, is not addressed in the software. Simulations offer the most integrated approach to story and instruction, but at the cost of traditional story models. I conclude that story and instruction are largely incommensurable when instantiated within a hypermedia environment. Instruction is transparent in the sense that we go to it in order to get something else: learning. On the other hand, story is opaque in the sense that it is an end in itself. Though we learn from stories, they are in the end too powerful and mysterious in their effects to be entirely harnessed to the horses of instruction. Though instruction can be entertainingly crafted, its didactic nature can never allow it to be only entertainment. The use of story in interactive instruction must necessarily be a balancing act.

INDEX WORDS: Narrative, Instructional design, Educational software, Interactive multimedia, Simulaitons, Gaming

AN ANALYSIS OF NARRATIVE-BASED EDUCATIONAL SOFTWARE

by

DAVID NOAH

B.S., Jackson State University, 1988

M.Ed., The University of Georgia, 1996

A Dissertation Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment of the Requirements for the Degree

DOCTOR OF PHILOSOPHY

ATHENS, GEORGIA

2002

AN ANALYSIS OF NARRATIVE-BASED EDUCATIONAL SOFTWARE

by

DAVID NOAH

Major Professor: Lloyd Rieber

Committee: Michelle Ballif
Michael Hannafin
Michael Orey
David Reinking

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
The University of Georgia
December 2002

DEDICATION

This is dedicated to the one I love: Sandy Bird.

ACKNOWLEDGEMENTS

This dissertation could never have been completed without the generous help and guidance of many people. I would especially like to acknowledge Lloyd Rieber, whose patience has been exemplary, Morgan Nolan, whose conversations have been crucial, and J. S. Bach, whose music has been an inspiration.

TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

The universe is made of stories, not atoms.

Muriel Rukeyser

In instructional design, as in all design, form follows function. It has become commonplace for educational software designers to borrow the forms of stories to embody the functions of interactive learning environments. This strategy assumes that stories and instruction share at least two functions--the need for learner/reader engagement and the structured presentation of information. Relying on stories to fulfill these functions, however, raises questions about how they are being used and whether they are a good match overall for the other necessary functions of an interactive learning experience.

Two problems complicate these questions. The first is the degree to which designers make use of contemporary narrative analysis when creating stories for educational software. A lack of critical analysis may produce unsophisticated narrative structures, thus reducing the instructional potential of story. The second is the power of interactivity to undermine traditional story forms when it was their familiarity and predictability that made them attractive scaffolding devices in the first place. This creates an unstable relationship between story and instructional design.

As to the first problem, story has perhaps been narrowly conceived as an instructional tool because its ready architecture and pervasive presence have made it so familiar that designers use it without thinking about its properties. Story is so implicated in every aspect of human experience, so fundamental to culture and cognition, that its structural characteristics, for instance, can be invisible. However, critical inquiry into its nature spans millennia, drawing on fields as diverse as philosophy, psychology, mythology, anthropology, and linguistics. In this century, the study of stories as such has

been identified as a separate field of its own--narratology (Bal, 1997). The literature of instructional design has ignored this rich discourse despite a growing reliance on the power and familiarity of narrative to bring form and motivational power to educational software. Our understanding of narrative in this context is thereby diminished, and consequently our ability to use it effectively as an instructional tool is also diminished.

For the second problem, the dynamic structure of hypermedia challenges both narrative and the design of instruction. Instructional designers using hypermedia must balance its affordances for learner autonomy (Conklin, 1987; Jonassen, 1989) against its potentially disorienting cognitive burden. Authors of stories in hypermedia must contend with the erosion of traditional narrative structure, since hyperfiction blurs the roles of author and reader and recreates story form as a transient, negotiated construct (Landow, 1997). Consequently, the educational designer relying on hypermedia narratives must find a way to bring the benefits of story form to instructional design without sacrificing the structural power of story for the pedagogical benefits of interactivity. Similarly, he or she must not rely so heavily on story form that constructivist interactivity is too constrained.

These questions about the use and suitability of narrative within interactive learning environments are pertinent to the interests of both commercial software developers and instructional design theorists, as well as being of possible concern to anyone interested more broadly in how narrative finds its way into every aspect of culture. Even a cursory examination of the educational software currently available reveals that narrative-based instruction is ubiquitous, especially in those pieces aimed at young children. Reader Rabbit, Math Blaster, Carmen Sandiego, Oregon Trail, Amazon Trail, the Magic School Bus series, the Living Books series, the Learning Company's Leap Ahead series, the Jump Start series, Disney's learning series, the Dr. Seuss Preschool series--these and many others either have some elements of story form to guide the user, such as animated characters or virtual landscapes, or they are presented completely within an explicit narrative. Not only have these commercial series relied on

story for structure, but also critically influential work such as the Jasper Woodbury series has similarly used stories to great effect (Cognition and Technology Group at Vanderbilt, 1992).

The purpose of this research is to broadly analyze how narrative structure is being used in selected examples of commercially and critically successful educational software to structure the learner's experience, and to develop a theoretical construct for its application. In order to focus the research, I will restrict the scope of this project to educational multimedia that has been favorably received both by the public and the professional community.

Background

Educational Design and Structure

All educational design relies to one degree or another on the application of structure to the learning environment, whether that design is based on instructivist or constructivist models of instruction. The linear structure of the presentation of information was especially emphasized when the educational technology field was centered within the behaviorist paradigm, before post-structuralist perspectives had challenged both the inevitability of certain categories of knowledge and the prevailing epistemological certainties of positivism (Tennyson et al, 1997). Instructional systems design, for instance, which had its origins within this paradigm, champions a highly-structured approach to the engineering of human behavior (Davies, 1997). As another example, Gagne, Briggs, and Wager's (1992) influential analysis of the events of instruction has been a touchstone for systematic pedagogical design. It is based on the assumptions that learning and knowledge are hierarchical in nature, that the acquisition of new skills relies on the mastery of existing ones, and that learning is a stepwise, rational process. Reigeluth and Curtis (1987) have pointed out that instructional designers rely on a handful of sequential strategies to structure learning environments.

Even within a constructivist model for design, however, the issue of how to structure the learning experience is still important. Bruner (1966), one of the pioneers of constructivism, argued that the "curriculum of a subject should be determined by the most fundamental understanding that can be achieved of the underlying principles that give structure to that subject." (p. 31). Admittedly, there is a continuum of constructivist thought, ranging from those who hold a radical constructivist position, in which the structure of the learning environment is kept to a minimum, to those who, while still identifying themselves as constructivists, think it appropriate to strongly scaffold the environment. Perkins (1991) contrasts the two positions with the acronyms BIG (beyond the information given) and WIG (without the information given). He is referring in the first instance to Bruner's (1973) book of the same title, which advocates an active role for the teacher while still allowing ample opportunities for the students to engage in constructivist learning activities. WIG refers to learning environments that provide the minimum of scaffolding for the learning. While the two positions occupy different places on the constructivist continuum, both must deal with the issue of structure in the learning experience.

There are many ways to consider what structure may mean in a learning environment. If structure is understood as a meaningful pattern of experience, then learning environments necessarily reflect cultural patterns that lend meaning--and there are no effective limits to the number of cultural patterns that can be identified.

Stories, Hypermedia, and the Structure of Learning Environments

Although the structure of the learning environment is an issue in any educational design, the confluence of hypermedia technologies and constructivist learning theories has brought this issue to the foreground (Collins, 1996; Duffy and Jonassen, 1992). In hypermedia learning environments the continuum of constructivist engagement is superimposed on a continuum of interactivity, or learner-created structure. The issue for the instructional designer is one of knowing how best to organize the learner's experience

when the interactive nature of hypermedia makes the learner a co-author of that organization (Jonassen, 1989; Landow, 1997). If the designer opts for a high degree of control, and structures the experience with too many constraints, the opportunities for constructivist learner engagement will be reduced and the affordances of the medium will diminish. If too much control is ceded, however, and organization minimized, then the designer risks overwhelming the learner with possibilities (Conklin, 1987).

Stories are one way to negotiate this passage. A story can create or support a structure for the learning experience by lending its own form to both content presentation and learner interactivity. Stories have this power because narrative discourse is fundamental to culture--some have argued that it is fundamental to cognition (Schank, 1990)--and exists in predictable patterns, so that our expectations within a story provide powerful organizers for leading us through the narrative experience. Within any given culture, and even to a large extent across cultures, there is usually a shared understanding of what constitutes a well-formed story structure (Bartlett, 1932; Propp, 1928/1968; Stein & Glenn, 1979).

What happens to stories, though, when the reader may choose to re-organize the paragraphs of the text? This is the case with hypertext. We have grown so used to the idea that there is but one way to present and understand sequence in a narrative, that it is difficult to see how a story of indeterminate sequence is even possible. Classical literary theory, from Aristotle to the present, has presumed the necessary existence of a fixed story line, a narrative flow from a discrete beginning to a resolving closure (Aristotle, trans. 1982). Hyperfiction subverts this convention by making the story line mutable and at issue (Bolter, 1991). Another way to say this is that hyperfiction democratizes the experience of story by promoting the reader to the author's level. It transforms the single voice of the author (the authority) into many voices. It opens up the hierarchical relationship structured by one author, one fixed meaning, and one ideal reader, into a heterarchy of multiple readings. It allows the text to connect with multiple perspectives

and discourses, and does all of the above explicitly--as both expressive device and comment upon traditional print-based narrative.

Instruction, Story, and Choice

The educational designer making use of hypermedia stories must find a balance between three broad areas of concern: instruction, story, and choice. (see Fig. 1.1 and Fig. 1.2) These areas interact along three continua. Instruction and choice may be seen to exist along a pedagogical line with instructivist ideas at one end and constructivist ideas at the other (Papert, 1990). Constructivism encourages the appropriate optimization of learner choice. The more choice, or interactivity, is emphasized, however, the more necessary it becomes to provide a familiar and stabilizing structure in which to exercise that freedom—in this case, narrative form. But narrative form in this instance exists along a line with traditional story form at one end and hyperfiction at the other; it ceases to provide familiarity when the reader, given choices, becomes the writer. Instruction and story may be said to occupy a continuum on which the didactic concerns of pedagogy at one end are opposed by the pure play of narrative at the other. At what point, or under what circumstances, is the tension between these areas most effectively resolved into a congenial and effective learning experience? Unpacking story structure, both its traditional forms and the emerging patterns being created in hyperfiction, seeing what kind of correspondence there may be between it and the structure of learning environments, may help resolve these concerns.

Narrative structure has been interpreted in a variety of ways, and the question of how best to understand its structure when looking at its use in interactive learning environments is immediately of concern. How can story form be analyzed in the fundamentally unstable environment of hypermedia? Since the continuum of interactivity in one of these environments may pass from straightforward linearity to complex user-created patterns, there is no single story format that will accommodate it.

Instead, I propose to use different models of narrative structure for the analysis of different levels of interactivity.

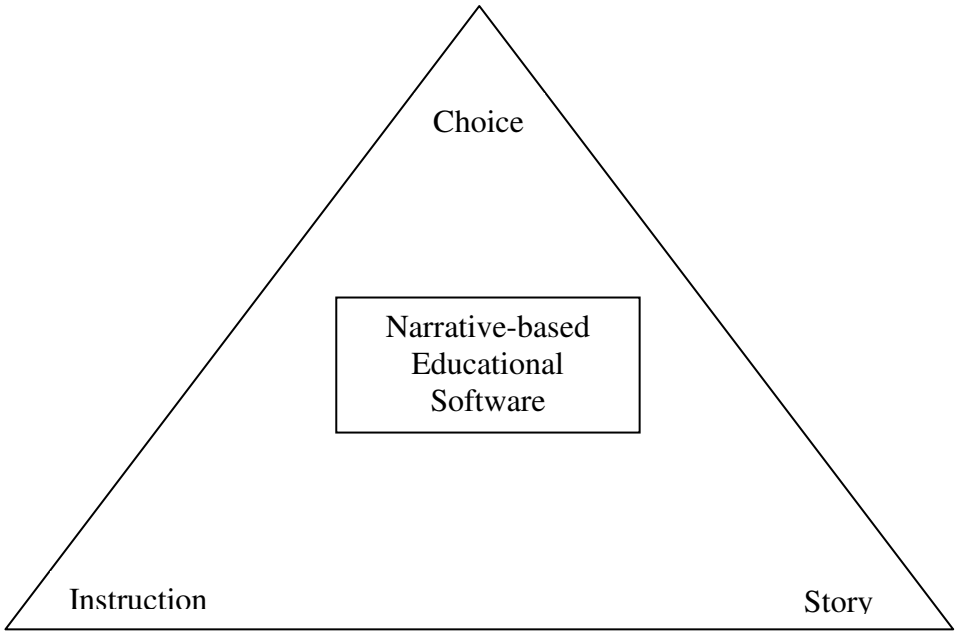


Figure 1.1 Narrative-based Educational Software

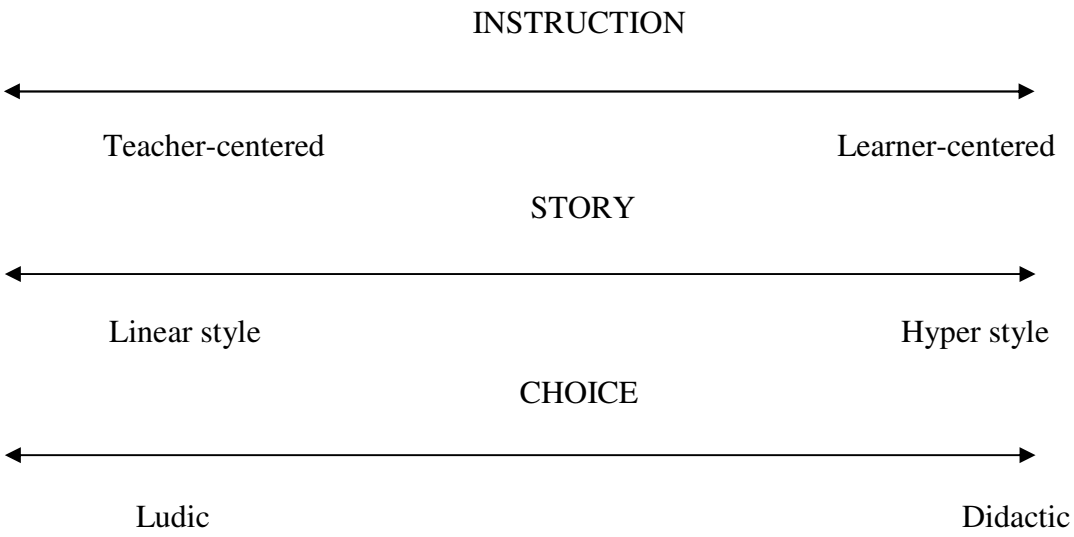


Figure 1.2 Conceptual Parameters for the Investigation

Levels of Interactivity

If the continuum is somewhat arbitrarily divided into three levels of interactive intensity, from least to most, then the following structural perspectives should capture something of each. The first is in terms of the functions of the story, as outlined by Vladimir Propp, one of the seminal narratologists in this century (Levi-Strauss, 1958/1963), the second is in terms of the mythic archetypes identified by Jospeh Campbell as the essential elements of the hero's journey, and the third is based on the patterns of hyperfiction analyzed by Bernstein (1998).

Propp

Vladimir Propp analyzed Russian folktales and reduced their structural content to 31 functions (see Table 1.1) performed by 7 actors: (a) hero, (b) villain, (c) donor, (d) helper, (e) dispatcher, (f) false hero, and (g) princess. Although this influential study has been criticized and refined (Greimas, 1971), its essential identification of structure with function continues to find its way into contemporary narrative analyses. There are several reasons why it is an appropriate perspective to take on stories in learning environments.

Propp applied his analysis to folktales, and one of the criticisms leveled at his study was the difficulty in applying it to more sophisticated literary productions. The stories being created for interactive learning environments, however, are more like folktales than novels. They are structurally short, with characters who are types rather than developed (and developing) individuals, and they often rely on the fantastic for their themes and setting.

Second, his analysis was structural, not only by virtue of its functional identifications, but also because he found that his 31 functions appeared in the same sequence in nearly all his folktales. This was also true of the structures identified by his research descendants, the cognitive psychologists who developed story grammars (Rumelhart, 1975; Stein & Glenn, 1979). As structure is very much at issue in hypermedia, it is appropriate to apply this perspective to stories found there.

Table 1.1 Narrative Functions: Propp

Narrative Functions: Propp

1. Family member leaves home
2. Interdiction to hero
3. Interdiction violated
4. Reconnaissance by villain
5. Villain learns something about hero
6. Villain deceives victim
7. Victim submits to deception
8. Villain harms family member
9. Misfortune is made known
10. Seeker decides on counteraction
11. Hero leaves home
12. Hero is tested
13. Hero reacts to future donor
14. Hero gets a magical agent
15. Hero is led to an object of search
16. Hero and villain join in combat
17. Hero is branded
18. Villain is defeated
19. Initial misfortune is liquidated
20. Hero returns
21. Hero is pursued
22. Hero rescued from pursuit
23. Hero arrives home unrecognized
24. False hero makes false claims
25. Difficult task proposed to hero
26. Task is resolved
27. Hero is recognized
28. False hero is exposed
29. Hero gets new appearance
30. Villain is punished
31. Hero is married and ascends throne

Third, one common denominator between stories and learning environments is functionality. The functions of the learning environment, for example, must, among other things, include an effort to focus the learner's attention, present information, give a progressively less guided opportunity to use it, and provide feedback about the learner's efforts (Gagne et al, 1992). All of Gagne's nine events of instruction can easily be re-construed as functions rather than events. While the functions of narrative are less easily described, it is apparent that they exist. Providing aesthetic pleasure, helping us to make sense of experience, dramatizing life's struggles--these, along with many others, comprise some of the functions of story.

This kind of functional and straightforwardly syntagmatic analysis of narrative pioneered by Propp would be not only necessary but also sufficient if the stories in educational software were linear. In hypermedia, though, the normal linear tradition of print-based stories is, to a greater or lesser degree, transformed into a less predictable form, so that we need a rubric for story form that is somewhat more flexible than the ladder of functions described by Propp. In some educational software pieces, Propp will

be the most appropriate because the interactivity is minimal and story form remains rooted in a traditional conception. But in others, where interactivity has loosened the formal constraints on the narrative tradition, we will need a less constrictive picture of story form.

Campbell

Joseph Campbell's work on the structure of the hero's journey in myth is a good candidate for the middle level of hypertext structure, neither too ordered nor too ill-defined, offering a structure that is still linear, still syntagmatic, but at a higher level of abstraction (Campbell, 1949). It falls short of a true paradigmatic analysis, but allows the tracking of larger themes within a shifting structure (McClellan, 1992). Campbell outlined three basic stages in the mythical journey of the hero--departure, initiation, and return, which are further divided into a number of more focused elements. His work is open to criticism on the basis of gender bias, since the protagonists of the hero's journey are most often male. Campbell also identified seven archetypes as recurring character functions in myth (see Tables 1.2 and 1.3).

In a story-based interactive learning environment, the learner/user *is* the hero. Using Campbell's structure, as modified by Vogler's 1998 synthesis (see Table 1.4) if necessary, it should be possible to track a story form that charts the progress of the learner through the learning experience in a way that is analogous to the hero's journey.

Hyper-narrative form

For those programs that take full advantage of their hypertextual possibilities, allowing the learner to control many aspects of their own experience, it is impossible to rely on a standard story form. As Landow (1997) points out, hypertext narrative takes a wide range of forms; in fact, the relationship between a narrative and its form in hypermedia is problematic in the extreme. Bernstein's (1998) work on patterns in hypertext fiction is one way to approach story form in hypermedia. Bernstein, who is concerned with developing a vocabulary for the structures that are being invented by contemporary authors, has described a suite of emerging patterns that hyperfiction

authors, and hypermedia authors, are using to structure the reader's experience. These include cycles, counterpoint, tangles, navigational feints, and others.

In a hypertext cycle, the reader revisits a node (a lexia) only to leave it by a different route. Recurrence creates structure; musical structure, for instance, relies on it. A cycle serves also to emphasize a particular section of experience. There are, as well, various types of cycles: those which revisit a previous node and depart on the same path, those which signal the end of a strand, and those which incorporate many sub-cycles within their overall larger organization. Counterpoint involves the movement back and forth between two intertwined voices or themes--as in an exchange of letters for instance, or in a dialog. Tangles are a collection of links that provide no immediate guidance about which direction to pursue, a strategy that sounds chaotic but which may serve disruptive and disorienting ends deliberately sought by the author. The navigational feint is the presentation of navigational opportunities within a hypertext that may or may not be

Table 1.2 Campbell's Model of the Hero's Journey

Campbell: Hero's Journey Model

1. Call to adventure
2. Refusal of the call
3. Meeting with the mentor
4. Crossing the first threshold
5. Tests, allies, enemies
6. Approach
7. Supreme ordeal
8. Reward
9. The road back
10. Resurrection
11. Return with elixir

Table 1.3 Archetypes: Campbell

Archetypes: Campbell

1. Hero
2. Mentor
3. Threshold Guardian
4. Herald
5. Shapeshifter
6. Shadow
7. Trickster

Table 1.4 Vogler's Synthesis of Campbell's Stages

Vogler: Campbell's Stages

1. Ordinary world
2. Call to adventure
3. Refusal of the call
4. Meeting with the mentor
5. Crossing the first threshold
6. Tests, allies, enemies
7. Approach
8. Supreme ordeal
9. Reward
10. The road back
11. Resurrection

immediately pursued, and that may or may not deliver on what they promise. These and other structural possibilities make possible narrative forms that do not rely explicitly on traditional narrative devices, and which may prove fruitful conceptual tools for understanding how story and instruction come together in hypermedia.

Implications of the Study

This study offers the possibility of promoting a better understanding of how to use stories in interactive learning environments. Previous research has shown that there is a correspondence between developmental levels and narrative understanding (Sutton-Smith, 1976), and that learners who have a clear grasp of story structure are better able to

understand and remember text (Gage & Berliner, 1988). Reading is more than the simple decoding of textual representations--it is also a semantic process, so that the meaning we create as readers depends on what we bring to the task in the way of schemata for understanding. There has been little application of this issue in regard to hypermedia narrative structures (McClellan, 1992b).

The essential problem of how to use a story to structure a learning environment will continue to be of importance, and possibly grow more important, as interactive learning environments proliferate, since the creation of these virtual environments implies the creation of a kind of landscape, and where we find landscapes we will find inhabitants, and where there are inhabitants, there will be stories.

Statement of the Problem

Educational designers working with stories in hypermedia must find an appropriate conception of story structure in order to use it in the most effective manner. Story form, however, is at issue in hypermedia environments, and reliance on its structure is problematic. How can a designer know the best use for story form when that form dissolves through interactivity? How can a designer strike a reasonable balance between the competing demands (and opportunities) of choice, instruction, and story?

Research is needed to clarify these questions. McLellan (1993) proposed a short taxonomy of hypertext story models that drew partially on the work of Bolter (1991) and Bransford, Sherwood, Hasselbring, Kinzer, and Williams (1990). In addition, this taxonomy was informed by research on story grammar (Mandler and Johnson, 1977; Mandler, 1984). Her list of story models included narrative design, episodic design, embedded data design, detective story design, and storytellers design. Although this list is suggestive, it does not specifically address the problem of how to instantiate those story models within a hypermedia environment, and does not take into account a literary perspective for understanding the structure of stories. In order to extend this line of research, more exploratory work is necessary to establish a theoretical basis for the use of

stories in educational hypermedia. One way to do this is by articulating the comparative structures of narrative and instruction. This will provide a more detailed and flexible analytic understanding of the large scale issues involved in these questions. By isolating the elementary functions of story and correlating them with the elementary functions of hypermedia instructional environments, decisions can be made about how to effectively combine the two into an instructional whole.

The purpose of this research is to broadly analyze how narrative structure is being used in selected examples of commercially and critically successful educational software to structure the learner's experience, and to develop a theoretical construct for its application. In order to focus the research, I will restrict the scope of this project to examples of educational multimedia that have been favorably received both by the public and the professional community.

Research Question

This study addresses one major research question and three sub-questions.

Major research question:

How are stories being used to structure educational multimedia software?

Sub-questions:

1. What instructional functions are present?
2. What is the structure of the narrative being used?
3. What is the correspondence between narrative structure and instructional functions?

CHAPTER 2

LITERATURE REVIEW

Introduction

This review of literature examines theoretical and empirical sources pertinent to a study of story-based educational multimedia. There are three areas of interest: theoretical conceptions of instructional event sequence in instructional design, historical and contemporary conceptions of narrative structure, and learning in hypermedia environments. The review is divided into three broad sections to reflect these areas of interest. The first section describes theories that have been influential in shaping approaches to sequencing in instruction. It draws on the work of cognitive psychologists and instructional designers. The second section traces the development of ideas about structure in narrative, from Aristotelean conceptions about drama to post-structuralist literary theory as it relates to hyperfiction. These two sections together establish a basis for understanding how to relate instructional sequence and narrative structure. The last section reports on empirical studies concerning the effectiveness of learning in hypermedia environments.

The literature brought together for this review was gathered from a wide variety of sources over an extended period of time. There does not exist, as far as I have been able to determine, a single source that speaks directly to my research concerns. Consequently, I have had to examine literature in apparently unrelated fields. The *ERIC Index* was a primary research tool for topics related to instructional design and hypermedia learning environments, *PsycInfo Index* was helpful in researching reports about story grammars and developmental studies related to narrative. Some of the central search terms were: instructional design, narratology, and hypertext. Initial searches provided clues to significant figures and their writings, while the advise of committee

members helped to both expand my conceptual approach by pointing to other sources and to sharpen my focus within particular strands of literature.

The conceptual basis for this review is best illustrated by the relationships displayed in Figure 1 in Chapter 1, which demonstrates the categories for my threefold exploration of narrative-based software.

Sequence in Instructional Design

This study concerns how instructional sequence can be correlated with narrative sequence in the sequentially disruptive environment of hypermedia. It is my supposition that the linear unfolding of the events of instruction can be usefully compared to the unfolding of events in a story, that in some sense every lesson is a story, just as many stories can be construed as instructional devices. In the section on narrative I will be looking at plot as the structural skeleton for the narrative experience. What is the plot of instruction? There is no fixed and universally accepted conception of this aspect of instructional design beyond a general sense that one should move from the simple to the complex in the presentation of material--though what is meant by the terms 'simple' and 'complex' provides much of the debate around this issue. Consequently, this section will describe the fundamental ideas in the literature concerning instructional sequence.

There are two basic approaches to the design of sequence in instruction: bottom-up and top-down (Leshin et al, 1992). The first treats instruction as a series of small steps that lead to larger ones, until the highest level of understanding is reached. Gagne's systemization of the events of instruction is emblematic of this first approach. The second is a more holistic approach and begins with a simplified version of the case and proceeds to revisit it at more complex and detailed levels. Bruner (1966) and Reigeluth (1983) are the seminal contributors to this approach.

The Conditions of Learning

Robert Gagne (1985) proposed a theory of learning that identifies five varieties of learned capabilities. These comprise intellectual skills, verbal information, cognitive

strategies, motor skills, and attitudes. Each of these classifications, according to the theory, is best suited to a particular type of instruction, so that characteristic internal and external conditions are required for a given variety. For instance, the learning of an intellectual skill will require the recall of the prerequisite skills that make up the new skill, as well as instructional intervention to guide the construction of these simpler skills into a more complex one.

This theory is based on several assumptions. First, that learners share similarities in terms of the kinds of learning of which they are capable, and second, that the conditions of learning for these varied capabilities are similar across different subject areas. In other words, learning a concept in math is very similar to learning a concept in geography, and everyone needs a similar condition of learning for attaining that capability. Third, that learning (particularly intellectual learning) relies on a hierarchy of learning experiences.

In terms of how narrative design might correspond in some ways to instructional design sequences, Gagne's theory provides a useful structure to correlate with the structure of narrative. The learning hierarchies he describes are the basis for a sequencing of instruction. If learning can for a moment be compared to story, then Gagne's hierarchy is similar to the traditional plot in fiction. Both require a structured sequence of events set within a particular context and leading to a resolution.

Gagne

Gagne, Briggs, and Wager (1992) proposed a ninefold division of the instructional process, as follows:

1. Gaining attention

Any event that awakens the learner's interest may be considered applicable here. Gagne points out that the ability to tailor this instructional function to the interests of the individual learner is a part of the teacher's art, and doesn't lend itself to a standardized content.

2. Informing learner of the objective

In some fashion, the learner must have an idea about the goal or purpose of the learning, and the instructor must communicate that information. Although this event serves to focus the efforts of the learner, it is not intended to narrow his responses in a way that is detrimental to a broader exploration of the learning goal.

3. Stimulating recall of prerequisite learning

This step is critical insofar as new learning is the result of the combination of ideas. The instructor's task in this event is to bring previous knowledge to the foreground of the learner's awareness so that it will be readily available.

4. Presenting the stimulus material

At the heart of the learning sequence is the presentation of what is to be learned. Gagne emphasizes the importance of matching stimulus material to the performance required of the learner. This event is often marked by the emphasis of features that shape the perceptions of the student--i.e., calling attention to discriminations between features by exaggeration or isolation. In addition, variety in the presentation of examples is important for the learning of concepts and rules, particularly for young people.

5. Providing learning guidance

This event can take different forms depending on the kind of learning being guided. For instance, guidance about nomenclature is usually best communicated with the actual names to be learned--one cannot expect the learner to intuit a particular term. On the other hand, some kinds of learning can best be guided by providing suggestions and hints so that the learner will come to the knowledge himself.

6. Eliciting the performance

The learner must be given an opportunity to present evidence that he has actually learned the material and to work with a variety of examples.

7. Providing feedback about performance correctness

As the learners practice their performance, the instructor must give information to them about how correctly they are performing.

8. Assessing the performance

The instructor must be satisfied that his observations of the learner's performance are valid and reliable.

9. Enhancing retention and transfer

The instructor can enhance retention of knowledge by systematic review throughout the instructional process, and promote transfer of knowledge by providing new varieties of tasks that require the application of what has been learned in novel situations.

Bruner

Bruner (1966) discusses the ways in which learning can be transferred, and divides transfer into two types: skills, and principles or attitudes. Skills are limited in their transferability to situations very similar to those in which the skills were acquired. Principles or attitudes, however, which he identifies as nonspecific transfer, are the groundwork for a broader use of learning.

> In essence, it consists of learning initially not a skill but a general idea, which can then be used as a basis for recognizing subsequent problems as special cases of the idea originally mastered. This type of transfer is at the heart of the educational process--the continual broadening and deepening of knowledge in terms of basic and general ideas. (Page 15)

He makes four general claims to support teaching the fundamental structure of a subject. First, that comprehension is improved by the understanding of fundamentals, no matter the subject. Second, that memory works better when detail is placed within a structured pattern. Third, that transfer, as noted earlier, from a specific to a general case is improved with the acquisition of fundamentals. Fourth, that attention paid to the fundamentals of a subject serves to close the gap between advanced and elementary knowledge of a subject.

Bruner is well known for his spiral curriculum, which states that it is possible to introduce an idea to even the youngest learner if it is presented at the most basic level consistent with the learner's development, and that the idea should then be re-presented in

increasing levels of complexity as the learner develops a more sophisticated understanding of the concept. So that sequence is based on the relationship between the learner's pre-existing knowledge and varying levels of content complexity. Reigeluth and Curtis (1987) report that it has been difficult for designers to implement this strategy, perhaps because Bruner did not offer specific guidance about the procedure of implementation.

Ausubel

Ausubel (1968) developed a theory of instructional sequence that emphasized the conceptual relationships that the learner builds up in a hierarchical system. This system is organized around maximally inclusive concepts which subsume subconcepts and data. Consequently, he proposes the use of advance organizers, which are inclusive, general ideas that precede the presentation of more specific and detailed ideas. This general-to-specific sequence is structured around anchoring ideas that function as organizers for the next level of specificity--these next ideas will in turn become advance organizers, or anchoring ideas, for the next level. This approach is well suited to conceptually rich domains such as the social sciences, but less applicable to procedurally based domains, such as mathematics.

Merrill

Path analysis is another conceptual approach to instructional sequence, one designed for procedural content. Merrill (1978) advocated the use of this analytical technique to chart the possible routes through an information processing flow chart. This allows for a sequencing of instruction that places the paths in a hierarchy of shortest-to-longest pathways, a variation on the simple-to-complex approach. The shortest operations are taught first, followed by increasingly complex ones, so that each iteration expands the depth and detail of the procedure being followed. The weakness of this approach lies in its applicability to procedural content, which is not always a major part of a given subject matter.

Reigeluth-Merrill

The Reigeluth-Merrill Elaboration Theory (Reigeluth & Stein, 1983) proposes a sequencing model that draws on all the previously described models, basing its technique on both the structure of concepts and the cognitive processes of the learner. This model is characterized by two defining aspects: the idea of the epitome, and a focus on a single content orientation. The epitome is understood to be the presentation of the most basic and representative ideas that can be applied at a skill level. As each lesson adds complexity, it is said to be elaborated. How these elaborations are operationalized depends on the content orientation--that is, whether the content is oriented to concepts, procedures, or principles. In this analysis, all instruction is assumed to be focused on one of these three orientations. The elaboration model will generate different instructional sequences based on what is considered to be the most important goal of the instruction (Reigeluth & Curtis, 1987).

Mayer

Of particular interest to designers of constructivist learning environments is the work of Richard Mayer. Mayer (1999) has developed a theoretical framework for designing constructivist learning in multimedia environments. He argues that constructivist learning can be the result of direct instruction if that instruction activates the following three cognitive process involved in knowledge construction: selecting relevant information, organizing incoming information, and integrating incoming information with existing knowledge (Selecting, Organizing, and Integrating, or SOI).

This model (SOI) can be used to generate instructional design sequences that encourage the learner to become actively engaged in the learning process by helping the learner "identify useful information, understand how the material fits together, and see how the material relates to prior knowledge." (p. 152) The first of these relies on the incorporation of techniques that draw attention in some way to the relevant concepts in the material. This may include headings, italics, bullets, icons, adjunct questions, statements of objectives, providing summaries, etc. The second, organization of the

material, suggests the use of outlines, headings, and pointer words to highlight the organizational structure. Graphic representations are also appropriate here. Knowledge integration, the third step in this process, can be aided by the use of advance organizers, illustrations, example, and elaborative questions.

Mayer points out that the promotion of constructivist learning is possible even when the learner is not behaviorally active, and that discovery learning is not always necessary. His conclusions can be implemented in a multimedia, story-based design by integrating his techniques into the environment of the story.

Summary

These models for sequencing instruction suggest a variety of approaches to the confluence of story structure and instructional design. Gagne's sequence of nine events, for instance, is similar to traditional narrative plots in that it is a fixed linear progression through a series of related events which work together to achieve closure. Bruner's spiral curriculum, ordered around the fundamental structure of a domain, can be compared to the structural repetitions that are found in many works of fiction. Ausubel's idea of conceptual relationships, which subsume concepts in a hierarchy, is similar to Rumelhart's story grammar, which argues for a hierarchical network of information categories within a story. Merrill's path analysis approach may have applications within a more interactive story structure, as the shortest structure of the story expands to a larger one when the reader enhances the initial reading with more hyper-linked explorations. Similarly, Reigeluth's elaboration theory suggests a possible fruitful instantiation within a hypertext narrative structure that offers the opportunity to revisit initial elements with greater depth. His idea of the epitome is even suggestive in some ways of metaphor. As will be seen in the following section on story structure, there are a number of approaches to understanding just how sequence in story can be understood. These parallels between story structure and instructional sequence offer instructional designers an opportunity to scaffold the learning environment.

Story Structure

What is narrative structure? Since the nature, form, and purposes of stories cannot be easily separated, the answer depends entirely on what we understand stories to be (Culler, 1975). What they are and what they mean are one. By way of example, even the most elementary definition of story is provisional, a placeholder useful only until we open the question in a richer and more complex discourse, so that the dependent question of story structure is not easily addressed. Here is one definition of a story offered by Prince (1987): a causal sequence of events pertinent to a character or characters seeking to solve a problem or reach a goal. This may be a succinct abstraction of narrative form, and it may well describe a necessary condition for our sense of story, but it is an insufficient rubric by which to measure the pervasive power of story in human affairs. After all, story, broadly conceived, holds all literature. We see immediately the difficulty of pinning down narrative structure when narrative itself is so simply perceived yet so richly developed.

Not only must we contend with the complexity of individual fictions, but we must also realize that stories are so widely used in our daily, non-literary lives that it may be impossible to step outside of them. Narrative is such a basic, universal speech act that anyone studying it is like a character trying to study the novel in which he appears.

The structure of anything is its constituent parts and their operation together. The parts of a narrative are often conceived as story elements—i.e., character, setting, theme, and plot. These are the elements we might expect to discuss in a class about appreciating literature. This century, however, has witnessed considerable debate about how and what a story can mean, and there is little agreement on what should constitute the appropriate analytical unit for narrative. This is especially so in light of the contemporary epistemological crisis, which has welcomed the many uses of narrative in a culture of relativity. Are stories examples of formal literary devices that operate independently of their semantic cargo (Greimas, 1971), are they a stage for the dramatization of perennially opposed existential themes (Levi-Strauss, 1958/1963), are they language

games shaped by the cultural and political perspectives of the tellers (Jameson, 1971), or are they mirrors of our cognitive expectations (Bartlett, 1932)? Whichever viewpoint is pursued, a different story structure will be revealed.

A psychologist, for instance, might see Conrad's story of the young captain and his double in *The Secret Sharer* as being structured by the divided psyche of the protagonist, while an anthropologist might argue that the 'real' structure of the story involves the captain's competing kinship communities. A narratologist might discuss the structure of the story in terms of plot events, and a literary theorist could see how that structure is a part of the larger structure of English fiction and its cultural traditions.

Although these issues make it impossible to identify the conditions of story structure in any final sense, in this review I will outline the major concepts that have informed the discussion, and identify the perspective most appropriate to my research interests. I will look at two literature strands: one concerned with narrative theory, and one describing the story grammars developed by cognitive psychologists. I have included the section on structuralism, which is a broad philosophical movement, under the heading of narrative theory, since it is only the narrative implications of structuralism that are pertinent to my proposed research.

I have found it useful to divide thinkers about narrative structure into those whose goal it is to understand narrative per se, and those who, in the pursuit of other ends, have looked to narrative as a vehicle for exploration. The recently identified field of narratology is comprised of the former group (Bal, 1997), while the latter includes anthropologists (Levi-Strauss, 1958/1968), ethnographers (Denzin, 1997), cognitive psychologists (Rumelhart, 1975) and writers in fields as diverse as cybernetics (Schank, 1990) and advertising (Vestergaard, 1985).

Narrative Theory

Efforts to understand what stories are, and how they work, are as old as civilization, so that it would be impossible to even sketch the development of Western literary theory over the course of the last three thousand years in a review as necessarily

brief as this one. However, most writers about narrative begin with Aristotle (Poetics, trans. 1982), and point out that his ideas were accepted as authoritative by eminent writers and scholars even up to the present century, and that little was added to the precepts he established until the rise of the novel in the nineteenth century (Lodge, 1980). Considering the extent of his influence, his ideas about narrative structure are worth recounting.

Aristotle

One of the first narrative theorists, as he was the first in so many things, his definition of the well-structured story has historically been the primary template for understanding the form of narrative drama. He argued that the purpose of art is to hold a mirror up to life, and that since life is composed of actions, then the art of the story must be to imitate those actions. It follows that plot, which is the narrated sequence of actions, is primary to story.

Aristotle identified properly constructed plots as consisting of five elements: completeness, size, unity, determinate structure, and universality. By completeness, he meant that the plot should, like the actions it imitates, have a clear beginning, middle, and a conclusive end. This may seem an obvious criterion, but it's very obviousness testifies to the hold Aristotelian poetics has on our thinking about narrative structure. Since life is an ongoing process, without clearly identifiable beginnings and endings save for birth and death, one might think that good art would successfully mimic this by avoiding closure. For Aristotle, completeness implies an ordered structure of causally connected events creating an experience that may stand alone—the beginning is not a consequence of some other thing, and the end requires no further consequence.

The appropriate size of a plot should be limited at the upper end to what memory can contain, and at the lower to the minimum size necessary to show a change in someone's fortunes. Psychologists in this century have also remarked on the relationship between the demands of memory and the structure of stories (Thorndyke, 1977).

Unity of plot depends on a closed, connected series of events. Since biography or history can offer narratives of events that have no apparent causal connections (that is, we are unable to make sense of them), Aristotle viewed these genres as inferior to fiction, where the artist can control the order of events and their relations.

By determinate structure he meant that every part of the story should be essential to the overall effect. The removal of anything from the story should have a consequence, or the story is ill formed. Finally, he argued that art is, or should be, universal; that is, unlike history or biography, fiction deals with what might happen, unlimited by the particular.

Propp

The pioneer analyst of narrative structure in this century was Vladimir Propp (1928/1968). In a structural analysis of nearly 500 Russian fairy tales, he identified and categorized the functions performed by the characters in the story. These functions are seen to operate independently of the characters. That is, he found that across many tales with diverse characters we find similar actions performed regardless of the attributes of the particular character performing them. Propp enumerated these functions, classified their significance and position within the tale, and devised compositional laws based on these structural signs. He wrote:

> Functions of characters serve as stable, constant elements in a tale, independent of how and by whom they are fulfilled. They constitute the fundamental components of a tale (Propp, 1968, p. 21).

He found tales to contain 31 key functions, and their order of appearance in the tale is always in the same sequence (though not all functions must appear in the same tale). For a complete list of the 31 functions, see Table 1 in Chapter 1. Propp grouped these 31 functions into 7 spheres of action, which correspond to the major character roles in the tales. He identified these roles as: hero, villain, princess, donor, helper, dispatcher, and the false hero.

Although Propp's investigation was limited to the very specific genre of Russian fairy tales, it has served as the exemplary model of syntactic, or syntagmatic, literary analysis, informing the work of numerous researchers (Dundes, 1962; Greimas, 1966 (as cited in Toolan, 1988)). A syntagmatic approach to literary analysis contends that the order of events in a story is analogous to the syntax of spoken language in that there are rules for the iteration and combination of story elements, just as there are syntactical rules for speaking and writing. This is in opposition to the paradigmatic approach, exemplified by Levi-Strauss (1958/1963), which describes the underlying patterns of stories as consisting of binary polarities (i.e., culture vs. nature) that are the 'true' structure of the story.

Critics have pointed out that Propp's analysis throws away too much of significance when it ignores the cultural context of the work. The tales he studied were Russian fairy tales, and his source was a much larger collection of folktales. To what extent were his conclusions based on characteristically Russian tales? To what extent do fairy tales differ from folk tales? Critics have also attacked his division of functions as being more intuitive than rigorous (Toolan, 1988). In addition, his method works best on oral narratives, and is less suited to complex literary productions.

It is easy enough, however, to see that the elements he identified are often present in one form or another in many stories, and his systemization of story functions, though debatable, provides a useful beginning for the analysis of narrative across many genres and cultures.

Russian Formalists

Propp's work was related to that of the Russian formalists, who created a linguistically oriented approach to narrative in the decade preceding the 1917 Bolshevik revolution, and successfully developed it during the following decade. The formalists avoided the study of literary content in favor of literary form, seeing content as merely the opportunity for the exercise of a particular form. In this sense, the Sherlock Holmes stories were not about the detective and his adventures, but were instead devices for

'holding together different kinds of narrative technique' (Eagleton, 1983). As an analogy, we might compare the formalist approach to form and content to the difference between genotype and phenotype in biology—the formalist would make the reductionist claim that the content of a story is a particular expression of a more universal code.

The formalists were acting in opposition to the mystical interpretation of literary texts promoted by European Symbolist critics, whose fin de siecle theories were still influential. The formalists attempted to put the study of literature on a more formal, scientific basis. Their initial conceptual thrust centered on the difference between literary and non-literary language, but their more lasting contribution was an emphasis on the analysis of literary devices for 'defamiliarizing' ordinary language and perception (Shklovsky, 1917/1965), and their distinction between story and plot. The increasingly repressive Soviet Union forced the group into exile by 1930.

Narratology

The field of narratology, which studies "narrative texts only in so far as they are narrative" (Bal, 1997), has come into being in the last few decades. It encompasses the study of the nature, form, and functioning of narrative in all media, and seeks to characterize narrative competence. Its focus is on what all and only narratives have in common, and in how the events of a story are narrated (Hawthorn, 1992). Narratology's origins can be traced to the seminal work of Vladimir Propp (1928/1963) and Claude Levi-Strauss (1958/1963), though it draws as well from historical sources of literary theory and criticism, linguistics, and anthropology. Narratologists take as their central issue the study of how the events of a particular story are narrated. However, there has already been enough growth in this field to stimulate a variety of definitions. Prince (1987) defines it this way:

> Narratology studies the nature, form, and functioning of narrative (regardless of medium of representation) and tries to characterize narrative competence. More particularly, it examines what all and only narratives have in common (at the level

of story, narrating, and their relations) as well as what enables them to be different from one another… (p. 65)

Narratology has come to rely on the difference the Russian formalists established between *fabula* (story) and *sjuzhet* (plot) (Genette, 1972/1980). Story is here understood to mean a 'series of real or fictitious events, connected by a certain logic or chronology, and involving certain actors' while plot is 'the narration of this series of events' (Hawthorn, 1992, p. 238). A detective fiction, for example, often starts with a dead body and ends with the discovery of its murderer, so that the order of events (the story) is reversed in the telling (the plot).

Narrative grammars may be divided into those treating the deep structure of a narrative and those discussing the surface structure (Rimmon-Kenan, 1983). Rigorous definitions of deep and surface structures, however, are scant. The idea of treating narrative in linguistic terms is common to most structuralist approaches, and comes from transformational generative grammar, which posits a limited number of deep-structure rules and a set of transformational rules to express them in a surface structure. Rimmon-Kenan (1983) points out that the surface features of a story are concerned with time and causation, and thus syntagmatic, while the deep level is paradigmatic, consisting of static logical relations between the elements.

Structuralism

Levi-Strauss

Levi-Strauss (1958/1963) is the premier proponent of deep narrative structure. His structural analysis of myth strongly influenced the ideas of structuralist poetics, and he coined the term 'mytheme', which he defined as the fundamental constituent element of a myth. He argued that every myth could be conceived as a four-part homology, correlating one pair of opposed mythemes with another, in an A:B::C:D equation. His celebrated reading of the Oedipus myth, for instance, identifies the correlation between two sets of opposed themes—'the overrating of blood relations is to the underrating of blood relations as the attempt to escape autochthony is to the impossibility to succeed in

it' (Levi-Strauss, 1958/1968, p. 216). In other words, he sees two parallel sets of opposed ideas working together. One set has to do with the relative importance of kinship, while the other is concerned with the role of will and human nature. The myth makes the latter problem more easy to deal with by relating it to the former, more common contradiction (Rimmon-Kenan,1983). The elements of narrative structure for Levi-Strauss, then, are mythemes, and his paradigmatic analysis pays little attention to the sequence of events occurring at the surface of the narrative.

Levi-Strauss is considered to be one of the most important figures in the French structuralist movement. Proceeding from of the work of the Russian formalists, and extending the linguistic ideas of Saussure (trans. 1966), structuralism has an interest in systems which can be studied synchronically, that is, not as historical developments but as an expression complete at one moment of time. Saussure revolutionized the study of language by emphasizing this possibility of synchronic linguistic analysis, and thus established the structural approach to linguistics. Structuralism has found applications in a broad range of disciplines. In literary theory, its advocates have pursued the possibility of a science of literature, one concerned with form instead of content (Rice, 1996). Saussure, who invented the field of semiotics, looked at language as a system for making meaning possible. In a similar vein, structuralists such as Todorov (1977) and Barthes (1967), have sought general principles in individual works that would lead to a grammar of literature, a system for understanding how literature is possible as a speech act.

Greimas

Greimas (1966), another prominent structuralist indebted to Propp's morphology, proposed a model of narrative emphasizing character roles. He described six roles, or actants, joined as three interrelated pairs:

giver/receiver

subject/object

helper/opponent

Despite the fact that Greimas' scheme is somewhat intuitive in its divisions, his system has nevertheless continued to be useful (Toolan, 1988), even finding its way into the study of advertising (Vestergaard, 1985).

Barthes

Barthes (1977), whose career spanned both structuralist and post-structuralist thinking, divided narrative structure into a hierarchical typology of three levels: functions (as in Propp), actions (as in Greimas), and narration (or plot). He further subdivides functions into a) functions proper, and b) indices. The functions proper, which are the acts performed in a narrative, carry the similarity to Propp, while indices are units referring to more or less diffuse concepts which are nevertheless necessary to the meaning of the story—for example, the character's psychological states, atmospheric indicators, etc. Functions proper are also subdivided, into nuclei and catalysers, or 'hinge' points in the plot and the business that surrounds them. The indices as well are categorized into subdivisions. Functions and indices may be seen on a continuum, with some narratives, such as folktales, being largely functional in construction, and others, such as more contemporary studies of character, being more indicial. Barthes' divisions and definitions have been criticized as being too intuitive, so that one person's nucleus may be another's catalyst.

The structuralists, rather than producing a codified grammar for understanding stories, have created a philosophical atmosphere emphasizing the structural approach to literature and culture in general.

Story grammar

Cognitive psychologists have investigated the nature and structure of narrative as a way of understanding cognitive architectures and how memory works. Questions about how we understand and remember written and spoken discourse have been a major research preoccupation since the early 1970s (Olson, 1988). Researchers have supposed that the cognitive structures used to understand single words and sentences are not sufficient to explain the more complex operations involved in story processing (Stein &

Glenn, 1979). In addition, since stories are so prevalent as a discourse mode, they have served as a ready means for investigating the cognitive processes in comprehension.

Although psychologists have been principally interested in stories as a means for studying memory and mental models, they have produced in the course of their studies a number of story grammars, which are of interest in many fields besides cognitive psychology. Their work has been more in the syntagmatic tradition of Propp and the Russian formalists than in the paradigmatic, deep narrative approach promoted by Levi-Strauss and the structuralists.

Bartlett

The pioneering work in story grammar can be attributed to Bartlett (1932), who introduced the concept of a mental structure, or schema, to account for our ability to remember stories. Noting that subjects usually changed the sequence of events in stories when recalling them, he concluded that comprehension has as much to do with the mental operations and pre-formed structures of the subject as it did with the material presented. For Bartlett, memory is an active process of construction, an interaction between new information and existing cognitive structures. He believes that the power and repetition of new stories will, over time, change the nature of the mental constructs as they adapt to the incoming information, but he also believes that the basic structures are stable, and shared by many individuals within a specified culture.

Stein (1978) points out that Bartlett's ideas were incomplete, making it impossible to clearly grasp the exact nature of a story schema. His contribution had more to do with identifying the existence of a schema for stories than it did with describing the details of a particular structure. As a result, researchers found it necessary to develop more rigorously defined grammars in order to pursue the implications of his work (Mandler & Johnson, 1977; Rumelhart, 1975; Stein & Glenn, 1979; Stein & Nezworski, 1978; Thorndyke, 1977). These made it possible to analyze stories in terms of hierarchically arranged categories and the relations between them (Stein & Glenn, 1979).

An underlying assumption of story grammar research is that children internalize the structures of stories they have encountered, and that this provides a mental scaffolding, or story schema, that allows them to encode and remember new stories (Mandler & Goodman, 1982; Whaley 1981). Researchers, using well-formed stories, have looked at how people used story schemas to understand stories, investigated the development of schema acquisition in children, and devised abstracted story grammars. Rumelhart

Rumelhart (1975) created one of the first and most comprehensive grammars, consisting of a "set of syntactical rules which could generate the constituent structure of stories" (p. 213). This grammar was amplified by the construction of rules for the semantic interpretation and summarization of stories. Rumelhart based his grammar on his analysis of the structure of folktales, fables, and myths, but he points out that his grammar works best on very simple stories, and he indicates a substantial debt to Propp's morphology (see Table 2.1 for Rumelhart's story grammar).

Table 2.1 Rumelhart's Story Grammar

Rumelhart's Story Grammar

1. Story → Setting + Episode
2. Setting → (State)*
3. Episode → Event + Reaction
4. Event → {Episode | Change-of-state ǀ Action ǀ Event
5. Reaction → Internal Response + Overt Response
6. Internal Response → {Emotion | Desire}Overt
7. Overt Response → {Action | (Attempt)*}
8. Attempt → Plan + Application
9. Application → (Preaction)* + (Action +
10. Preaction → Subgoal + (Attempt)*
11. Consequence → {Reaction | Event}

('+' joins two items, '*' indicates one or more units, 'ǀ' separates mutually exclusive alternatives)

Rumelhart understands comprehension in general to be a process of selecting and verifying a conceptual schema to account for a situation or text (Rumelhart, 1977), and stories in particular to be largely composed of problem-solving schemas. His basic analytical unit is an informational node, or category, which refers to specific types of information that serve a different function within the story structure. These categories exist in a hierarchical network organized in a logical sequence, and each category can be described in terms of higher order categories, so that the hierarchy is basically a binary network (Stein & Glenn, 1979). Rumelhart concluded that memory for the different nodes was better at the higher levels, and observed that stories were distorted during comprehension and/or reconstruction to fit into the existing schema (Rumelhart, 1977).

Though influential, his grammar has been criticized as being cumbersome and artificial, particularly in its distinction between syntactic and semantic rule structures. Consequently, a number of other grammars have been devised, all based on the assumption that the reader or listener relies on an internal template for the successful encoding and retrieval of story information (Mandler & Johnson, 1977; Stein & Glenn, 1978; Thorndyke, 1977).

The work of Rumelhart, as well as that of Thorndyke and other cognitive psychologists who studied story structure and memory, had more to do with memory than with narrative structure, and has not proved to be a seminal influence on narratology or psychology. In light of this, their work was not germane to the final analysis of the programs' narrative structures. There were hints of possible future applications for this strand of research, however, perhaps in the way that the researchers discovered that causal relationships within stories were better recalled than those which were not causal. This could have some applicability in the creation of stories for instruction.

Mandler and Johnson

Mandler and Johnson (1977) devised a grammar using the basic ideas of Rumelhart, but revised to be more flexible. Their work incorporates the fundamental ideas of story grammar proposed by Rumelhart, develops them for greater ease of use,

but avoids the perhaps oversimplified approach of later researchers. They argued that the underlying structure of a story can be represented as a tree structure, which relates events (nodes) both by their place in the tree structure and by between-node connections which may be either causal or temporal (see Table 2.3).

Items enclosed within parentheses represent optional expansions of a node. Parentheses marked with a superscript ^{n} indicate that the parenthetical item occurs one or more times. Brackets indicate mutually exclusive items; either may occur in that node, but only one kind may occur at a time. Event* indicates that one terminal event is conjoined with one or more other terminal events within a single higher-level node.

The nodes represent either a STATE or an EVENT, and usually correspond to some surface expression. Three types of relationship connect the nodes: AND, THEN, and CAUSE. However, these terminal nodes are subsumed under "basic" nodes, which are not represented by a list of the terminal states and events. They can appear only in certain places in the tree structure and have more constraints on their format and connections than the lower level nodes.

Mandler and Johnson emphasize the difference between oral and written stories in terms of memory capacity controlling structure, and their basic goal in this research has been to 'be able to predict precisely what people will and will not remember from connected discourse." They explicitly question the definition of a well-formed story. Most people will agree on whether a given string of sentences is or is not a story, but this intuitive sense of story rightness is of little help to researchers. To solve this problem, they work from the other end, and rely on what people can and cannot remember, and on the nature of the distortions that occur in memory, for their definition (p. 130). This may be begging the question, since they are arguing that people rely on the schema of a well-formed story to help them recall its events, but they define 'well-formed' as those elements in the story that are consistently recalled.

Some pertinent implications of their work provide for the possibility of prediction in story recall. They conclude that more information will be encoded than will be

recalled, which is to say that the encoding and recalling processes are different from one another. The effects of story schemata will be more apparent during retrieval than during encoding, and the longer the delay between telling and recall, the more recall will come to approximate an ideal schema instead of the actual story heard. The more a story conforms to an ideal structure, the better recall will be--a fact that could have considerable import to a designer using stories for instruction. A story whose surface structure has all the basic nodes of an ideal structure will be more accurately and extensively recalled than a story that lacks one or more nodes. The more the sequence of sentences in the surface structure follows the sequence of an ideal structure, the better recall will be.

The basic node is the main unit of recall. Elaboration of nodes is poorly recalled. Nodes which are optionally deletable from the surface structure will be less well recalled than other basic nodes. Causally connected episodes will be better recalled than temporally connected episodes. Additions of new material into recall will supply basic nodes either missing from the surface structure of the story or whose content is not retrievable. They point out that before the grammar can make even modest claims to adequacy, it must be expanded to include more precise transformational rules governing the relationships between the surface and underlying connections.

Stein and Glenn

Stein and Glenn (1979) produced a grammar also similar to Rumelhart's, but much simpler and more appropriate for a wider variety of stories. Their initial assumptions included the above mentioned generalization about encoding and retrieval, and the belief, found also in Rumelhart and other developers of story grammar, that stories have an internal structure analogous to that of sentences. They further specified the subjects' expectations concerning sequence of information presentation in the story and the nature of the information expected. Their study of recall supported the idea that when the temporal sequence of events in an episode matches the story schema, subjects are easily able to remember the correct order. Also of interest is their discussion of the

Table2.3 Mandler and Johnson Story Grammar

Mandler and Johnson Story Grammar

1. Fable → story and moral
2. Story → setting and event structure
3. Setting →{state* (and event*)}

   {event*}
4. State* → state((and state)^{n})
5. Event* → event (({and} event) ^{n}) ((and state) ^{n})

   {then}
6. Event structure → episode((then episode) ^{n})
7. Episode → beginning cause development cause ending
8. Reward
9. Beginning→ {event*}

   {episode}
10. Development → {simple reaction cause action}

    {complex reaction cause goal path}
11. Simple reaction → internal event ((cause internal event) ^{n})
12. Action → event
13. Complex reaction → simple reaction cause goal
14. Goal → internal state
15. Goal path → {attempt cause outcome}

    {goal path (cause goal path) ^{n})
16. Attempt → event*
17. Outcome → {event*}

    {episode}
18. Ending→ {event* (and emphasis)}

    {emphasis}
19. Emphasis → state

possible relationship between the kind of logical relation connecting two episodes or statements and recall success. They suggest that temporal sequences connected by CAUSE relations may be most easily remembered, those joined by THEN relations somewhat less so, and those connected by AND relations least of all (p. 116). This may be particularly true of preoperational children (Piaget, 1960), who are unable to reverse a logical order (see Table 2.4).

Thorndyke

Thorndyke (1977) also studied the effects of structure and content variables on memory and comprehension of prose passages, and proposed a grammar representing the abstract structural components of plot Like other grammars, and particularly Rumelhart's, it provides rules of the narrative syntax that operate independently of the story content (see Table 2.5).

Table 2.4 Stein and Glenn Story Grammar

1. Setting: Introduction of the protagonist; may contain information about physical, social, or temporal context in which the remainder of the story occurs.
2. Initiating Event: An action, an internal event, or a natural occurrence which serves to initiate or to cause a response in the protagonist.
3. Internal Response: An emotion, cognition, or goal of the protagonist.
4. Attempt: An overt action to obtain the protagonist's goals.
5. Consequence: An event, action, or endstate which marks the attainment or nonattainment of the protagonist's goal.
6. Reaction: An emotion, cognition, action or endstate expressing the feelings of the protagonist about goal attainment or relating the broader consequential realm of the protagonist's goal attainment.

Table 2.5 Thorndyke's grammar rules for simple stories

Thorndyke Grammar Rules for Simple Stories

1. Story → setting + theme + plot + resolution
2. Setting→ characters + location + time
3. Theme → (event)* + goal
4. Plot → episode*
5. Episode → subgoal + attempt* + outcome
6. Attempt → {event*
7. Outcome → {event*

   {state
8. Resolution → {event

   {state
9. Subgoal}

   Goal} → desired state
10. Characters}

    location} → state

    time}

Summary

Narrative theory and story grammar, though they come to structure from different directions, have much to do with one another. Narrative theorists pursuing a formalist analysis of story have provided terms for identifying constituent elements of narrative, and revealed some of the patterns that often underlie narrative's surface. Cognitive psychologists have demonstrated that useful story grammars can be constructed that help explain the sequence of events and their relations within a story, and that most people have a culturally common set of expectations as to what makes for a well-formed story. Story structure is not arbitrary, though neither is it fixed. We would do well to recall that the word narrative drives from the Latin word, *gnarus*, which means "knowing" (McCabe, 1991). Stories are a kind of boundary object that we create to mediate between reality and ourselves—like all our tools, it affects us even while we create it.

Narrative theory suggests that narrative structure is more than the inspired vision of writers but something that, though not equal to a science, still permits of analytical rigor. It is something that instructional designers can approach and use with attention to its constituent parts (though these will be seen to change within a hypertext environment).

Hyperfiction

When Gutenberg printed the Great Bible in the middle of the fifteenth century, he could not have foreseen James Joyce and Stephen King, bus schedules and musical scores, or cookbooks and paperback classics. His predecessors, the scribes of Mesopotamia, could not have predicted Plato's written dialogues from the business records they kept in clay. The pre-literate ancestors of those scribes could not have guessed that images scratched on a cave wall could be abstracted into the inscribed signs of sound and meaning—and make possible these words. It has been argued that every change in the technology of writing has opened not only new ways to communicate but also new ways to think. How we write may affect not only what we can write, but also what and how we can think (Ong, 1982).

Computers are a new writing space (Bolter, 1991). We are at the very beginning of its development, and no one can say what subtle marvels of expression it may someday afford. Our current incunabular stage can only begin to suggest the mature characteristics of the medium, especially since we approach this new writing space with the habits and mental tools of the old. As Murray (1997) and others have pointed out, any new medium is first understood in terms of older ones. Early movies, for instance, were treated as plays; the camera was fixed in place, seated like a member of the audience before the stage. The art of cinema wasn't born until moviemakers began to realize the expressive possibilities peculiar to the medium, such as changing camera angles and cutting.

However this new medium develops, it will surely be used to tell stories. Already there is a small but growing band of hyperfiction authors exploring computer-based narrative. There are, perhaps, a few hundred published works of hyperfiction, although it is difficult to estimate their number since there is not as yet a clear definition of what

constitutes a member of the class (Shumate, 1996). Is any fictional prose presented in a hypertext format necessarily hyperfiction? Should any story posted to the web be understood as part of a planet-wide metatext being created by our species as a whole? Should only those narratives whose links function as essential structural and expressive components be admitted into the definition? These questions reflect a continuing uncertainty about the nature of this infant medium.

Although the craft of hyperfiction is rapidly creating a vocabulary of its own (links, nodes, lexia, breadcrumbs), and it has produced a few works quickly regarded as classics, the medium is still too new to have developed a set of conventions. The technology has been changing too rapidly, and with too great an influence on what is possible, for any consensus about first principles to emerge. Despite this, a number of critical and theoretical perspectives on hyperfiction have appeared.

Hypertext is generally considered to consist of interconnected blocks of text, or lexias (Barthes, 1970/1974), whose links to one another may be accessed by the reader in a sequence more or less of her own choosing. The term was originally proposed by Theodore Nelson (1987) in the 60's to identify the non-sequential text experiences made possible by the computer, and the concept of hypertext may be traced to the seminal article by Vannevar Bush (1945). As computers and the Internet have become more and more graphical media, the idea of hypertext has broadened to include images, sounds, movies, animations, and anything else that may be presented in a multimedia format, so that the term 'hypermedia' is now used interchangeably with 'hypertext' by many authors (Landow, 1997). If everything published on the World Wide Web is included within the definition of hypertext, along with all the hyper-linked text developed for multimedia software applications, then it is clear that this universe of potentially inter-linked documents (the 'docuverse') has metastasized into something whose nature and scope is profoundly changing the ways in which we record and access information.

Within this developing context of inter-linked documents, artists and writers have begun to find ways of using hypermedia for personal expression, and the results

demonstrate that the nature of hyperfiction creates some new ground rules for what is possible in narrative. The nomenclature is still evolving, but any of the following terms—hyperfiction, hypernarrative, hypertext fiction, digital narrative—may refer to stories (which may or may not include images, sounds, etc.) that allow for multiple readings of lexias (Barthes' term for nodes of text). The organization of these lexias as a whole is a structure negotiated between the reader and the author, and exists along a continuum of interactive possibilities that determine the degrees of freedom and constraint enjoyed by the reader. That is, the author may provide only a collection of text nodes linked to all or some of the other nodes without predetermining any particular path for the reader to follow as he makes his way through them, or the author may provide more or less suggestive paths that, while still permitting a high degree of reader control of sequence, give an overall structure to the reader's experience.

Hyperfiction and Story Structure

What happens to stories when the readers write them during the act of reading? Robert Coover (1992) has pointed out that "with hypertext we focus, both as writers and as readers, on structure as much as on prose, for we are made aware suddenly of the shapes of narratives that are often hidden in print stories." (p. 24). The issue of narrative structure has become both subject and issue for hypertext authors. If the traditional story line is no longer present, how can we create or even detect a narrative experience?

Within any given culture, and even to a large extent across cultures, there is usually a shared understanding of what constitutes a well-formed story structure. Propp (1928/1968) and Levi-Strauss (1958/1963), for instance, directed their research into narrative along lines that resulted in patterns and templates for understanding structure in stories, and cognitive psychologists such as Rumelhart (1975), Stein and Nezworski (1978), Stein and Glenn (1979), and Bartlett (1932) showed that we early in life develop a schema for stories.

In place of this schema, hyperfiction offers to both revisit more primitive narrative techniques and to look ahead at some structural strategies impossible to achieve

in conventional print-based narrative. In many ways, hypertext productions resemble rhetorical styles of pre-literate oral cultures. Ong (1982) identifies orally based thought and expression with the following characteristics: a) additive rather than subordinative; b) aggregative rather than analytic; c) redundant or 'copious;' d) conservative or traditionalist; e) close to the human lifeworld; f) agonistically toned; g) empathetic and participatory rather than objectively distanced; h) homeostatic, and i) situational rather than abstract. Hyperfiction invites the return of these attributes in a new guise. It is, for instance, congenial to additive processes. The easily created links between lexias encourage addition of extra elements rather than categorical subordination of ideas, and the problematizing of closure provided by the endless paths of hypertext opens the door to lexias without end. Hypertext is aggregative because it strings together nodes of text instead of dividing it into chapters, sections, and pages. Redundant, because the reader revisits individual nodes in the course of constructing (rereading) a path through the text. Empathetic and participatory in its interactivity, homeostatic because it dissolves the climactic linear production of plot in favor of the timeless present, and situational because the meaning of any given node is always determined by the transient context of the reader's history with the text. All of this is to say that the ways in which authors are dealing with the structural possibilities of hyperfiction are strikingly similar to certain characteristics of pre-literate rhetoric.

Indeed, archaic narrative production shows evidence that their authors, be they single or multiple, built their epics from pre-existing elements, and assembled them in different orders at different times. This shuffling of lexias, or nodes, or tropes, or conventional descriptions, or what you will, is mirrored in hyperfiction. It is the reader, however, who does the assembling.

So crucial to the experience of hyperfiction is the role of the reader, that some have begun to identify the reader/author as a single unit of narrative production, hence reader + writer = wreader. It may be argued that the reader is always constructing a different text, even when he or she is encountering a linear book, since the functional

existence of the author and the limits of the text's borders are considered by many contemporary literary theorists to be dissolved when viewed through the lens of post-structuralist criticism (Barthes, 1970/1974; Foucault, 1977). Hypertext, however, makes explicit, in this as in many things, what is implicit (and often invisible) in linear, printed text.

Narrative, in this context, is the ephemeral iteration of negotiated sequence as the wreader weaves a novel pattern from the textual strands first gathered by the author. This bears some relation to the traditional, Aristotelian idea of a satisfactory plot—there is, after all, a beginning to the experience, a middle, and an end; but in hyperfiction these parameters are, if not arbitrary, at least not obligatory. Today I may read (or wread) a text starting from one spot and following a path unique to this reading, tomorrow I may read the 'same' text in an entirely different way, producing a very different narrative experience. The author's function, then, would be to cleverly construct the possibilities of multiple readings, so that the nodes of text and their connections could be satisfactorily visited and re-visited no matter what sequence the reader devises. Bolter (1991) writes:

> …in this shifting electronic space, writers will need a new concept of structure. In place of a closed and unitary structure, they must learn to conceive of their text as a structure of possible structures. The writer must practice a kind of second-order writing, creating coherent lines for the reader to discover without closing off the possibilities prematurely or arbitrarily. This writing of the second order will be the special contribution of the electronic medium to the history of literature.

Hyperfiction and Post-structuralism

Heraclitus (trans.1979) once remarked that no man ever steps in the same river twice. While this has been commonly understood to mean that the world is dynamic, the experience of wreading hyperfiction reminds us that the man doing the stepping is also mutable. The river of text will change with the reading. But if the text is fluid and transient, if its structure is an ephemeral performance, more verb than noun, then what and where is whatever we are calling the 'text'? The idea of the text has been extensively

reworked in recent decades, and much of what contemporary theorists have discussed as abstract conceptions are made concrete and operational in hypertext.

Roland Barthes, the French essayist, has written about the breakup, or breakdown, of linear texts and the difference between 'writerly' and 'readerly' texts (Barthes, 1970/1974). He argues that intertextuality, which is the interrelation of all texts within a culture, is too complex to permit either a naïve linear rhetorical approach or a successful mapping of the textual landscape. What the reader brings to the experience already complicates the act of reading: "I is not an innocent subject, anterior to the text…This 'I' which approaches the text is already itself a plurality of other texts, of codes which are infinite, or more precisely, lost (whose origins are lost)" (Barthes, S/Z, 1974, p. 10). Writing before the development of hypertext, he proposed an ideal form of textuality:

> In this ideal text the networks are many and interact, without any one of them being able to surpass the rest; this text is a galaxy of signifiers, not a structure of signifieds; it has no beginning; it is reversible; we gain access to it by several entrances, none of which can be authoritatively declared to be the main one; the codes it mobilizes extend as far as the eye can reach, they are indeterminable… (S/Z, 1974, p. 5-6)

This is strikingly similar to what hypertext actually makes possible. Foucault also speaks of text as a network of nodes and links.

> "[The] frontiers of a book are never clear-cut…it is caught up in a system of references to other books, other texts, other sentences: it is a node within a network…[a] network of references" (Foucault, 1976, p. 23).

What divides the text from everything else? It is easy enough with books to point to the physical object itself as the embodiment and delimiter of the text. One or more authors produce a written text, which is forever fixed in printed form with x number of copies extant. Derrida (1976), however, as well as Foucault, has emphasized the inter-relatedness of one book to another. In scholarly writing, this can take the form of footnotes, citations, and other explicit references to related works. In fiction, it can be

both explicit, as when James Joyce structured Ulysses around pre-existing myth, or implicit, as when a relationship to another work is merely suggested. T. S. Eliot (1920) argued that all works of art were related to one another in an ever-changing relationship—a new masterpiece makes us read other masterpieces in a different way. In hypertext, both as narrative and as non-narrative prose, these connections can be made manifest, can in fact become a crucial dimension of the work, so that it is no longer easy to discern the limits of a single text.

Just as the physical text no longer becomes the center to the experience of reading and writing when we are in a hypertext environment, so the relationships within the text are decentered. Deleuze and Guattari (1987) have written about rhizomatic structures as the appropriate metaphor for the decentered text. A rhizome is an interconnected root system that is without beginning or center—one may suppose that its delimiting circumference could be considered an end. A complex hyperfiction is rhizomatic in the sense that its interconnected nodes have no transcendent structure. Deleuze and Guattari also discuss postmodern thought as being nomadic, a concept which applies as well to hyperfiction. From this perspective, the current epistemological crisis is a conflict between hierarchical modes of thought and relativistic ones. Those who stand on the hierarchical mainland, as it were, see truth as fixed; those who sail nomadically from island to island occupy first one perspective, then another. Hyperfiction encourages this kind of shifting nomadic vision, in which the center not only 'cannot hold', it cannot be said to exist at all.

Emerging Patterns in Hyperfiction

Despite the apparent chaos of sequence and presentation that hyperfiction seems to afford, expressive patterns are beginning to emerge. The author (?) of a hyperfiction can contrive the narrative in such a way as to ensure that the reader will follow either very general or very specific paths through the work. Storyspace, the most commonly used software for creating hyperfiction, allows the author to control the reader's experience in several ways. It provides guard fields, which can make certain links

accessible only under certain circumstances—for instance, after a particular node has been visited but not before. It also provides lists of possible link destinations from any given spot, so that the reader can choose the direction to travel; however, these destinations can exist as clusters of possibilities that only become apparent from some predetermined location within the narrative.

Mark Bernstein, head of the most well-known hypertext publishing company, Eastgate Systems, Inc., has identified a number of structures evident in hyperfiction (Bernstein, 1998). One is the cycle, in which the reader returns to a node already visited and departs again on a new path. This rhythmic repetition of elements makes a structure that can be expressed in many small or large interlocked cycles. This also serves to make certain frequently visited nodes stand out from the rest of the text, and allows for a new context in which to perceive the node—a kind of structural irony that Michael Joyce, for instance, uses to good effect in his now classic afternoon, a story (1990). The rhythm of repetition is a traditional rhetorical device, evident in song, story, and pedagogy. Joyce argues that hypertext demands rereading, and mentions some of the many uses of repetition: "recursus, hallucination, déjà vu, compulsion, riff, ripple, canon, isobar, daydream, and theme and variation…" (1997, p. 584).

Mirrorworld is another pattern that Bernstein identifies. This is a structure that provides a parallel narrative to the primary voice of the work. Buried within the main narrative there may exist a secondary (or tertiary, etc.) narrative that reflects or comments upon the main one. While this is somewhat possible to achieve in traditional linear print form, hyperfiction makes it possible to interweave the separate narratives more intimately, and allows for a fine-grained cross-pollination of the two, so that the tension between the narratives becomes immediate and significant. Uncle Buddy's Phantom Funhouse (1992) by John McDaid, for instance, skillfully mirrors the main story by providing a parody, a funhouse mirror, of the narrative.

Bernstein discuss several more patterns of structure, such as the tangle, the sieve, the montage, the neighborhood, the split/join, the missing link, and the navigational feint.

The tangle is self-explaining, though its uses as a deliberate disorientation technique may prove more powerful and subtle than one would think at first glance. The sieve and the split/join can be used to rather narrowly confine reader choices. The neighborhood is very much a strategy peculiar to hyperfiction. The Storyspace software allows for the creation of a visual overview of the writing spaces in a narrative, so that their physical closeness (whether or not they are explicitly linked) suggests an organization of elements. The idea of the missing link is that when we are led to expect a link, but do not find it, its absence creates an imaginary structure, which the author may use for expressive purposes. One imagines a link to the finished dissertation, for instance… The feint is somewhat similar, except that it serves to awaken in the reader's mind the real possibilities that may lie ahead in the narrative experience. All of these may of course be combined together in various ways.

Hyperfiction and Hypermedia

Most of the discussion about hyperfiction centers on text-based versions of it. As hypertext becomes hypermedia, however, its characteristics will open to even more possibilities. We may be becoming a more visually oriented culture—film, movies, television, advertising, and computer screens certainly take us further in that direction. If this is true, then there will be considerable consequences for the meaning of literacy and the rhetoric of fiction.

Writing about the shift from a text-based culture to a graphics based one, Bolter (1996) points out that "This renegotiation [of word and image] is leading to a crisis of rhetoric. For both ancient and modern rhetoric have depended upon subordinating pictures to words" (p. 12). Is it possible to say the same things in images (or images plus words) that one might say in words? One argument against this, which is also an argument for the seriousness of what happens when the rhetoric changes, is that images are assumed to be transparent in some sense while prose is a mediated representation. This assumption has not always been the case. In Plato's Greece the spoken word was understood to be the 'natural sign' (p. 12). Bolter identifies the idea of image as natural

sign with those who want to create a virtual reality with the computer, an environment in which we are one with an experience. In contrast, hyperfiction authors seek to complicate the relationship between signifier and signified by making the reader work for understanding.

It is anyone's guess as to what a truly multimedia language might become, one in which words, sounds, images, and animation are integrated into an expressive whole. The most horrible and powerful example we currently have of this may be televised advertising, which combines media for rhetorical persuasion. When these elements are added to interactivity, literary expression enters a terra incognita. Writing about poetry as hypertext, William Dickey (1991) said:

> As soon as we move away from textual and graphics elements in the poem, as soon as we introduce such elements as randomization, or sound, or animation, we have arrived at a work of art for which the page is no longer an adequate representation; at best the page can provide a kind of vocal or orchestral score for the poem, and even there its nature will be limiting and misleading, as it enforces its own qualities of linearity and singleness on works that are no longer governed by those qualities (p. 149).

Hyperfiction and Virtual Immersion

The apotheosis of hyperfiction may be as an interactive, completely immersive virtual reality environment. The technology for this is still very primitive, but development of it could proceed faster than we think given the continuing improvement in the speed and power of ever-smaller microprocessors. Janet Murray (1997) imagines what it might be like if the fourth wall of theater could be absolutely erased, allowing the audience to become interactors in a narrative within a completely convincing illusion. She argues that digital environments, seen as an expressive medium, have four essential properties. They are: procedural, participatory, spatial, and encyclopedic.

By procedural she means everything about computer technology that allows for programming—rule based behaviors, avatars, artificial intelligence, algorithms,

heuristics, all of its ability to embody complex, contingent behaviors. Participatory because digital technology creates the possibility of interactivity. It is spatial in the sense that our experience when we navigate from 'location' to 'location' in cyberspace engenders the illusion of a topography. Encyclopedic because the computer can hold such large amounts of information. These qualities, developed by artists who have grown to see them as part of their natural birthright of expressive means, will certainly offer novel creative possibilities.

The Nature of Hyperfiction

Hyperfiction blurs the boundary between reader and writer, opens the door to multimedia forms of expression, and overturns 2000 years of narrative convention. We have no way of knowing, in these early days, what it will become, because it is impossible to say what changes the computer revolution will bring to future computer writing, and impossible to know how those changes will be integrated into our culture. It may be that hyperfiction will someday soon be seen as a quaint development in the intersection between writing and technology that was quickly superseded by easily produced immersive animations. Hypernarrative may be too difficult for most people to enjoy, since it requires, by its interactive nature, that the reader engage the text rather than passively receive it. However it develops, it has raised questions about the nature of story and discourse that are not easily answered.

One way to understand its epistemological anxiety is in terms of the relationship between art and nature. Alexander Pope (1733/1966), in his *Essay On Man*, wrote that

> All nature is but Art, unknown to thee;
> All Chance, Direction, which thou canst not see;
> All Discord, Harmony, not understood;
> All partial Evil, universal Good:

Hyperfiction offers the possibility of chiasmatically reversing at least the first three-quarters of this thought, by re-introducing nature into art. Pope's Enlightenment values of hidden order and divine authority are arguably at an end in the current climate

of post-structuralist relativism. One aspect of this ending is that we have changed how we understand the idea of nature. If we understand nature to be what is uncontrolled, irregular, surprising, mysterious, pre-existing, and free of artifice, the wilderness versus the garden, chance if chance means actions not ordered by human intervention (though they may be infinitely patterned), then the interactive nature of hyperfiction is the re-inclusion of nature into the human impulse to control. It is a recognition that we now negotiate meaning rather than discover it. It is the acknowledgment of instability and uncertainty at the most fundamental levels, if indeed any level can now be considered fundamental. In *Writing Space*, Bolter wrote: "Electronic text is the first text in which the elements of meaning, of structure, and of visual display are fundamentally unstable." (1991, p. 31). The putative author of a hyperfiction cannot control how the reader will undertake to engage the narrative. He or she can set up possibilities, but cannot control the order of those possibilities without producing a work more suited to the printed page.

Summary

Hyperfiction is a nascent literary form that offers new options for story telling while at the same time calling into question many of the traditional perspectives and practices of narrative. The structure of narrative is opened up in hyperfiction, one might almost say atomized. Hyperfiction relies on reader-created links between the nodes for its overall structure, rather than on an overarching narrative movement that comes to a closure. In this, hyperfiction in some ways resembles pre-literate narrative techniques.

Hyperfiction, and hypertext in general, is argued by some to be the embodiment of post-structuralist literary theory, in that it is de-centered, rhizomatic, and democratizing. Though it breaks down traditional narrative ideas about story structure, there are nevertheless patterns of expression emerging within hyperfiction, which are principally concerned with varieties of repetition.

Though hyperfiction is largely concerned with text, the development of hypermedia opens even more questions about the structure of narrative by including

graphical and auditory elements within the text. These may in the end lead to an immersive experience that is far removed from contemporary ideas about narrative.

Hypermedia Learning Environments

This section describes the research on learning with hypertext. Hypertext-based research has often been atheoretical, shaped more by enthusiasm for the developing capabilities of the technology than by a thorough grounding in cognitive theory or informed educational practice (Spiro & Jehng, 1990). The researchers have nevertheless shared some assumptions about the efficacy of hypertext learning environments. These assumptions may be grouped into those having to do with cognition and those concerned with learning. Though they have received little empirical verification (Jacobson, Maouri, Mishra, & Kolar, 1996), these assumptions have provided the underpinnings for much hypertext research.

Hypertext and Cognition

Research assumptions about cognition and hypertext stress the idea that the structural and functional characteristics of hypertext are analogous to the structure and functioning of the human mind. A hypertext system lets the user roam at will through a body of information, freely exploring the links that join the nodes. This representational network of associated lexia is believed to mirror the way that the mind structures knowledge (Bush, 1945; Jonassen, 1990), and the process of browsing between the nodes is understood to correspond to the way that the mind functions. This correspondence between representation in hypertext and cognition has led researchers to believe that hypertext may facilitate learning.

From its inception, hypertext has been viewed by its proponents as an analog for the human mind. Vandevar Bush, who is credited with the first articulation of the hypertext concept, wrote prophetically in 1945:

> The human mind...operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the

> cells of the brain.... Man cannot hope fully to duplicate this mental process artificially, but he certainly ought to be able to learn from it. In minor ways he may even improve, for his records have relative permanency. The first idea, however, to be drawn from the analogy concerns selection. Selection by association, rather than by indexing, may yet be mechanized. (p. 10)

Jonassen (1988, 1990), one of the most ardent proponents of this idea, draws explicit connections between schema theory (Schank & Belson, 1977), active structural networks (Quillian, 1968), and hypertext. He argues that these theories, which describe the organization of human memory as associative networks, also describe the node/link relationships in hypertext. He also contends that hypertext can map more directly than linear text the semantic structures of the knowledge it is representing (Jonassen, 1988). Duffy and Knuth (1990) support this argument, and add that hypertext can effectively represent the knowledge structure of the expert, which the learner can absorb as he explores the knowledge domain.

Hypertext as a model of the mind, sometimes referred to as the 'plausibility' hypothesis, has not been well supported by the empirical evidence. In particular, the idea that the non-linear format of hypertext environments eases learning because the mind is itself non-linear has not been empirically verified.

Jonassen (1993) studied the assumptions of the plausibility hypothesis in a series of three experiments designed to examine whether differing hypertext browsers promoted greater acquisition of structural knowledge of the material studied. In one, subjects were told to learn as much structural knowledge as possible, and were grouped by browser type—each type giving access to varying perspectives of the hypertext structure. There was no significant difference between the results of the different groups. In another, the subjects were told to construct semantic relations themselves in order to see if structure knowledge varied with type of access to the information. Once more, there were no significant differences. However, in the third study he asked one group of subjects to be prepared to produce a semantic map of the information after the experience, and the other

group to just learn as much as possible. The latter group did less well than the former group when asked to construct that semantic map. Jonassen concluded that the representation of knowledge structures was less crucial to learning the information than the goal directed behavior of the learners. In other words, the hoped for automaticity of knowledge transfer proposed by hypertext enthusiasts did not happen, and the assumed innate similarities between hypertext and human cognition did not facilitate learning. A similar study conducted by Beasley and Waugh (1996) confirmed this distinction.

McKnight, Dillon and Richardson (1990) in a study that compared learning results between subjects exposed to hypertext presentations and subjects exposed to linear text, found that those receiving the linear text treatment performed better. Subjects in this small study (n=16) were found, in the linear format, to have a better conceptual map of the information document, higher levels of accuracy when tested on the information, and spent considerably less time referring to the index and contents pages. The authors conclude that the design of hypertext learning environments must be targeted to only those tasks which are best suited to this type of presentation, and that hypertext is "not the universal panacea which some have claimed it to be" (p. 18).

Verreck and Lkoundi (1990) in a somewhat similar study compared learning results achieved with a hypertext presentation and a traditional text presentation of the same material, and found no significant difference in the results. Interestingly, the control group of text-based learners showed more incidental learning than the experimental group. This finding contradicts the idea that a hypertext environment will promote, through browsing, greater incidental learning. Orientation within the hypertext document is a concern for the designers of hypertext learning environments, and is also relevant to the plausibility hypothesis. Where memory and conscious intent make sense of the associative network within our minds, how can that function best be instantiated within the hypertext environment? That is, how should the information best be organized for accessibility?

Beasley and Waugh (1995) studied learner disorientation within a hierarchically organized hypermedia environment. The three treatments in this experiment exposed the subjects to either a) a hierarchical concept map, b) a spider (concept) map, or c) hotwords for navigation. Learners in the hierarchical map treatment reported significantly less disorientation than either of the other two treatments. Those with a concept map were found to have the same level of disorientation as those with the hotwords treatment. The failure of the concept map to be the most effective organizer indicates that, though our minds may be organized by association, we do better learning when we are presented with a logically ordered structure of information about a domain.

Forrester (1995) interpreted the empirical results of a study evaluating the effectiveness of teaching and learning within a hypertext environment in a more sanguine light. Although his study failed to establish that hypertext was a superior learning environment, he did conclude that students "would not be disadvantaged relative to contemporary lecture-based methods." He also reported that motivation was higher in the hypertext treatment group of his study, which compared hypertext courseware and lecture-based teaching.

The failure of the plausibility hypothesis to be empirically verified may have several causes. Whalley (1990) offered the earliest and most trenchant criticism of the basic assumption. He pointed out that, though the brain may organize information by association, it does so at a level of semantic complexity that the current technology cannot imitate. "The simple web structures of hypertext are not of the same order of complexity as human semantic knowledge structures." (p. 63). The associations that the mind forms are meaningful in a way that the exploratory associations in a hypertext environment are not. No matter how complex we make a hypertext node, the mere fact that it is concrete where mental associations are manifold, dynamic, and evanescent make it necessarily a cartoon of the mind's operation. Whalley further points out that the supposed linearity of traditional texts has been seriously questioned by linguists and reading comprehension theorists (Grimes, 1975; de Beaugrande, 1980). A skillful author

of an instructional text can design a document that encodes complex relations between the concepts. It would be the rare learner who could navigate such a rich text without visiting and revisiting the various parts of the text--a process often claimed as the prerogative of the hypertext domain.

The size of the nodes of information in hypertext are similarly only superficially correspondent to information storage in the brain. The designer of a hypertext must make decisions about how much information to include in each node, a semantic decision that may not mirror either the learner's most efficacious conception of the knowledge or the structure of the knowledge itself.

The associational networks in hypertext documents have been assumed by the proponents of the plausibility hypothesis to automatically induce learning in the individual. The empirical results show that this is not necessarily the case.

Hypertext and learning

Theoretical assumptions about learning in hypertext hold that it supports multiple representations of information and matches instructional principles for self-regulated, constructivist learning. The learner, by browsing purposefully through the hypertext document, necessarily creates a unique knowledge structure (Jonassen, 1988). Mayes et al (1990) point out that hypertext nourishes exploratory or discovery learning. Duffy and Knuth (1990) argue that the learner-directed nature of hypertext can improve motivation. Landow (1990) promotes the idea that it will stimulate critical, relational thinking--cognitive skills that are crucial to constructivist learning. This line of thinking essentially argues that navigation through a non-linear text will force learners to organize their own understanding of the material. The oxymoronic nature of forced individuality is immediately apparent.

The idea that encoding information in a variety of representational modes facilitates learning is widely held (Clark, 1983; Dale, 1946; Glaser, 1991; Kozma, 1991; Salomon, 1979; Spiro et al, 1991a, 1991b). Paivio (1986) proposed the dual coding theory, which asserts that we have a least two means of encoding information in

memory--the verbal and the imaginary. This idea has been used to support the efficacy of multimedia representations in learning. Spiro et al (1991a, 1991b) point out that the single perspective approach to instruction may not be adequate for learning in ill-structured domains, and that knowledge transfer from those domains may be enhanced by the use of multiple perspectives. The construction of mental representations is expected to be made easier by the processing of multiple external representations (Tergan, 1997b).

Hypertext environments are uniquely suited for the joining of disparate media into a single instructional presentation, since in them it is possible to visit and revisit information displayed as audio, video, text, game, etc. Salomon (1979) argued that the symbol systems of particular media were more or less appropriate for modeling particular cognitive tasks, and thus multiple media increases the likelihood that the most pertinent symbol system will be engaged.

The idea that hypertext can support multiple modes of knowledge representation**,** and that this approach to the design of instruction will improve learning, does not have a long history of empirical investigation. An immediate concern revealed by early studies (Beeman et al, 1987) was that learners did not necessarily choose to experience multiple forms of representation, but instead picked the 'easiest' navigational route through the material. In a later study, Cunningham et al (1993) found that when the hypertext system was experienced as part of a larger curricular event, and a task required this kind of browsing, that learners would access different perspectives. Generally, it has been reported that the success of hypertext documents as learning tools is dependent on a large number of factors (Duffy & Knuth, 1990), and that the more successful multiple representation results come from information documents which are pre-designed to be accessed from multiple representations.

The work of Jacobson and Spiro (1995) suggests that the presentation of information in multiple contexts, though less effective for the memory of factual knowledge, nevertheless better helps knowledge transfer. In a study with 17 subjects, Jacobson and Spiro investigated a theory-based hypertext learning environment

concerning a complex and ill-structured domain. This small number of subjects raises questions about the validity of the study. Drawing on the earlier work on cognitive flexibility theory (Spiro, Feltovich, Jacobson, and Coulson, 1991b), they devised an experiment comparing the learning effects of a thematic criss-crossing hypertext activity with those of a minimal hypertext/drill presentation. They argued that the instructional approaches suitable for introductory learning in simple and well-structured contexts may not be appropriate for more complex and ill-structured domains. Five instructional approaches were identified as being unsuited to their goals: a) using a single conceptual basis for knowledge representation, b) abstracting conceptual knowledge from its context, c) oversimplifying complex material in early instruction, d) compartmentalizing knowledge components, and e) rote memorization. As one part of their antidote to these problems, they relied on cognitive flexibility theory to support their use of multiple conceptual representations of knowledge. The students were asked at the end of the study to write an essay that measured their ability to apply their knowledge in a new situation, to transfer it in other words. The group that received the thematic criss-crossing treatment was significantly more able to accomplish this task.

The multiple representations of knowledge that a hypertext environment makes possible rely for their effectiveness, in part, on the multiplicity of media and symbol systems that this technology can provide. Research studies that examined the effects of these affordances have been usually a part of larger studies concerned with the broader effects of learning with hypermedia, or "focused on the innovative technology of structuring and accessing subject matter content and were not explicitly concerned with the question of whether the integration of multiple media may have any additional value for enhancing learning performance." (Tergan, 1997, p. 11). Though Salomon's (1979) work with media and cognition has not been consistently supported by the subsequent research (Clark & Craik, 1992), there may be motivational effects associated with multimedia instructional presentations (Barron & Atkins, 1994).

The empirical results concerning multiple representations of information have been equivocal. Learners must be able to construct a task-appropriate mental representation of the material. The necessary conditions for these constructions may not be fully realized in the extant hypertext environments. Multiple perspectives may contribute to disorientation and conceptual confusion. The instructional context in which the multiple perspectives are presented is also relevant to the learner's experience. Jacobson et al (1996) point out that explicit modeling and scaffolding support are necessary for a learner presented with the potentially bewildering array of perspectives this approach can provide.

When these multiple representations are presented not only in conceptually different perspectives, but by different media, then conditions arise which may be confounding the results of the studies. The additive concatenation of information via different media channels may be merely redundant, or the different media may serve only to highlight certain aspects of the information. When learner variables and cognitive requirements of the task are considered, then the multi-coded aspect of the experience is difficult to isolate as an empirical variable (Clark & Craik, 1992).

The work of Scanlon and O'Shea (1988) indicates that the novice learner may be at a disadvantage in a learning environment that offers multiple perspectives, since his or her "cognitive economy" may be put under too much stress in such a situation. This is consistent with the findings of Spiro and Jehng (1990) and Jacobson and Spiro (1995), whose studies report that more advanced learners make the best use of hypermedia.

The failure of multiple representations of subject matter to unequivocally produce superior learning results may have cognitive explanations. It is difficult enough for learners to mindfully absorb and transfer knowledge from a single perspective in a well-understood linear print medium--the addition of other perspectives in alternate symbol systems may just increase the cognitive load of the learner rather than elucidate the subject matter (Wenger & Payne, 1996). In addition, the different perspectives may confound each other, since the learner may falsely interpret one or more of them. The

pedagogical virtues claimed by the proponents of multiple representations may actually work to constrain effective cognitive processing instead of facilitating it. Research approaches that have failed to take into account the possible confounding factors of multiple representation in hypertext learning environments, such as cognitive constraints from overloading, poor theoretical basis in research assumptions, and inadequately isolated variables in design, cannot be relied upon to provide the final word concerning the efficacy of this research approach (Tergan, 1996).

Similarly, empirical results do not support the constructivist assumption about learning in hypertext. More traditional text-based learning, when experimentally compared with hypertext, often results in increased understanding of the central ideas, although the amount of facts recalled may be higher in a hypertext environment (McKnight et al, 1990; Verreck & Lkoundi, 1990). As previously mentioned, individual learning goals and other learner differences are a more powerful determiner of results than the structure of the hypertext environment (Jonassen, 1993). Beeman et al (1987) pointed out that students, when offered the opportunity to create their own exploratory and constructivist experience with the data, did not always accept the offer. Instead, they chose the easiest route through the material. These findings were supported by other studies (Verreck & Lkoundi, 1990; Schroeder & Grabowski, 1993).

The expected automaticity of effect from the technology is once again seen not to occur, and a constructivist approach is found to be centered not in the arrangement of the material but in the characteristics of the learner. It is only when the learning experience is explicitly scaffolded and contains well-defined learning goals that learners may be supported in effective constructive processing (Cunningham et al., 1993; Jonassen, 1993; Jacobson et al., 1995).

Why have the empirical results not supported the constructivist assumption? One reason is that the majority of learners are not competent to make use of a self-regulated learning environment. Jacobs (1992) equated unstructured hypertext with discovery learning, and since discovery learning has not been effective for the majority of learners,

it is not reasonable to expect it to work in hypertext. Jacobs points to Jonassen (1990), who found that learners don't choose their learning strategy wisely, and Pask and Scott (1972), who showed that learners need well-planned conditions in order to make the best use of constructivist approaches.

The other problem may be that it is unfair to the concept of constructivism to reduce it to an identity with non-structured hypertext browsing. Whalley (1990) and Jacobs (1992) discuss this in terms of "browsing". Jacobs (1992) refers to McAleese (1989) and Osborne (1990) to support his contention that browsing might not be considered a learning strategy. It is only the most radical of constructivists who perceive learners to be entirely autonomous agents who need little or no instructional constraints to guide their learning (Duffy & Jonassen, 1992).

There is a basic conceptual contradiction in argumentation concerning the effects of learning with hypertext. The plausibility hypothesis contends that the similarity between the associationally structured hypertext information and the associationally structured mind make it easier to learn information, and that browsing will both support this activity and replicate the mind's behavior. That is, there exists a coherent structuring of the information represented in hypertext, which may mirror the structure of the expert, and the mind can more easily replicate that structure when exposed to its reification in the hypertext environment. In contradiction to this, others argue that the non-structured nature of hypertext makes it easier for the mind to construct its own understanding. One group believes that being "lost in hyperspace" works against learning by exploration in hypertext (Conklin, 1987), while another thinks that this a desirable condition (Jacobs, 1992). This ambivalence in theoretical approach is reflected in empirical findings that show students both hindered and motivated by disorientation.

Tergan (1997a) has pointed out that the conceptual shortcomings of hypertext research may be grouped into one of three categories. These categories are: a) inadequate tailoring of hypertext/hypermedia design to the structural characteristics of a subject matter domain and the cognitive requirements of effectively processing such domains, b)

disregard of the conditions of effective learning in instructional contexts, and c) use of unequivocal and obscured concepts of media.

In his discussion of the first category, Tergan (1997a) refers to Landow's (1990) discussion of the fallacies about hypertext. Landow argues that analogies of space and navigation may not be appropriate for structuring the orientation of the learner in a hypertext environment. This metaphor is unexamined by researchers, and "navigation, the art of controlling the course of a plane or ship, presupposes a spatial world, but hypertext is not experienced as a spatial world" (Landow, 1990, p. 51).

Tergan (1997b) also points out that hypertext research has paid little attention to different types of systems, which may promote different aspects of learning. Jonassen and Grabinger (1990), for instance, distinguish between structured and unstructured hypertext--a distinction not always observed in the design of research. In addition, research has paid little attention to learner characteristics, relying instead on the automaticity of learning thought to be possible with the technology. Empirical results obtained from one type of hypertext design, with particular learners, may not be generalizable to other types with different learners.

Another conceptual problem concerns evaluation of learning results. There has been a reliance on traditional school learning evaluation mechanisms such as basic comprehension and retention of subject matter when examining the effects of hypertext on learning (Jonassen, 1993). This is at odds with the constructivist orientation of many of the hypertext researchers (Duffy & Bednar, 1992).

Whalley (1990) argues that hypertext is not really designed for education. Instead, it is really designed for entertainment and the efficient retrieval of information. He argues that design principles and cognitive processes attempting to achieve coherent understanding in the learner may not be well served by a hypertext environment, and further raises the question of whether it is a good idea to deliberately fragment educational materials in order to make them more accessible to browsing.

Summary

The results of empirical studies on learning with hypertext demonstrate the need for some kind of scaffolding in a discovery learning setting. The studies show that, though our brains may be organized by association, the associational networks created by hypertext links do not necessarily mimic that structure nor, in and of themselves, promote significant learning. The goal-directed behavior of the learner, the learner's motivation, has more to do with success than does the hoped for automaticity of learning from hypertext. Although hypertext may be said to instantiate mental structures, or post-structuralist literary perspectives, or constructivist pedagogy, that very instantiation within a concrete and delimited artifact works against the nomadic and peculiar nature of cognition and learning.

One way to do address this is by logically ordering the information within a domain for the most effective presentation of the conceptual relationships within that domain. Jacobson et al (1996) argue that modeling and scaffolding must be explicit for the learner to negotiate the potentially bewildering array of representations that hypertext can support. However, we bring to any experience powerful scaffolding tools of our own, and narrative may be one way to support our explorations of a domain. The research in hypertext confirms the necessity for effective organization of the learner's experience within the hypertext learning environment--story, which is a nearly universal organizer of our experience, may be used to great effectiveness for this purpose.

Chapter Summary

There exists a widely accepted idea that sequencing the presentation of information should move generally from the simple to the complex, and that the learner's engagement with the material should move from instructional dependence to learner independence. Iterations of this structural sequence have been refined and elaborated in differing ways depending on the perspective taken by the instructional theorist, concentrating in some cases on the conceptual organization of the material and in others

on the experience of the learner and his cognitive proclivities. There also exists a commonly held idea about the structure of narrative that describes a character's redemption through struggle with adversity. Though this idea has evolved over time, and may take many specific forms, it is fundamental to narrative design. These ideas about instructional sequence and narrative structure are at issue in the destabilizing environment of hypermedia.

CHAPTER 3

METHODOLOGY

This chapter describes the descriptive and theoretical qualitative study approach I used to explore the relationship between narrative form and instructional design in educational multimedia.

Overview

This research was descriptive and theoretical in nature, and was consistent with the Type 2 developmental research techniques identified by Richey (1996). Developmental research is "oriented toward a general analysis of either design, development, or evaluation processes as a whole or any particular component" (p. 1217). Its product can be a new model for understanding a given component of instructional design--in this case, its goal was a theoretical basis for the use of narrative in educational software to structure the learning sequence.

The paucity of research concerning the theoretical linking of narrative and instructional design within interactive multimedia learning environments ruled out a statistically descriptive approach to the research questions, since it would have done little to advance understanding to enumerate the frequency of its use before there was in place a theoretical construct to guide observation. Further, a classically qualitative approach, which would have focused perhaps on the designer's experiences and objectives, might have deflected attention from how the stories have actually been designed. In design, as in fiction, the creator's intentions are not necessarily the best guide to understanding or evaluating the final product, since the product exists as a text independent of its creator's intentions. Basing an interpretation of a work on the author's intentions is known in literary terms as the intentional fallacy.

This research investigated an area that draws on many fields--narrative analysis, instructional design, hypermedia, cognitive psychology, and others. Consequently, there

was no single, clearly defined methodology that was patently appropriate. Qualitative approaches to research are in any case always a particularized negotiation between the researcher and the subject of study, so that the methodology emerges as the study proceeds. However, I situate myself as a researcher within the constructivist paradigm outlined by Guba and Lincoln (1994), which is relativist, transactional, and subjective. I understand this to mean that the researcher approaches the study from a perspective that recognizes reality (realities) as "multiple, intangible mental constructions, socially and experientially based, local and specific in nature…" (p. 110), so that there is no absolute truth, only more or less sophisticated constructions concerning it. Further, that the interactive relationship between the investigator and the object of investigation creates the findings as the investigation proceeds.

Within this context, I collected and managed data based on items drawn from the checklist proposed by Huberman and Miles (1994), which describes what information needs to be stored, retrieved and retained from a qualitative study. These items included:

1. Raw material: this consisted of software programs, their associated manuals and documentation, and their packaging.
2. Coded data: write-ups with specific codes attached. This refers to the instructional events and narrative elements that I identified and correlated.
3. The coding scheme: successive iterations of the categories and sub-categories of analysis.
4. Journal, memos, or other analytic material: reflections on the conceptual meaning of the data.
5. Data displays: matrices, charts, and conceptual networks displaying retrieved information along with the associated analytic text.
6. Member checking: the submission of formative analyses to the scrutiny and suggestions of colleagues.
7. Results

Purpose

The purpose of this research was to broadly analyze how narrative structure is being used in selected examples of commercially and critically successful educational software to structure the learner's experience, and to develop a theoretical construct for its application. In order to focus the research, I restricted the scope of this project to educational multimedia that had been favorably received both by the public and the professional community.

Sample

The study focused on an undetermined number of selected narrative-based educational multimedia programs. I limited the research to CD-ROMs, excluding Internet-based programs as well as video and DVD, in order to make the sample more homogenous. There may or may not be differences between these media in terms of their use of narrative structure and its consequences for instruction, but the determination of those differences was not the purpose of this research. Three issues were used to determine the samples of educational multimedia used in this study: characteristics of narrative-based programs, criteria for program selection, and sample size.

Sample size

At the beginning of the study, I could not specify the exact number of programs that I would examine. I envisioned between five and ten programs. I ended the study with an analysis of six programs.

Characteristics of narrative-based programs

There is no universally agreed upon definition of story that will immediately allow for the identification of narrative-based software. For the purposes of this research, I looked for the presence of the following characteristics to identify software that is narrative-based:

1. The presence of characters. These characters might have been visual or textual in nature, but they had to be evident to the learner and they had to be

integral to the structure of the program. An example of an unacceptable character is the paper clip figure that is used to provide help tips within Microsoft Word. Although this is clearly a character, it is not integrated into any larger narrative that structures the user's experience. The learner may also be considered as a character, but if the learner was the only character in the program, then I excludee that program from the study.

2. The presence of a virtual setting. This could take many forms, and it could be more or less realized in terms of verisimilitude, graphic sophistication, and complexity. It is the presence of an environment in which the characters are situated.
3. The presence of one or more story lines. Although a universally persuasive identification of story structure is impossible (see Chapter 2), I relied on an operational definition provided by Prince (1987): "A causal sequence of events pertinent to a character or characters seeking to solve a problem or reach a goal". Preliminary observations suggested that most narrative-based programs were conceived with one over-arching narrative line that is was sometimes sub-divided into smaller narratives.

Criteria for program selection

This study examined the use of story form in educational programs, and its goal was a picture of how stories are commonly used. Consequently, I chose samples that were representative of general use without including programs that were unacceptably poor examples of instructional design. The following criteria were used to select the programs:

1. Availability. The program had to be a commercial item or available through a library.
2. Professional review. I looked at samples from the following educational software review sources: (a) California Instructional Technology

Clearinghouse, (b) TechLearning, (c) Children's Software Review, and (d) Association for Supervision and Curriculum Development

3. Intended audience. The intended audience of learners had to be within an age range appropriate to the 4-12 grades. Although children at the kindergarten level show some awareness of narrative structure, research indicates that by the fourth grade they are more capable of comprehending and producing complex narratives (Stein, 1979).
4. Publication date. The software had to have been published after 1990. I allowed software which was originally issued before that date if there existed a version published within the selected time frame.

Research Design

I planned to use a matrix for coding and displaying data gathered from each program. This matrix was based on the coding template I developed during a preliminary case study of the program Aladdin: Math Quest. Overall, this preliminary case study suggested that the categories I had chosen as research parameters were appropriate, although not all of them were used to pronounced effect in that particular program. Further, the study bolstered my supposition that the designers were using story form without fully taking advantage of the opportunities for instructional scaffolding that the form permits. See Figure 2 for a partial representation of the chart I prepared for use in Aladdin.

Procedure

Scenes

This matrix structured the analysis of the software first in terms of scenes. I defined a scene as any coherent juxtaposition of character and environment, and a change of scene as any change in this virtual setting--sometimes this meant a complete change of location and character, while at other times it meant a new focus on some particular sub-locale within a larger setting. This provided an overall system of registration for

recording the various categories of information which that were of interest. During the study of the program Aladdin: Math Quest, I constructed a matrix of some 30 scenes and found it a valuable device for ordering the general analysis (see Table 3.1).

However, during the course of the research, this formal matrix came less and less to seem a necessary or appropriate rubric for recording and responding to the information in the programs. In SimCity 3000, for example, the simulation does not lend itself to division in terms of scenes. In Physicus, as well, the virtual geography is much more the organizational technique than discrete scenes. As a result, instead of squeezing the material into the matrix I identified and recorded the elements more informally in paragrahs.

In both the original matrix and in the modified textual representation, I identified the presence or absence of characters, setting, Propp's functions, Propp's dramatis personae, Campbell's stages of the hero's journey, Campbell's archetypes, Bernstein's patterns, and the instructional events. In the original matrix, I constructed a graphic representation of the places in the program where the learner could make choices or take actions. This also proved to be impractical in many of the other programs, so I did not pursue it as a coding technique.

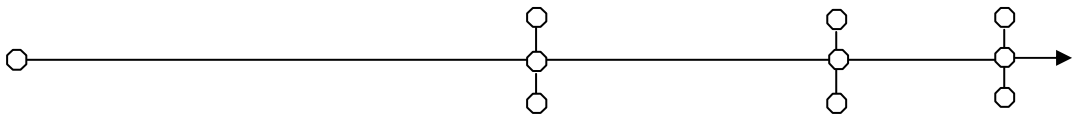
Characters

I identified the presence of characters. I noted characters as being present even if they were only made present by the user's interaction with the scene. That is, if there existed an option that called forth one or another character into a scene, even if this was not obligatory for the story to proceed, then I counted that character as present. In Aladdin, there were scenes in which only the voice of the character was heard or only the character's image was present, without voice or behavior. In both cases, I coded the characters as present.

Table 3.1 Aladdin: Math Quest matrix

Scene	1	2	3	4	4.1	4.2	4.3
Characters	G	B, Sn	B, A, J, Ab, G, I	G, I	S (G, I)	S (G, I)	G, I
Setting		Pyramid	Dungeon	same	same	same	same
Propp Functions			VIII.7	IX, X, XI		XII, XIII.7, XIV	XII, XIV
Propp Dramatis Personae		Villain	Villain, Princess, Helper		Donor	Donor	Helper
Campbell Stages	Meet the mentor		Call to adventure	Crossing first threshold		Tests	
Campbell Archetypes	Mentor	Shadow, Herald	Mentor, Allies, Threshold guardian	Allies, Mentor	Threshold guardian	Threshold guardian	Allies, Mentor
Bernstein Patterns				Cycle		Cycle	Cycle
Instructional Events						Puzzle (sorting and classifying)	Puzzle, (add and subtract)

Choice: (circles represent nodes where decisions must be made by user in order to navigate through the piece and exercise options.)



(Legend continues on next page.)

Characters:

G - Genie	B - Bizarrah	V - Very-unkammen
I - Iago	S - Spider	F - Fortune Teller
A - Aladdin	W - Wacky Wakeem	S - Snake
J - Jasmine	M - Mosaic Dealer	MH - Mechanical Head
A - Abu	C - Camel Dealer	

Setting

The setting is the virtual landscape which the characters (or the user) occupy. It was necessary to identify this for possible correlation with the other elements of instruction/story that were examined, although the structural function of setting is not addressed by Propp or by other narratologists. Within an interactive, animated medium such as digital multimedia, however, there exists the very real possibility that the setting can function as a more dynamic and interactive element than would be the case in print fiction.

Propp's Functions

I identified the presence of Propp's functions (see Table 1, Chapter 1). Although the presence of a particular function, as defined by Propp, was not always obvious (as I discovered in Aladdin), I believe that it was possible to make appropriate and supportable identifications from a reasoned and reasonable perspective. Similarly, Propp's dramatis personae often required interpretation for a coherent placement, since the same character might at different times play a number of roles. However, the need for interpretation of character function is consistent with Propp's own experiences. There was a surprising correspondence between Propp's morphology and isolated segments of the Aladdin program, although as a whole the story resisted a detailed and complete correspondence.

Propp's Dramatis Personae

I identified which of Propp's seven character types were present in the scene. That is, I matched the character's behavior and role in the scene with Propp's character

types when it was feasible to do so. There was behavior that was inconsistent with any of the types, and there was behavior that suggested more than one at a time. This required my interpretation. The immediate problem with this identification was that the interactive presence of the user creates an ambiguity. Who is the hero? The user or the main character in the story?

Campbell's Stages

I noted any evident correspondence between Campbell's stages of the hero's journey and the general idea of the scene under scrutiny (see Table 3, Chapter 1) In Aladdin the model of the hero's journey was only loosely approximated by the events of the story.

Campbell's Archetypes

I noted the presence of Campbell's archetypes (see Table 4, Chapter 1). In my preliminary study of Aladdin I found that the archetypes were present in various guises.

Bernstein's Hypertext Patterns

I noted the presence of Bernstein's hypertext patterns, if any could be discerned. Their presence was a function of the level of interactivity that was permitted in the program. A highly interactive program offered more opportunities for pattern development. In Aladdin, Bernstein's patterns were hardly present, as this program is only marginally interactive at a structural level. The user's choices are extremely constrained. The instructional events were limited chiefly to puzzle solving and math practice.

Instructional Events

I identified the presence of instructional events in the program. The initial analysis relied on Gagne's events of instruction as the model for the sequential presentation of instructional events. However, as the analysis proceeded I was concerned to identify any other sequential structure for instructional presentation. Riegeluth's elaboration model, for instance, could have found expression within a program. The learning environment was examined to see if Mayer's SOI model of constructivist design

was present. This is information that was not easily coded within the matrix I originally developed, and I reported more generally within the text of my findings about this and other instructional opportunities the programs offered.

Within the programs

Within each program I performed the following steps:

1. Identified the instructional functions present in the program. This was done in terms of Gagne's events of instruction as a kind of baseline analysis, but I remained open to the identification of functions from other perspectives.
2. Identified the structure of the narrative being used. This was necessarily a somewhat subjective identification. However, the functional approach pioneered by Propp was generated in just this manner of examination. Propp acknowledged the difficulty of providing any "objective" existence of a given function's character and presence, but believed nevertheless that it was possible to proceed. This was done in terms of Propp's functional analysis, Campbell's archetypal narrative pattern, and Bernstein's hypertext patterns. I did not pursue the use of Stein and Glenn's story grammar, since there was little evidence of its applicability. In addition, I noted the existence of any underlying binary oppositions that suggested a structuralist reading of the text, and remained alert to cultural codes that found expression within the program.
3. Correlated the narrative and pedagogical elements. That is, I identified whatever correspondences existed between these elements. I was particularly looking to see if the designers had associated specific narrative stages, or functions, with specific pedagogical functions.

Between the programs

Between the programs I noted the consistency of narrative and pedagogical correlations. That is, I was looking to see if a particular narrative function was consistently associated with a particular pedagogical function.

Researcher bias

I began this study as a proponent of the use of stories in hypermedia learning environments. My advocacy of narrative had its roots in my personal inclinations, in how I perceived the field of instructional technology, and in the general intellectual climate that prevailed when the study was first conceived. I have spent a lifetime reading stories of one sort or another, and I believe with many others that the lies of fiction are the best route to the truths of human experience. My understanding of stories, and my advocacy of their use, has been shaped by magazines, movies, comics, television, cheap fiction, great literature, radio plays, live theatre, personal anecdotes, bathroom graffiti, newspapers, narrative histories, philosophical dialogues, folk music, and board games (this is a partial list). I am in favor of storytelling whenever possible, and cannot help but believe that the forms of stories have found their way into every aspect of my life, whether I am aware of that invasion or not. I think that my interest in stories at a personal level guided my choice of research areas, but I have tried not to let this unduly color my research findings. It is always impossible to fully separate the self from the work; one can only proceed with as much self-awareness as possible.

The field of instructional technology has found many applications in education related to the sciences, but not so many in the humanities. It is almost as though researchers in the field have equated the means of instructional technology with a necessary subject matter, so that when computers are used to help learning then they must be used to help someone learn something that relates to computers. I have felt this as a challenge to spur my professional involvement with the field into the less traveled direction. This perspective partly motivated my research design, and inspired in me the desire to find the study of narrative a useful tool for the instructional designer.

Stories, in the largest sense, are always metaphorical expressions of our understanding of the world, and my love of stories has given me an epistemological bias that encourages me to understand all expression as metaphor. I believe that all symbolic expression, whether occurring in and as stories or as expressions of those systems of

thought we most often think of as stringently non-fictional and objective, are at their heart metaphorical. Language itself is, I think, essentially metaphorical in its operations. This study was begun within the then current intellectual climate that epistemologically privileged narrative as the mode for producing meaning. At that time, the unexpected presence of narrative was being identified in every field, even in those such as physics and mathematics that had once been thought to be free of metaphorical thinking. This undoubtedly contributed to my own interest in narrative, and helped to persuade me that my research direction was consistent with the spirit of the times. This also gave an impetus to my research that made narrative seem a crucial question to explore in any context.

Though these biases helped shape the direction and motivation for my research, I have tried to be aware of their persuasiveness. I believe that the conclusions I found myself drawn to at the end of the study bear out my resistance to these forces.

CHAPTER 4

ANALYSIS

This chapter presents an analysis of the story structures and instructional design models observed in the software programs. This analysis is based on my experiences working through the programs, transcribing, in some cases, the events that any user would encounter in that process, and then examining the transcriptions, where pertinent, for evidence of narrative structure that does or does not correspond to the structural templates of Propp and/or Campbell. This is followed by an examination of the programs for evidence of the use of any instructional design model and a discussion of how the instructional design of the program is or is not integrated into the story structure.

Each program treatment consists of the following sections:

Title

Overview of program

Correspondence with Propp/Campbell

Instructional design

Critical analysis

Summary

Operation: Weather Disaster

Overview of program

The company producing this CD is Discovery Channel. This program is a single CD. Its instructional content is weather-related information, and its narrative environment involves the user in a quest to stop a villain from unbalancing the world's weather patterns. The following introduction to the program is taken from the brochure that accompanies the CD:

Team Xtreme Acquires You New Recruit:

The evil Dr. Rainwater (AKA The Evil Weatherman) has taken control of the world's weather. He's reeking havoc, using tornadoes, hurricanes and other weatherly tricks as his tools of destruction. Your Mission: Join Team Xtreme, an elite scientific task force, to stop The Evil Weatherman. At your side will be Millibar, an advanced technological infobot who will help you become a Weather expert, and go head to head with the Evil Weatherman.

The intended learner, who is middle-school age or above, is immediately placed in an interactive story that requires weather-related knowledge in order to progress. More specifically, there are challenges situated in the narrative that force the learner to explore the immediate situation, identify a problem, and solve it by the application of logical thinking informed by weather related information.

Briefly, the plot is as follows. The user watches as Stratus, the leader of Team Xtreme, flies the team jet to investigate unusual tornadoes. Once there, however, Stratus is kidnapped by the evil Weatherman, who is disrupting weather around the world in violently destructive ways. He creates, for instance, conditions that will produce drought, floods, winds, unusually high or low temperatures, and other atmospheric phenomena. After watching this short prologue, the user enters the picture interactively by being at the site of the crash landing of Stratus' jet, Stormrunner, where he finds Millibar, the infobot that had accompanied Stratus. Repairing the injured Millibar, and thus gaining access to her data collection, he accompanies her to several scenes of weather disasters. At each scene he must solve various problems in order to restore normal weather and advance to the next scene. The database accessed through Millibar contains all the knowledge about weather necessary to solve the puzzles, though there are also a variety of objects that the user must collect in the journey that prove essential as well. After progressing through the five scenarios, which take place in Oklahoma, Stonehenge, the Giza plateau, Team Xtreme Headquarters, and the lost city of Atlantis, the user must confront The Weatherman in his lair and engage him in battle. Defeating The Weatherman restores the

weather in the world to its normal balance, and the user is made an honorary member of the team.

Below is an index of the scene sequence in the story:

1. Introduction
2. Chinook
3. Headquarters
4. Stonehenge
5. Giza
6. Atlantis
7. Final

The program presents a graphical environment that is more or less realistic in appearance, and each scene is comprised of a number of still images with occasional small animations played against them. The user can change directions within the scene and approach various spots by clicking in that direction; this also allows close-ups of objects.

The story line is rich in incidents, since the user can choose to explore a number of alternatives in a given situation. For instance, one may usually choose a cardinal direction at the opening of scene, and follow that by interacting with whatever objects are visible, so that one can choose to pick up an object, investigate an entry way, or engage a puzzle. These choices, however, eventually resolve themselves into a pre-determined sequence of events. In any given scene, there is a skeleton of events that must occur before the user can progress. The user can flesh out this skeleton by exploring alternatives. One aspect of this multiplicity of possible events is that the narrative structure allows frequent opportunities to correlate it with Propp's narrative functions. As Propp himself noted, there is an element of subjective judgment involved in this type of analysis--at what level of grain is it appropriate to identify some incident (or possible incident) as significant? This is, of course, a problem not unique to the analysis of hyper-narratives.

Correspondence with Propp/Campbell

Propp's 31 functions are not represented in their entirety here, but there are enough correspondences to them, sometimes with startling fidelity, to make the application of his analytical scheme seem appropriate. For instance, Propp identifies the first element in his scheme as*: One of the members of a family absents himself from home*. In the opening of the story, Stratus leaves radio contact with his team mates to investigate the strange weather being caused by The Weatherman. If we understand the team as a family surrogate, then these correspond readily. Stratus is the oldest team member, which also corresponds to Propp's explicit identification of the absent family member as sometimes being of the older generation. Propp's second function--*An interdiction is addressed to the hero*--also is readily apparent in the warning that Stratus' team members deliver as he flies away. Engaging pursuit of the villain, Stratus violates the interdiction, which is number three in Propp's list--*The interdiction is violated*. These correspondences can be traced throughout the program, though many of the items on his list are not represented in the story. The most complete match for the functions comes at the beginning and end of the piece.

The middle scenes of the program, scenes three through six, are essentially structural repetitions of each other. They comprise Propp elements 12 through 15:

12. *The hero is tested, interrogated, attacked, etc., which prepares the way for his receiving either a magical agent or helper.*
13. *The hero reacts to the actions of the future donor.*
14. *The hero acquires the use of a magical agent.*
15. *The hero is transferred, delivered, or led to the whereabouts of an object of search.*

These elements, or functions, take many forms. Each puzzle to be solved can be construed as a test, and each object obtained in a scene can be regarded as a magical agent or helper. Often the scene and its associated puzzles culminate in the user finding a necessary object of search.

In the final scene there is a direct confrontation between the user and the villain, which corresponds to Propp's 16th element: *Hero and villain join in direct combat.* This takes the form of a game of skill that the user must play, a game described by The Weatherman as one of weather domination. Propp's 18th element states: *The villain is defeated.* Winning the weather game defeats the villain, and his defeat sets in motion the events that will result in the 19th element: *The initial misfortune or lack is liquidated.* The weather balance in the world is restored, Stratus is rescued, and the user is invited to join Team Xtreme. Though Propp continues his index of the necessary story functions through several more items, they are mostly involved with the hero's return to his home and the complications that ensue during that journey. The last element is: *The hero is married and ascends the throne.* It is not too much of a stretch to interpret the hero's invitation to join the Team as a reflection of this function--he is "marrying" into the family.

The Campbell story structure is a broader and more general level of analysis than the Propp index of functions. The story line in this program loosely fits Campbell's model, arguably embodying most of the stages. If the first, introductory, section in which Stratus is abducted is understood as the temporary hero, who serves until the user has the opportunity to begin interaction, then the first scene in Oklahoma which initiates user interaction corresponds to Campbell I: *Ordinary world*. This is rapidly followed by II: *Call to adventure*, which is the destruction of the user's home town and the opportunity to catch the villain while restoring balance to the world. There is no refusal of the call, which would be Campbell's third stage--since doing this would be tantamount to quitting the game, it is difficult to see how it could be integrated into the experience.

Campbell IV: *Meeting with the mentor* is an important part of the myth structure, and is correspondingly important in the game. Millibar, the infobot, is the mentor. Her presence is necessary through all of the rest of the story, and it is through her that the weather related information necessary for solving the puzzles can be obtained. It is by

accepting her offer to go with her that the user *Crosses the first threshold* and enters the story proper.

Propp's function number 12, which identified an element that saw the hero attacked or tested, finds a corresponding stage in Campbell's analysis. Campbell VI: *Tests, allies, enemies* describes the user's passage through the succeeding puzzles and challenges. The other team members serve as allies with occasional help for the user. This pattern repeats through most of the program.

Campbell VII: *The approach* is echoed by the final approach to the Weatherman in the last scene, just before we see Campbell VIII: *The supreme ordeal*, in which the hero confronts and defeats the villain. In this case, the hero must beat the villain at a game. Campbell IX: *Reward* corresponds to the freeing of Stratus, which releases the crystals (mystic balancing powers stolen by The Weatherman) and restores balance to the weather in the world. The user then returns with Stratus to Team HQ--Campbell X: *The road back* and joins the team, thus becoming a new person (Campbell XI: *Resurrection*). Finally, as the crystals are automatically returned to their places, we see an occurrence of Campbell XII: *Return with the elixir*.

Instructional design

The instructional aspects of this program chiefly rely on the user going to the database accessed through Millibar. There are elements within the scenes that direct the user's attention to various retrievable objects in the environment. The cursor changes into a hand to indicate when an item can be picked up. There are, as well, Mager-like instances of directional support for the user's explorations. For instance, when the user first meets Millibar he finds that an electrical wire is draped over her body. The message box will suggest that the user find something with which to lift the wire after the user has unsuccessfully used his hands (cursor) in an attempt to move it.

The puzzles that the user must solve require, at certain levels, knowledge of weather information. However, this knowledge is rarely integrated into the nature of the puzzle itself. When the user is first able to talk with Millibar, for instance, he must put

together several items from the environment in order to repair her. Retrieving each object is a small puzzle to solve. It is only after several of these that the user encounters a problem that relies on weather data. After gaining access to Millbar's control panel, the user must solve a puzzle that requires knowledge of how the atmosphere is divided into four distinct levels.

By accessing the database, the user is exposed to information about weather phenomena. The information is organized topically and alphabetically, but is not arranged in an orderly sequence of instructional events. It is rather like a child's encyclopedia of atmospheric phenomena. The specific information required by the user in any given situation is usually retrievable directly through a topic, but sometimes it requires a little searching on the part of the user.

Critical analysis

This is an engaging and well produced program. The combination of live action, animation, and interactivity creates an energetic narrative environment. The story itself, while not complex or elaborate, does successfully embody enough classical dramatic elements to produce the sense of a 'real' story unfolding.

The correspondence between story models and the program is consistent enough to suggest that the creators of the program were consciously or unconsciously aware of the models. This is especially true of the Campbell model--the software embodies all but two of Campbell's narrative stages. Of these two missing stages, it is unlikely that the refusal of the call (Campbell 3) could ever be easily implemented in an interactive adventure. The integration of instructional design with story, however, is not very successful. Relying as it does on episodic visits to Millibar's database for instructional content, there is very little actual integration of instruction and narrative. The story works perfectly well without any visits to the database if the user is already familiar with the instructional content. Granted, this may be an inescapable condition (one can, after all, skip any or all sections of any instructional experience if the content is already learned), but it does serve to distance the narrative from the instructional content. If the

story can function successfully as a story without any of the instructional design experiences included in the program, then I don't think that the program has created a seamless integration of instruction and narrative.

Summary

This program creates an interactive learning opportunity that succeeds as a narrative but not necessarily as a learning environment. Although the user may move somewhat freely within any given scene of the program, the hyperlinked possibilities of interactivity are not elaborated. The user must follow a predetermined path through a fixed sequence of scenes in order to complete the story and the program, so that there is a meta-narrative structure which exists as a spine on which the user may flesh out the experience.

The instructional content is presented largely in a self-contained area of the program. The puzzles which the user must solve are sometimes based on weather information but often are not, so that finishing the program will not necessarily result in a systematic instructional sequence.

JumpStart Adventure 5th Grade

Overview of program

This program was produced by the Knowledge Adventure Company. This single CD program is a skills practice exercise designed for 9-11 year olds. Its list of content areas is extensive: U.S. History, logic, problem solving, deductive reasoning, map reading, Earth science, geography, compound words, prepositions, pronouns, verb tenses, prefixes and suffixes, fractions, decimals, equations, long division, multiplication, geometry, ratios, physical science, and art history. The story environment in which the program is set presents the adventures of Jo, a fifth grade student, who must foil the plans of a mad scientist (Dr. X) to destroy the city by blowing up the dam.

The structure of the narrative consists of repeated episodes that require the user to solve various kinds of puzzles and practice exercises. The plot is as follows. Jo wakes

from a nightmare in her bed, one involving a mad scientist trying to hunt her down through surrealistic city streets. When she wakes, she tries to watch a detective movie marathon on TV, but there is only static. The reason for this is revealed as she turns on the radio, which announces that Dr. X has blown up the television station and plans to blow up the rest of the city, one building at a time until he blows up the Hooverville Dam, thus destroying the entire city.

Jo rides her skateboard to school, where she boards a school bus that is taking students to the local museum for a field trip. She isolates herself from the group and soon observes a troubling scene. She watches as a junior scientist type is abducted from the museum by three hoodlums with odd purple hair. As they exit, the scientist drops his dark glasses. Soon a janitor enters and reveals that the kidnapped scientist is his nephew. They are approached by a large rat, who somehow has the ability to carry messages from the kidnapped scientist back to Jo. Each message is a crossword puzzle that reveals clues to the whereabouts of the next bomb. The puzzle can be solved by visiting various rooms in the museum and finding information that will help fill out the crossword. When the puzzle is solved the user will be able to find the next bomb destination.

When Jo visits the destination she finds someone associated with that locale, for instance a worker in a factory, who describes the location of the bomb and the necessary steps to get to it. Before she can enter each building, she must solve a series of math problems in order to open the lock. Also, each location requires Jo to come up with three items that will help her get to the bomb. There might be a need for a jewel, a ladder, and a piece of rope--or three other completely unrelated items. Jo must then travel around the city to obtain those items. Before leaving the site she will always have the opportunity to overhear the hoodlums discussing the necessary requirements for reaching the bomb as well. However, she must solve 'missing word' puzzles in order to do so. This is a check of knowledge about parts of speech.

There are three places she visits for all of the items on each bomb puzzle. One is the junkyard, where the user is required to manipulate shapes into a tangram-like puzzle,

following which the junkyard owner will give her the requested item. Another is a juice bar, where she must help the bartender mix drinks in certain proportions. This is a test of fraction knowledge. The last place she must visit is an abandoned mine which has become a repository of historical memorabilia--Indian artifacts, cultural mementos, etc. (something like a miniature Smithsonian underground). The caretaker for this mine asks her to retrieve some objects from there, but Jo must examine many levels of the mine and avoid being run over by falling boulders in order to comply. After successfully getting the objects, she is rewarded by the caretaker with the item that she was seeking.

Jo must skateboard to each of these three sites. During her trip she is chased by villains. If captured, she is thrown into a cell containing differently sized boxes. She must rearrange the boxes in order to build a ladder that she can use to escape.

When Jo has acquired the necessary items she returns to the latest bomb site and uses them to access the bomb. Each bomb, when opened, requires her to solve a circuit problem based on math reasoning. If the problem is correctly solved, then Jo returns to the museum for the next clue. If not, then the bomb explodes without doing any lasting harm and the user is offered another chance to defuse it.

This series of events repeats several times without significant variation until the user has defused all of the bombs. The final scene takes place at the Hooverville Dam, where Jo must divert the water flow so that the town won't be flooded when the dam blows. She does this, then releases the abducted young scientist and makes her own escape. The dam blows up, which kills Dr. X., but the city is saved.

Correspondence with Propp/Campbell

There are several correspondences between the story models and the interactive story presented here, though not enough to firmly establish either model as the basis for the narrative. Propp's first function--*a family member leaves home*--is enacted by Jo leaving for school and the trip to the museum. After that, however, the next correspondence doesn't occur until Propp 8: *Villain harms family member*. This is

Figure 4.1 Lock Puzzle

Figure 4.2 City Map

accomplished by the abduction of the scientist, who is a member of the janitor's family. This, in fact, may or may not be an example of Propp 8, since the family is not one to which the hero belongs, but the story did not have to contain this relationship, so that its presence seems significant. When the rat enters the museum and gives Jo the crossword

Figure 4.3 Mineshaft

Figure 4.4 Word Fill

puzzle that will contain clues to the scientist's whereabouts, we see evidence of Propp 9: *Misfortune is made known; a request or command is made to the hero; he leaves*. This is

followed by instances of several Propp functions, from 10 through 15: *Seeker agrees to counteraction; Hero leaves home; Hero is tested, interrogated, attacked; Hero reacts to actions of future donor; Hero gets use of a magical agent; Hero goes to location of object of search*. These functions are repeated with every repeating scene as the user takes Jo through the puzzle-solving necessary to advance to the next bomb. The villain is defeated when the final bomb blows up the dam--Propp 18: *Villain is defeated*--and the scientist is rescued. The rescue enacts Propp 19: *Initial misfortune is liquidated.*

Campbell's stages are less easily assigned to the events of the story. There is *an ordinary world*--Campbell 1--which starts the story with Jo in her bed at home, and *a call to adventure*, Campbell 2, when Jo sees the kidnapping in the museum and meets the janitor. The rat who passes messages could be considered the mentor in the program, though he functions more as an intermediary than as a source of knowledge and wisdom that guides the user. As in any story or interactive program there are *tests, allies, and enemies*, which is Campbell's sixth stage, and they are enacted here in the puzzles that the user must solve. There is a final *supreme ordeal*, Campbell 8, in which the mad scientist is confronted and defeated.

Instructional design

There is no instruction at work in this program per se. The puzzles are all examples of the application of basic skills in a variety of subject areas, and there is no systematic presentation of instruction. The museum does exist as a kind of databank or storehouse of information resources. When Jo must solve each new crossword puzzle, the user can wander through the museum rooms and search for the information that is necessary. This information, however, exists as isolated facts. For instance, the paintings in the museum can be clicked on to reveal a paragraph or two about the painting and/or its artist. The crossword puzzle might ask for the name of the city where the artist lived, or require the name of the artistic movement that the artist participated in. The juice factory which the user must visit for each new scene requires knowledge of fractions, but doesn't present any instruction about how to do them. There is feedback in the sense that

the user is allowed to progress to the next set of problems when one set is finished, but this feedback is not integrated into an instructional sequence.

Critical analysis

This program was not very satisfactory at any level. The story itself is too repetitious to be engaging over any period of time, and the lack of correspondence between the story models and the narrative may be part of the reason why the program feels 'flat' as an immersive experience. The necessity of doing the same acts over and over again with only different problems substituted rapidly becomes tedious. There is an option in the program to experience the problems at different levels of difficulty, but the problems remain skill practice problems. The characters are literally cartoons, and two dimensional. The story line and the nature of the problems presented have no relation to each other--any problem in the story could just as easily have been put in place of any other without effecting the narrative development.

Summary

This program offers the user an opportunity to practice basic academic skills in the context of an animated detective/adventure story. The lack of meaningful interaction, a developing story, or instructional design makes for a flat narrative experience.

Physicus

Overview of program

The company producing this CD was Tivola. This program is a double CD. It presents an imaginary world experiencing an extraordinary problem which the user must solve in order to save that world. In order to solve that problem the user must solve various puzzles by the application of some specific bit of scientific knowledge. The scientific content ranges across these five topics: electricity, mechanics, acoustics, optics, and heat.

The background story, as presented by the accompanying brochure:

A meteorite has crashed into your planet, causing it to stop rotating around its own axis. One half looks set to freeze solid in arctic conditions, while scorching heat makes life unbearable on the other half. You are the last hope for humankind. You must try to generate electricity in various locations for a large impulse machine. If you are successful, the machine's enormous repulse will send your planet rotating again. There are many scientific problems to solve. Use the vast knowledge database of Physicus to find the solutions.

Early in the game, the user encounters a laptop database, which, once acquired, is present throughout the game. The database provides access to a series of tutorials about the five areas of scientific knowledge, and may be opened at any time during the game. If the user is able to work through the problems unaided, then the laptop need never be used. This device also serves as a visual interface for the acquisition and application of the several items that must be gathered and used during the game.

The user of this game is identified by the company as being at least 10 years old. The tutorial presupposes a fairly sophisticated level of verbal and mathematical abilities, so that it would be an unusual ten year old who could make the best use of it--a middle school or high school age student might be a better match for the game's challenges.

The user first watches an animated image of a sailing ship scurrying across the water as a narrator's voice explains the planet's predicament. The viewpoint then shifts upwards beyond the planet's atmosphere and a small space vehicle glides into view, then descends towards the planet's surface, and finally lands beside a small island. The space ship, the buildings on the island that the user will soon encounter, and all of the mechanical devices present there, are rendered in a very realistic style and all suggest a kind of pseudo-Victorian sensibility. It is as though this world had its origins in a Jules Verne novel. The look and feel of everything present is at once ornate, weathered, organic, and mechanical. Once the space ship has settled, the viewpoint shifts to inside

the capsule and becomes the first-person viewpoint of the user. It is at this point that interactivity begins (see Figure 4.6).

Figure 4.5 First Scene After Landing

The user then is free to wander about the island on which the ship has landed, although there are certain areas and buildings that will only be open to access after a particular puzzle has been negotiated. The user may wander here and there within the confines of a given level of accomplishment within the game, but there is a minimal, least-effort path that traverses each necessary spot on the island and allows for access to each item that must be gathered to solve the puzzles. This path has some thirty stops, and requires the user to pick up about fifteen items for later application.

The first stop involves the manipulation of various devices in a building identified as a forge or smithy (see Figure 4.7). The player must use the weights present in the room to achieve the proper balance for the forge. When this is done the forge is opened, giving the player information about the size and shape of the desired result. However, the player must first discover that the ladder in the background leads to a burner which will melt the iron he or she must collect from other places in the game (see Figure 4.8).

Figure 4.6 The Forge

Figure 4.7 The Burner

The overall structure of the game involves starting three generators that are necessary to power the impulse device which will re-spin the planet. This is rarely straightforward, but instead requires the completion of several subsidiary tasks before each generator can be activated. The first generator, for instance, can only be started after the following events have been accomplished:

1. A mirror and a 2kg weight are picked up in a house;
2. A magnet is picked up in smithy;
3. The magnet must be inserted into a complex lock of the ship door, which can then be set to a number corresponding to the boiling point of water in Kelvin (that it must be set to this number is only hinted at in a clue left in another building);
4. In the ship, another 2kg weight is available, as well as an electrical resistor and a convex lens. The weight, however, is not visible until the mirror from the first house is placed in a frame angled so that the mirror reflects sunlight down a dark corridor;
5. The resistor is then inserted in the control box of an outdoor elevator and the user must calculate the appropriate voltage to enter in the box;
6. The user can now take the elevator to another level, where a third 2kg weight is available;
7. The three weights are then tossed into a furnace at the smithy, where they are melted together into a single weight;
8. This weight is then attached to a magnet at another location, which provides enough lift to open a basement door where a particular key is found;

9. The key will open a windmill;
10. Inside the windmill a hand brake must be released to free the action of the mill, and a block of wood removed to increase its speed;
11. Now the first generator is being powered by the windmill, and a transformer must be set to the appropriate number of windings.

All these steps must not only be performed, but their necessity must be first divined by the user. Many of the steps outlined above often require several steps of their own. The discovery of the necessary actions required can occupy considerable time and effort, and often entail coming and going between various locations several times before success is achieved.

When the three generators have been started the user can have access to an observatory control room, where the final voltage settings must be calculated before sending the electricity to the impulse device. Once this is done, the game ends quickly.

Correspondence with Propp/Campbell

This game, perhaps because of its impressive degree of user freedom in an imaginary world, is not easily mapped to either Propp's or Campbell's narrative templates. Once the initial situation has been engaged, one doesn't so much travel through a narrative arc as complete a series of more or less equal tasks in a row. If there is an overall narrative motion through the series it is more easily correlated to geographical access than thematic progress. Certain parts of the island are not available until particular puzzles have been solved. These locales might be considered the equivalent of scenes, but there is no dramatic development from one to the other.

There is no villain in the story, so that the dramatic conflict between hero and villain is never present. Instead, it is the situation and its mystery that the hero struggles against. Various Propp functions can be mapped to the program, but not systematically or comprehensively. Propp's 12th function, for instance,--*The hero is tested, etc.*--can here be understood to correspond to the puzzles and logical challenges that are encountered in the story, and his 14th function--*The hero acquires the use of a magical*

agent or helper.--might be said to match up with the items the player must accumulate in order for the story to advance. However, these isolated correspondences are not enough in themselves to make Propp's analysis appropriate to a good understanding of this program.

Campbell's stages are similarly inadequate as a template for this story line. There is a hero--the player--and a challenge to overcome, but there is no narrative arc. Instead, the narrative is dramatically flat for most of its development. There is no mentor character to aid the hero/player. The database that the hero accesses is not personalized. There is no sense that the story reaches a climax in a dramatic sense.

Instructional design

The tutorials that can be accessed through the database are self-contained, often lengthy, and comprise an instructional sequence that, if not comprehensive, at least builds on itself to link together elementary science concepts into a unified instructional presentation. They are necessarily somewhat limited in their scope. They are best seen as presentations of elementary science ideas, supported with multimedia examples and illustrations. The user can choose any given unit, page back and forth one screen at a time within that unit, or jump from sub-section to sub-section within the unit. The production values are high, and the animations that illustrate the concepts are sophisticated. There is an optional voice-over that reads the text on the screen. There are no opportunities for testing in the tutorials, so that the learner is not tasked with demonstrating mastery of the subject.

Since the tutorials are self-contained, and the user need not necessarily experience them in order to complete the game, then it is fair to say that they are not integrated into the play of the game in any explicit way. However, when the user encounters a puzzle that resists resolution, the tutorials are there to provide information.

Critical analysis

This is a sophisticated and engaging game. The production values are very high, as excellent as anything that I've seen. The imaginary world created here is very

convincing; it carries the sense in every scene that everything is part of a unified, related whole. The puzzles are genuinely challenging--I found them very difficult in many instances. They are perhaps too difficult. The sense of imaginative engagement with the world is often undermined by the difficulty of a puzzle, which throws the user out of the experience.

The piece fails, however, at creating a convincing sense of story. Though the visual background is rich, and there are clues to the lives of the missing people left within their dwellings, the sense of story feels attenuated compared to the visual richness on the screen. The tutorials are engaging and very well done, but they would not work very well for anyone really wishing to learn anything substantial about any of the science units they cover. Their approach is entirely didactic (though interactively so), in contrast to the open-ended play possible in the imaginary world they support.

Summary

This program is successful at many levels, but fails to fully integrate the science knowledge that supports it into the play of the game. In the puzzle, for instance, that requires the user to enter the boiling point of water in Kelvin into a lock, there is no reason why that number should be there rather than any other. The imaginary world is beautifully realized, but the sense of a compelling narrative flow is replaced with a sense of tasks to be completed.

PLATO Educational Software

Overview of program

PLATO is a well-designed, richly scaffolded instructional sequence for teenagers and young adults. There are programs treating reading, math, applied science, and vocabulary building. The programs are designed to be used with the help of an instructor, possibly in a classroom situation. There is, within the program, the capability to record a given user's progress through the CD, and to create a report. The instructor

may control student access to the program by requiring passwords, and may also view the reports of student progress.

The math series presents problem-solving activities in which the user must solve authentic, real-world problems within a fixed scenario. This series offers seven different areas of mathematics. At the beginning of the sequence, there is an introduction to the course and the problem. The user decides on a level of coaching, views the scenario that presents the problem, and them confirms or alters the level of coaching required. The problem is solved with the aid of various tools presented on-screen, the program gives feedback to the user about the correctness of the answer (within the context of the scenario), and the user may try again if the first effort did not lead to success. Alternatively, the user may choose to rework the problem with more or less coaching--to achieve mastery of the activity the user must solve the problem at least once without any help. The activity may be repeated again, even if the user was successful, with slight variations on the terms of the problem.

Correspondence with Propp/Campbell

The user is presented with a real world situation and required to solve a math problem in that context. Propp's functions are represented only in the sketchiest possible way, as the hero's tests might be said to map to the problem challenges. There is no villain, no climactic scene; the story is implied around the scene. One has the sense that the player is part of a larger story, of which this scenario is but one small part. Similarly with Campbell's structure, the lack of an overall dramatic arc obviates the necessity for character development. The coaching tips might be understood as playing the mentor role within Campbell's template, but they are not given a character.

The Smart Shopping scenario, for instance, opens with the user receiving a letter asking for help buying some of the supplies for a party. The letter details the recipe for S'mores, give the number of people expected at the party, specifies the number of S'mores that each person will receive, and sets a dollar limit on the purchase of supplies. The scene then shifts to the inside of a grocery store. The user sees a typical grocery

aisle (see Figure 4.x). On the left of the screen is a panel of tools to help the user decide about the correct purchases. There is:

1. a calculator;
2. a note sheet for each of the ingredients (crackers, marshmallows, chocolate) that lists the elements that will go into the user's calculations about the relative costs of two products. For instance, the cost of box, the unit price, the size of box, cost per box serving size, etc.;
3. a goal statement;
4. the recipe for S'mores;
5. a picture of the grocery shelf where the ingredients are kept, which provides the cost of the box, the number of servings, and the suggested serving size. At this place, the user may drag the appropriate box to the cart for purchase;
6. a checkout.

There is only a suggestion of a story. The only character supplied by the story is the writer of the letter, whose presence is only revealed by the letter. The user may access any of the tools in any order, put them down and return to them, or not access them at all.

In the Car Buying scenario, the user is assumed to be a young person trying to figure out if the cost and upkeep of a car can be afforded based on a given salary from a part-time job. The user is given the necessary figures to make the calculation: cost of the car, cost of its upkeep (itemized), gas costs, salary, percentage of salary earmarked for upkeep of the car, etc. In this case, we see the following tools on the left of the screen:

1. a calculator;
2. a goal statement;
3. list of upkeep costs;
4. notebook for calculating total expenditures;
5. notebook for determining the percentage of salary that will be represented by total expenditures;

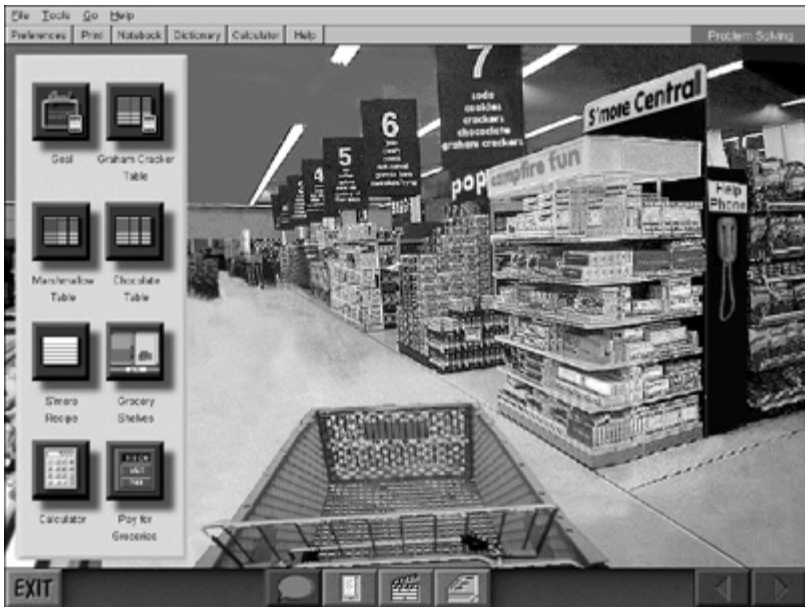


Figure 4.8 Shopping Aisle

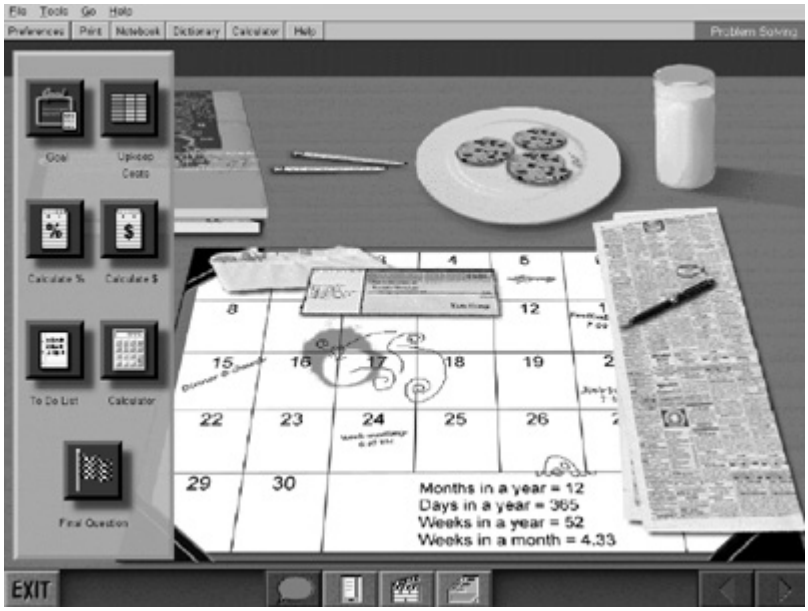


Figure 4.9 Car Buying Scenario

6. a to do list that provides essential figures for the calculations;
7. a page for the final question "Is there enough money to afford the car".

The early screens of this scenario show a car parked in front of a suburban home. The scene that accompanies the calculation section is that of a typical student desk, with pencils, books, calendar, dessert, and a copy of the newspaper ad (see Figure 4.x). Again, the story is implied rather than developed.

In the Playground Resurfacing scenario, the user is a volunteer at a community center. The user is asked to help with a project, which is to calculate the amount of supplies needed to resurface and fence a playground area. The user is shown information about the supplies. For instance, that the resurfacing material is sold only in cubic meters, that the fencing material is sold only in meters, that the ground is to be resurfaced to a depth of 15 centimeters, etc. There is a blueprint of the playground visible, which provides the minimum necessary mathematical information for calculating the area of the playground. The tools provided are:

1. a calculator;
2. a goal statement;
3. a table;
4. a template for calculating the amount of resurfacing material;
5. and a fax machine for submitting the answer.

The actual calculating is done while viewing a scene of a desktop set in a typical middle class living room. There is available also a copy of the blueprints and a notebook containing helpful information. The only character in the scenario besides the assumed character of the user is the director of the community center, who give the user the necessary information. There is no further story development.

Instructional design

The instructional design of this program relies chiefly on scaffolding the learner's experience through the coaching tips available at different levels. The three levels of

coaching are: the Show Me level, which offers maximum assistance by offering guidance at every step of the problem; the Assist Me level, which provides occasional guidance; and the Leave Me Alone level, which provides no assistance at all. The presentation of the scenario reveals the context, the task to be performed, and what the user must do in order to succeed. When the presentation is over, the user must correctly identify the end goal of the activity and confirm the coaching level. At all times there is visible below the screen the following button options:

1. a help button which suggests steps for solving the problem. This is only available in the Show Me level of assistance;
2. a Learner's Log review notebook, which lists the steps the user has taken so far;
3. a review of the problem presentation; and
4. a button that restarts the problem with some other level of help.

If the user chooses the Show Me level, the steps for solving the problem will automatically display.

The program identifies the area where the problem is solved as the Problem Hub. Here the learner will find tools and access to necessary information. Typically, the tools will include a calculator, a simplified spread sheet to record calculations, a re-statement of the goal, and some way to submit the answer that makes sense in the scenario context. All of the tools can be open at one time, facilitating their use. When the user has submitted an answer, the conclusion is presented within the context of the scenario. There is one screen that follows the correct answer, and from one to six that possible wrong answer screens.

The tool set for each scenario is unique, though each is similar to the other. The tools are there to help the user investigate, represent, and solve the problem. They are meant to represent real-life tools that anyone might use in solving these math problems in the real world. The tools may be used in unique ways, as well, and the user may arrive at the correct solution by generating a unique path through the tool set.

The coaching resources have a variety of responses, depending on the level chosen. In the Show Me level there are the following features:

1. a list of suggested steps for solving the problem;
2. a feedback message when the user does something unnecessary;
3. a feedback message when the user enters an incorrect calculation;
4. a feedback message confirming the right response and suggesting the next step; and
5. hints to help guide tool use.

In the Assist Me level, the list of suggested steps is not available

Critical analysis

This program is an excellently designed opportunity for learners to practice problem solving in "real world" situations. The scenarios embed challenges that require a thoughtful use of the math concepts which these problems rehearse, making for an experience that goes beyond drill and practice. Each scenario offers slightly different details when it is tried for a second or third time, which forces the user to re-think the elements of the problem. The coaching levels support its use by learners of varying degrees of readiness. The program could best be used as an adjunct experience for classroom learners, who could use the program under the guidance of a teacher. The various tools available to the learner support individualized pathways through the problems. The program has been developed as part of a curriculum, and each of the activities references the parts of the curriculum that are related, integrating the whole. The program makes minimal use of narrative structures to situate the problems. There is no narrative development within each scenario. The opposition is provided entirely by the intellectual challenge in the scene, and there are no characters to contend with.

Summary

The Plato series as a whole is a well-developed curriculum. This program, as part of it, presents basic math concepts in brief scenarios that imply stories without actually developing them. The scaffolding and thoughtful use of problem presentation make for a learning experience that goes beyond skill practice in a narrow sense. The problems

presented here must be thought about, and the math concepts required for their solution must be well understood, before the learner can advance to the next scenario.

SimCity 3000

Overview of program

SimCity is a strategy game that simulates the development and growth management of a virtual city. The user plays the role of the Mayor, and is in control of various elements that are necessary for a successful city. Although it is not marketed as an instructional program, it nevertheless requires the user to understand how competing civic forces must be balanced with other in order to attract residents, provide them with the necessary infrastructure, and regulate the budget. The simulation is rooted in reality, and though it cannot capture the true complexities of urban development, it is complex enough, and challenging enough, to give the impression of verisimilitude. The program has been one of the enduring successes of interactive game play, having gone through at least three incarnations of increasingly more graphically persuasive and interactive development. In addition, it has spawned a number of other Sim titles: SimFarm, SimAnt, The Sims, etc.

As Mayor, the player may alter the terrain, zone properties, build transportation networks, construct power plants and utilities, provide specialized civic structures such as schools, hospitals, and libraries, respond to emergencies, meet with civic advisors, review and adjust the budget, control how fast time passes in the city, and respond to pleas and complaints from the populace. All of these resources are activated from a toolbar that is always visible at one side of the screen. The main screen area shows an overview of the city, which may be enlarged or reduced in size and detail. At the greatest level of detail the viewer can see individual citizens walking around the city streets. At the greatest distance from the city, only the buildings are visible. The scene may be shifted to view the city area from underground, in order to see the water pipes and subway tunnels that can be sited there. In addition, the view may be one of several maps that show some

aspect of the city's functioning--air and water pollution, for instance, or space protected by police or fire departments. The player may choose to activate random disaster events in the scenario, such as fires or tornadoes. If this option is chosen, then the player must respond to these events with the emergency services available. The scenario may be entered at different levels of difficulty. Easy games start with more money in the Mayor's coffers. The starting date may also be chosen. Earlier dates mean that there are limits on the technology available.

Figure 4.10 City Overview

Figure 4.11 Advisor

Figure 4.12 Budget

Correspondence with Propp/Campbell

There is only the most tenuous connection between Propp and Campbell's story models with the narrative experience enjoyed by the player of this game. There are characters in a setting, and challenges to meet, but the scenario proceeds without Propp's detailed narrative events or Campbell's stages. The interactive nature of the simulation experience makes this program a sophisticated expression of hypernarrative structures. Because of the rich number of possible actions and the interacting results of those actions, the story line can be taken in apparently limitless directions. The player acts the role of Mayor in the city. There is no consistent antagonist or villain, though there are characters who make proposals that are in their self interest and that, if enacted, would cause harm to the city in one way or another.

The Mayor has advisors for various aspects of city planning: financial, social, commercial, etc. These advisors can be accessed for communication and advice at any time, and they occasionally seek the Mayor's attention to propose an activity.

There is no overall narrative arc to the program that reaches a climax. The city grows or doesn't grow. There can be failure if the city is destroyed by natural or other disasters, or fails due to economic collapse. There are various sources within the game for accessing information about the best way to develop a city, and these sources could be understood as mentors. However, there is not any significant correspondence with Campbell's stages. The highly interactive nature of a simulation may account for this. A simulation as richly detailed as this one is permits nearly limitless possible actions, or at least sequences of actions, so that any fixed story line soon is atomized.

Instructional design

Although there is no explicit instructional design in this program, it nevertheless requires the player to understand the elements of city planning and how they must be balanced with each other in order for play to proceed. For instance, garbage begins to accumulate as the city grows. The Mayor must decide whether to zone for landfill or construct incinerators. Either choice will have ramifications for pollution, cost, and land

values. Similarly, the Mayor must decide how much money to spend on police services for the city. If this is lacking, then crime rises, land values go down, the citizens become unhappy, and population decreases. If too much money is given to the police, then minor infractions of the law are treated harshly by over zealous officers with too much time on their hands. The player has the opportunity to learn these lessons in a variety of ways. Population and budget are always visible and change in real time to reflect the state of the city. At any given time the player may access a screen that details budget items--the police budget for instance. There is also a constant stream of news presented as a ticker tape presentation at the bottom of the screen. It is here that the Mayor may learn that citizens are upset about an overzealous police force, or that some parts of the city are not getting enough water. In addition, there are the Mayoral advisors. These characters will, when asked, advise the Mayor on the implications of various policy decisions; they will also provide background information about city issues and provide general guidelines.

If the player doesn't pay attention to the balance of forces in the city, then the city will rapidly deteriorate and collapse, providing a negative feedback. If the player does make an effort to balance the elements, then the game will offer positive rewards. Population will increase, money will accumulate, the citizens will announce their pleasure with the city. There is no practical end goal to the simulation, unless it is a state of equilibrium in which the entire playing area has been completely filled with city structures and the population has reached a maximum for the given land area. This state is difficult enough to achieve that the game can be played for a long time without fear of exhausting its challenges.

Critical analysis

This program is an intelligent and artful balance of game play, interactive narrative, and educational opportunity. It offers the best meld of learning, story, and interactivity that I have come across in this study. Some part of this must be due to its nature as a simulation, which allows for unity of story and interactivity. There is no fixed story line here. Only as the game unfolds from the player's decisions can the story be

said to exist at all. The learning opportunities are implicit in the game play. There is no division between the story and the knowledge necessary to proceed. It is this unity between story and instructional possibility that sets a simulation apart from the other kinds of story-based educational software. In the others, no matter how well designed, there is always a discontinuity in the narrative as the designer inserts the educational resources necessary for the story to proceed. In SimCity 3000 this information is presented when and as appropriate in a kind of Mayor-advisor dialogue that happens in "real time" game play.

Summary

This program is an excellent combination of narrative, interactivity, and instructional design. Though it doesn't have a narrative arc that resembles the story lines described in either Propp or Campbell, there is nevertheless a story that fits the most basic description of the narrative experience: a character (you, the Mayor) in a situation (creation of a city) that presents obstacles to the goal (building and maintaining a growing city). The interactivity is richly detailed and provides an almost unlimited number of options for the player within the basic parameters of the scenario. The instructional design, while not following a traditional instructional design sequence, still embeds considerable information about city planning into the game--so seamlessly that the player never feels that he or she has had to leave the game universe in order to acquire that information.

Where In The USA is Carmen Sandiego?

Overview of program

This is a single CD program designed to expand the user's knowledge of US geography, history, art, music, and industry. It is also advertised as an aid to developing skills in critical thinking, deductive reasoning, reading, database research, and map reading. The story involves the user in a search for the master criminal Carmen Sandiego. The identified learner is 8-12 years old.

The learner must chase and catch 39 crooks across the United States before Carmen can be found. The chase involves interviewing people encountered in a given locale, building up information about each crooks' attributes, consulting a database as necessary, and deducing the next state to which the crook has traveled. Once arriving at the state where the crook is hiding, the learner must pick him or her from the other citizens in the area and make an arrest based on the previously gathered information. The environment for the story is seen in connection with the Acme Get-A-Clue Case Pad (Figure 4.1), which provides access to various game functions--the Clue Log (A), the database of state information (B), a video button to contact the Chief (C), the CompuCrook Button (D), the Crime Net Travel Button (E), the State Map (F), a choice of questions to ask of the characters (G), and the Battery Meter (H) (see Figure 4.1).

The Clue Log (A) works as a notebook. Anything that any of the characters says in a speech balloon may be copied to the Clue Log. The database of state information (B) provides an index of data about each of the fifty states.

This information includes references to the state's geography, history, prominent people, sights, and economy (see Figure 4.3). This screen also provides access to information about landmarks, industries, interesting facts, local music, and a short video about the state. The music of a given state plays automatically in the background when the user visits that state; in the database a user may listen to all of the selections from that location in their entirety.

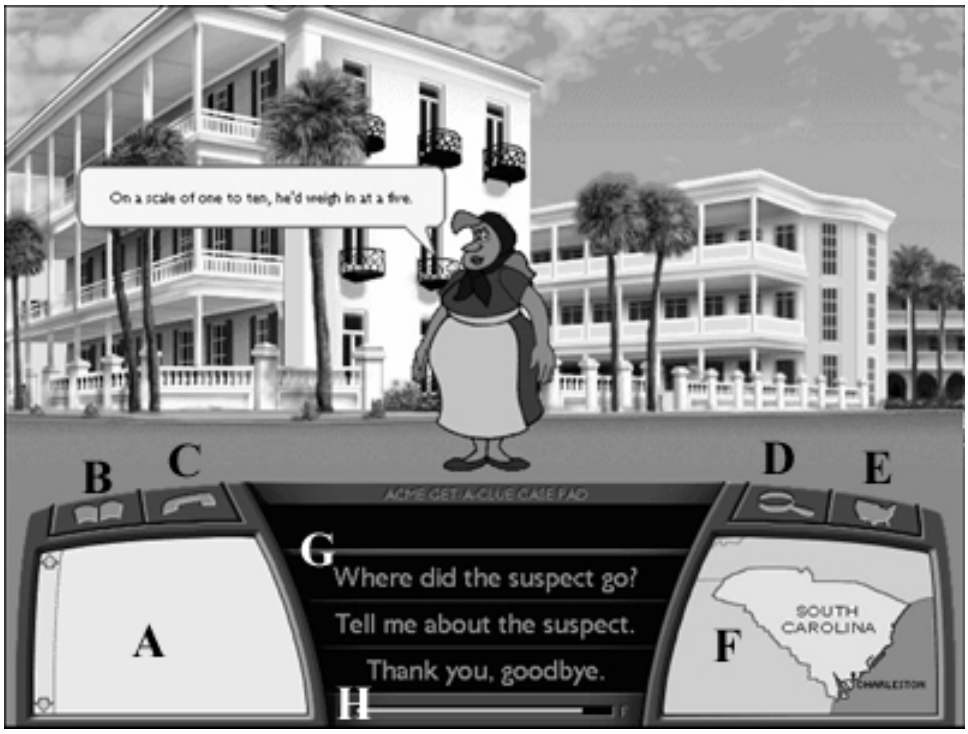


Figure 4.13 Acme Get-A-Clue Case Pad

Figure 4.14 Database Of State Information

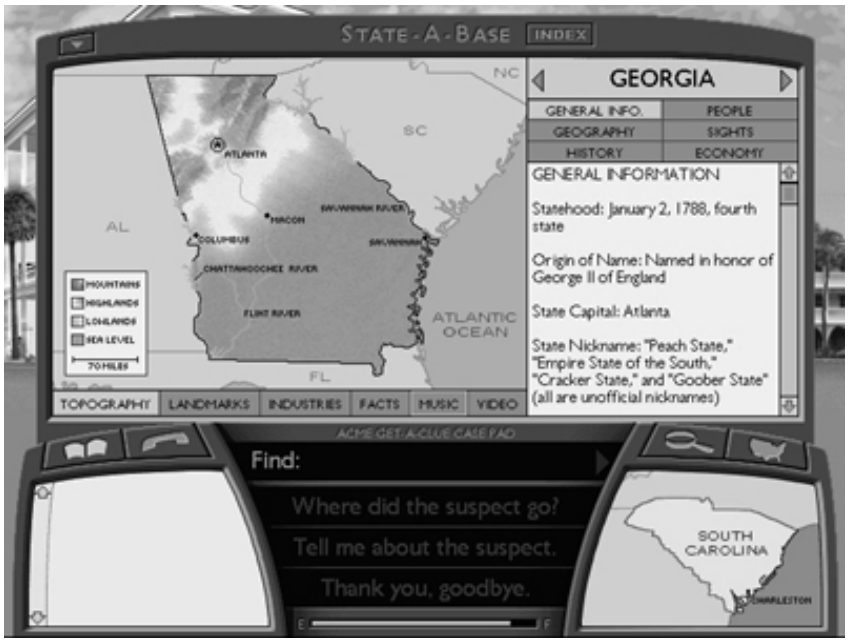


Figure 4.15 General State Information

The video phone contact (C) starts a video of the The Chief (the player's superior officer) who outlines each new case and provides feedback about the player's results.

The CompuCrook button (D) opens a warrant screen where the physical characteristics of the suspect can be visually recorded as the player learns them through conversation with the characters (see Figure 4.4).

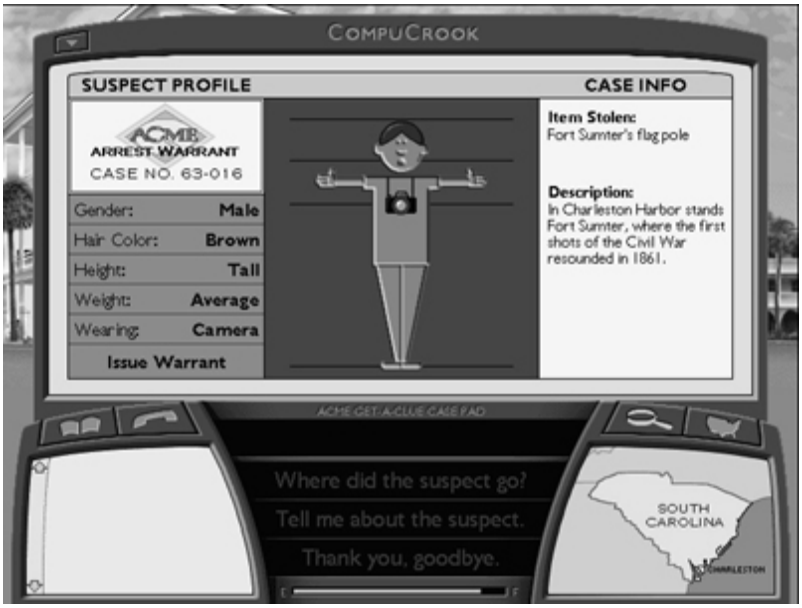


Figure 4.16 CompuCrook Warrant Screen

The CrimeNet Travel button (E) displays a map and list of possible states to which the crook has fled. One of these must be chosen for the player's next move (see Figure 4.5).

As the player visits each state, information about the criminal is provided by interviews and recorded. By clicking on a given character on the screen, the player may get their attention and ask about the suspect's whereabouts and appearance. The Battery Meter is reduced a bit for each question. If the player chooses, the database may be accessed and scanned. For instance, a character might indicate that the crook has gone to a state where buffalo once roamed. The player can glance at the map of possible states and select one from the database; reading the information there may be enough of a clue to suggest the next state to visit. If the characters' clues are insufficient, then the player

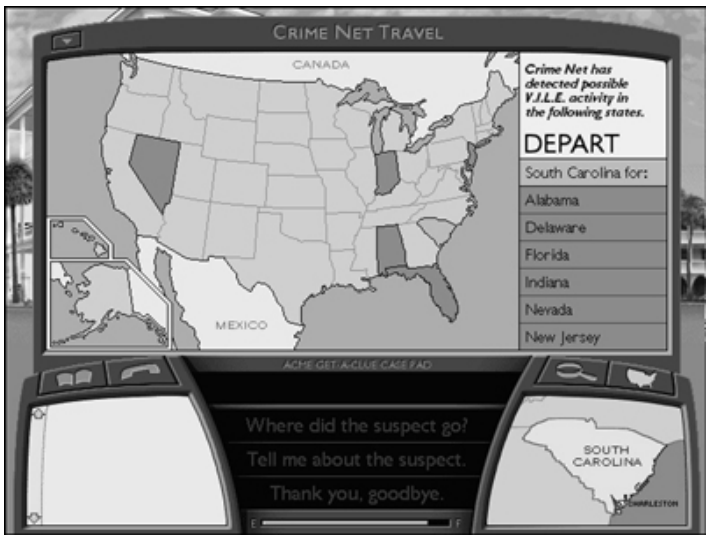


Figure 4.17 Crime Net Travel Map

may enter a search term directly into the database and find the answer that way. However, this reduces the Battery level significantly. Consequently, there is a premium to be paid for lazily asking the database without working through the information there oneself.

There are eight levels of achievement to pass through before Carmen can be caught. These add up to 39 cases. The cases do not increase in difficulty. When the last case is solved, the final episode reveals Carmen in disguise. The player must correctly

identify her based on clues accumulated during the game and make the arrest. After that, the player may start the game over.

Correspondence with Propp/Campbell

There is little correspondence between Propp's inventory of story functions and the narrative arc of this game; this is equally true for Campbell's stages. The episodes are sequential in the program, and each contains the same elements: the Chief presents the new case by describing a crime; the player 'travels' to that state and asks questions of the animated characters present there about the criminal's appearance and whereabouts; the player makes an arrest. The various characters might be seen as mentors, though they are also possible suspects in the last stage of each scenario. There is the possibility of accessing a guide through the database, who will point out facts about a given state--this is probably a closer match for what Campbell had in mind as a mentor. There is a villain, Carmen Sandiego, but there is not a direct engagement with her.

Instructional design

The instructional design of this program encourages the player to browse through information about a particular state, but it doesn't present that information in any systematic sequence. The music that plays in a given state creates an association between that state and its music, but otherwise the player has only to skim through the information in the database to isolate the particular information required--even this is not always necessary if the player can identify the next state from clues in the character's conversation alone. There is no formal instructional design sequence present here.

Critical analysis

This is a lively and thoughtful program. The characters are varied enough to remain interesting despite the similarity of their functions in a given scene. The animations are charming. The amount of information present in the database is not so much as to overwhelm the search capabilities of its intended audience level. The conversations with the Chief are fun. The production level throughout is high. The similarity of one case to the next does promote boredom if they are played in bunches,

but the average player will probably not spend hours at the game. It is possible to learn some basic facts about a state and its people by playing the game. However, there is not a necessity to do so. The information isn't presented within any developed context or effective sequence of learning steps. The player is rewarded for finding information without having to ask the database explicitly for it, but the player need only scan through short columns of text in order to get that information. The program succeeds as a game by allowing appropriate levels of challenge and skill. The interactivity required is generous only within the narrow limits set out by the game structure. That is, one may make many wrong choices, which will eventually result in Battery depletion, but only a few choice strategies actually can be successful. The story line is very flat; each case presents the same narrative events.

Summary

The Carmen SanDiego program creates an opportunity to learn varied bits of geographical information, and situates this learning experience in a narrative, but the narrative as a whole is repetitive and very simplistic. As in most of the programs studied, the program can be played very successfully without ever consulting the isolated instructional presentations, so that there is very little actual integration of story and instructional design.

Chapter Summary

The programs varied considerably in the sophistication and complexity of their narrative and educational aspects. The story models developed by Propp and Campbell were only intermittently present in the programs. The instructional design was generally concentrated in an isolated instructional space that existed independently of the story arc. That is, while the location of that instructional space may have been integrated into the general narrative structure of the program, the learner/user could navigate the entire story without altering its progress in any way while avoiding visits to the instructional space. In Weather Disaster, for instance, it was the identified as Millibar's database. Any puzzles or questions posed in the course of passing from one scene to another that could

be answered from the user's previous knowledge obviated the necessity of a trip to the database. In JumpStart 5th Grade, the information presented in the Museum need never be investigated if the user already has that knowledge. Physicus presented very attractively designed instructional sequences, but like the other programs, did not require the user to access them if the knowledge was already there. The Plato program and the SimCity 3000 program were somewhat different. The Plato program embedded the instructional presentations within the help function, which was available as different levels of aid. This program was in any case minimally narrative. The SimCity program deftly conjoined instruction and narrative, but at the cost of any real narrative arc.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

The purpose of this research was to broadly analyze how narrative structure is being used in selected examples of educational software to structure the user's learning experience. An additional purpose was to develop a theoretical construct for the use of narrative in educational hypermedia environments. These purposes arose from the observation that many instances of educational hypermedia, especially those designed for elementary age children, use stories for structural and motivational support. My supposition was that this use of story was not well informed by critical discourse on narrative, and that stories were being used ingenuously. This supposition was supported by the fact that little literature exists that explores the possible use of story form for educational purposes in multimedia (McClellan, 1992b). This lack of conscious attention to the forms and history of narrative structure is detrimental to the successful development of a systematic application of story for educational purposes.

This study has not been an examination of the effectiveness of the programs as learning tools. It has been assumed that they are reasonably well-regarded examples of the genre, based on the popularity and expert review. The study has centered on the relationship between narrative and instruction within the programs.

This study concentrated on educational hypermedia published on CD-ROMs that were critically and/or commercially successful. Their necessary characteristics included the presence of characters, a virtual setting, and one or more story lines. The sample was further narrowed by looking only at examples appropriate for 4th-12th grade children that had been published in the last ten years. The general procedure used in this study was to play through each sample and record the presence of story elements and instructional elements. I paid particular attention to those story elements identified by Propp (1928/1968) and Campbell (1949), and to instructional elements outlined by Gagne

(1992). I evaluated the relationship of story elements and instructional elements within each instance of the user-defined experience.

The question that has guided this research design is*: How are stories being used to structure educational multimedia software?* The parameters that guided my initial efforts drew from many fields, but I found that three conceptual lenses were essential for this analysis--story, instruction, and choice (see Figure 5.1). For analytical purposes I relied on narrative structure to represent *story*. My approach was informed by the historically new field of narratology (Bal, 1997), as well as by the critical contributions of cognitive scientists to story grammar (Bartlett, 1932; Mandler & Johnson, 11977; Stein & Glenn, 1979) and the critical theorizing of those who have made a study of hypertext in general (Conklin, 1987; Jonassen, 1989) and hypertext fiction in particular (Landow, 1997).

It was necessary to reduce the complexity of narrative for the purposes of this research, but in doing so it was also necessary to put aside much that might have been at least equally pertinent. Character, for instance, which has been a central concern of Western writers for centuries, is here given short shrift, except insofar as it is an aspect of Campbell's monomyth. But then, the development of character, save in whatever sense the user may be considered as engaged in a bildungsroman, or story of self-development, while using the software, has not revealed itself as a primary concern for the authors of educational software, even when narrative has otherwise been central to the piece. Similarly, the use of story to reveal and/or express cultural concerns broader than the development of individual character, no matter how heroic or iconic, which has been the focus of both serious storytelling and critical analysis, has here been left untouched--though the stories in the software could probably be usefully examined as cultural artifacts of great expressive precision. Instead, I have used the form of stories as the aspect of narrative most congenial to the exploration of my research question. I believe, however, that narrative form has been not only a congenial avenue for this exploration

but also a rational and useful one in which to examine the relationships that have been my concern.

This belief is based on the idea that plot, the linear structure of events unfolding in a narrative space, can be isolated for study more easily and with greater precision than many of the other elements of fiction. Character, for instance, is a comparatively recent development of fiction. The study of character in ancient stories is necessarily a different

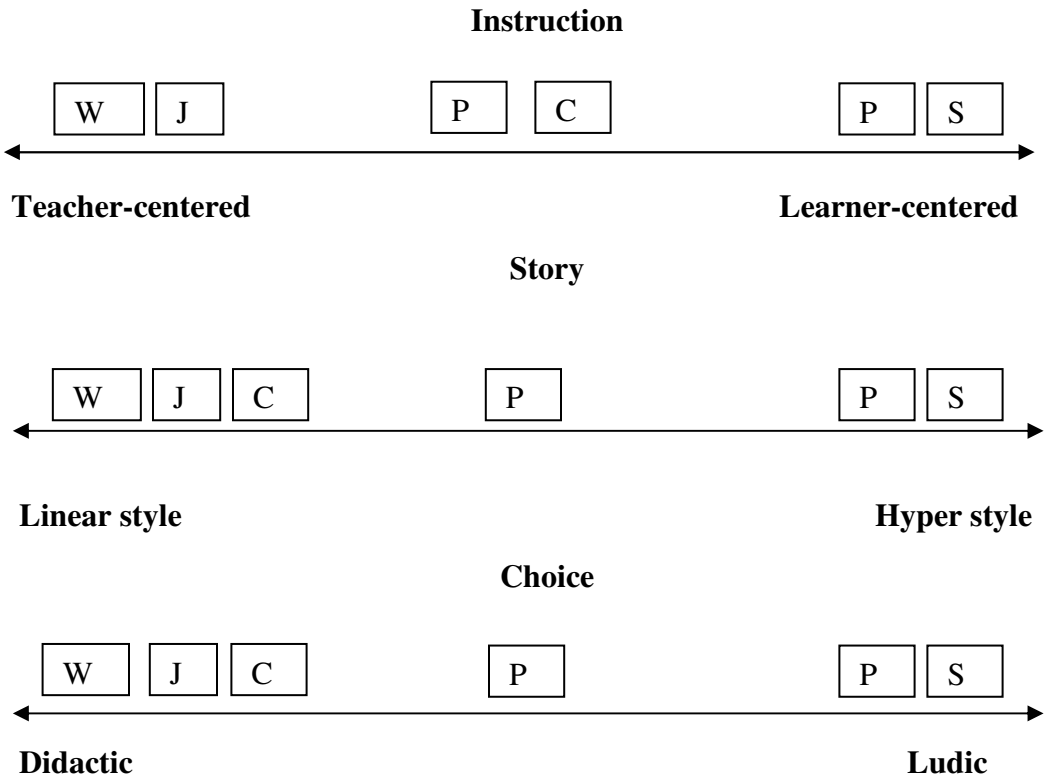


Figure 5.1. The three lenses

WD = Weather Disaster	JS = JumpStart 5th Grade	CS = Carmen SanDiego
SC = SimCity 3000	PL = Plato	PH = Physicus

kind of enterprise than its study in contemporary novels. Plot, on the other hand, may be lifted from stories ancient or modern with greater assurance, making it easier to approach.

Narrative form has long been studied, and has a history of development (Aristotle, trans. 1982; Bal, 1997; Barthes, 1977; Bernstein, 1998; Bolter, 1991; Coover, 1992; Derrida, 1976; Greimas, 1966; Levi-Strauss, 1958/1963; Lodge, 1980; Murray, 1997; Ong, 1982; Prince, 1987; Propp, 1928/1968). Since the stories examined as part of this research have their home in hypermedia environments, and thus are part of a new chapter in the history of narrative, a knowledge of the history of narrative form has been essential to this study. Narrative structure unfolds sequentially, at least in traditional media; this characteristic can be compared to the sequential nature of traditional instructional design and contrasted with the non-sequential nature of hypermedia environments.

This study was based on the particular narrative structures from Propp's analysis of folktales and Campbell's description of story structure in certain kinds of myths. Both possess a clear linear structure and the nature of the stories that they studied bears some significant resemblance to the kinds of stories found most often in educational software. That is to say, the folktales and myths that these scholars examined draw from the same universe of story design that one may find in the simple adventure stories used to scaffold educational material.

Instructional design has been, of course, a necessary part of this study. Since this study seeks to understand the relationship between story and instruction, *instruction* was a necessary second lens from which to view this material. Instruction, like story, takes many forms (Ausubel, 1968; Bruner, 1966; Gagne, 1985; Merrill, 1978; Reigeluth & Stein, 1983; Mayer, 1999), and can be viewed from diverse perspectives. It serves ends that are at once personal, political, and cultural. Personal because the variety of approaches to instruction allows instructional designers to make personal choices in its application, and also because instruction must be designed, in so far as it is possible, for the individual needs of the learner. Political and cultural because these are interwoven into every aspect of our lives. It has a developmental history, and can be studied as a structure. Instruction, like story, works its way into every aspect of human behavior to

such an extent that culture without it is unthinkable. Despite its ubiquitous and manifold existence, I have used only selected aspects of instructional design in this study. As with narrative structure, the topic of instruction is large, complex, and ultimately mysterious in its effects and organization. Similarly, only one analysis of instructional design--Gagné's events of instruction--was considered here. This was a necessary reduction for the purposes of this study. Gagne's events of instruction was used as the metric by which to measure the presence or absence of identifiable elements in an instructional sequence. This made sense because it permitted a comparison with the events of story as identified by Propp and Campbell. Although I have relied on Gagne's events as a benchmark, I have remained open to other kinds of instructional presentation during the research. Instruction in the instances examined in this study ranges from well organized presentations of discrete lessons about a single subject to implied learning objectives in a simulated environment, as well as to practice sessions for basic concepts. While Gagne's events may not have been the best metric for taking the measure of these instructional designs, it has nevertheless provided a starting point for this analysis.

The third corner of my research triangle is *choice*. This is a shorthand way of referring to interactivity both in story and in instruction. Choice is arguably the most pertinent aspect of interactivity to examine in this context. All of the software pieces examined in this study contain varying possibilities for user interaction, as any hypermedia piece will. The development of interactive fiction has yet to have profound effects on literature as a whole, though it continues to thrive as an energetic, if marginal, genre (Coover, 1992). It is having its most telling effect in electronic gaming (Murray, 1997). Perhaps the Internet as a whole may be seen as a single hyper-linked document. In any case, the theoretical possibilities, much discussed in critical circles, that interactive fiction suggest, cannot be disregarded in educational hypermedia based on stories. In addition, interactivity in instruction, both as an aspect of its presentation in electronic media and as an aspect of constructivist pedagogy, made this a crucial element for this study.

Together, these three lenses provided a framework for examining story in educational software. Each of the nodes--i.e., story, instruction, and choice--was further divided, or spread, along a continuum. Instruction was conceived as being either teacher-centered or learner-centered. This loosely corresponds to a continuum with instructivist ideas at one end and constructivist ideas at the other, and it should be emphasized that this was not understood as a rigorous and mutually exclusive dichotomy. Instructional design that wholly occupies one position on that continuum is rare. More common is the mixture of the two in varying proportions. Story's continuum put traditional linear narrative at one end and highly interactive hyperfiction at the other. As with instruction, these poles are difficult to pin down with great assurance. Even a standard story in a book, after all, admits of re-reading, browsing, and idiosyncratic approaches--not to mention the infinite number of cognitive interconnections between books. Hyperfiction, however interactively conceived, is usually structured in some sense of the word. Choice was assigned to a continuum that stretched between the ludic and the didactic. Although this is a somewhat arbitrary distinction, it nevertheless was useful in distinguishing between interactivity that supported user exploration of a learning environment and interactivity that was endemic to the playful experience of the user within the story.

These concerns and rubrics shaped this research and led to this study's three sub-questions:

1. What instructional functions are present?
2. What is the structure of the narrative being used?
3. What is the correspondence between narrative structure and instructional functions?

For all of the questions, I proceeded first to work my way through the software and then to revisit various parts of it. In some of the software I created a written transcript of my experience as I worked through it. This artifact was then used as a basis for coding the presence of instructional events and the elements of story found there (see Table 5.1). As the study unfolded, I found that this approach, which helped me to orient myself to the

presence of the themes in the first software studied, was unnecessary in other cases and impractical in still others. The SimCity 3000 software, for instance, is virtually endless, and the permutations that are a result of its open-ended nature, in conjunction with the thousands of small decisions that are made in the course of the game, make it an unfeasible candidate for transcription.

This analysis of the story structures present in the narrative-based software included in the research design sometimes demonstrated a correspondence with Propp and/or Campbell, and sometimes relied on a linear presentation of instruction similar to Gagne's model. In one of the pieces, Weather Disaster, many of Propp's elements may be observed, as may many of Campbell's stages. Similarly, Carmen SanDiego also demonstrates many elements of Propp, though not so many of Campbell. In both Plato and SimCity 3000 there is very little correspondence. In terms of the instructional design, the software relied for the most part on a separate place in the narrative for the user to access the instructional experience (with the exception of JumpStart 5th Grade and the possible exception of SimCity). This placed the learning experiences generally outside the main narrative flow. These experiences were usually presented in a linear, traditional format. JumpStart 5th Grade did not have a formal learning element, but instead merely provided opportunities for the user to practice their understanding. SimCity 3000 integrated the knowledge necessary to understand the simulation within the simulation activities, but provided specific instructional aids in the form of advice from multiple characters.

How are stories being used to structure educational multimedia software? The results of this study show that stories are being used for structural purposes, but I conclude that neither Propp's elements nor Campbell's monomyth is the most useful guide to understanding that structure. In all of the pieces studied one may find stories or their elements presented to motivate and guide the user through the intended educational experience. However, this correspondence was not consistent, so that it is difficult to

Table 5.1. Table correlating story models and ID elements by software

	Propp Elements	Campbell	Gagne
Weather Disaster	1,2,3,8-16, 18-20, 30, 31	1, 2, 4-9, 12	1,2,4,6,8
Jumpstart 5th Grade	1, 8-15, 18, 19	1, 2, 6, 8	1,2,6,8
Physicus	12, 14	4?	1,4,6,8
Plato	None	4?	1,2,5,6,7,8
SimCity 3000	None	4, 6	1,2,5,6,7,8
Carmen SanDiego	5, 9, 10, 11, 12, 15, 16, 18, 19, 20	2, 4?, 6, 8, 9	1,4,6,8

(The question mark after the number 4 under Campbell's model in Table 1 indicates my uncertainty as to the presence of that element in the software in terms supplied by the story models. The number identifies, in Campbell's terms, the meeting with the mentor. Is the scaffolding supplied in Plato best understood within that context? It isn't personified, so that there is no character associated with it. In Physicus, the laptop which contains the science lessons, and which is accessible at any time in the game, isn't characterized but the player does have the option of having the information read out loud. This suggests a character, but the suggestion isn't developed in the rest of the game.)

make much of the correspondences that were discovered. The elements that Propp identified in Russian folktales, and the stages of the hero's journey outlined by Campbell, are the everyday stuff of adventure stories, and their presence here may or may not point to a significant structural identity.

One way in which the designers of these pieces rely on the stories for structure is by linking the testing of the hero in the narrative to the learning objectives of the piece. For instance, in Weather Disaster, the user must overcome challenges in the form of puzzles that (sometimes) require knowledge about weather facts in order to proceed

through the game. In Physicus, the user must demonstrate a knowledge of basic physics in applied situations by solving puzzles. In Carmen SanDiego, a knowledge of geography facts is necessary in order to catch the criminal. In Jumpstart 5th Grade the user must solve various math, history, and geography puzzles in order to make the game proceed. In all of these we see a union of story, choice, and instruction. This was common to all of the software pieces save for Plato and SimCity 3000, though a more generous interpretation of the narrative presence in these two pieces would reveal this linkage even there.

Beyond the presence of the stories, or their implied elements, and the frequent reliance on using the challenges presented to the protagonist of the story as opportunities for the user to apply the learning objectives, there is no consistent use of the story models used for this research. However, the results lend themselves to the following observations.

The use of story engages the learner's attention. In my opinion as a researcher, the stories help to capture the player's attention by the use of narrative hooks, sympathetic characters, colorful animations, and appropriate challenges (McClellan, 1992). At the risk of forming a circular argument, the stories are engaging because stories are by their nature engaging. That this assumption is borne out by the software in question seems self-evident, though it is difficult to demonstrate it empirically. My experience with the software was that even the sketchiest narrative event served to heighten my interest. I cannot help but believe that few students would pursue the educational content of JumpStart 5th Grade, for instance, without the animated story context that surrounds it.

Story form follows the Propp and Campbell models only intermittently. The software studied sometimes showed remarkable correspondence between the story models in certain instances, and little or no relationship to it in others. In Weather Disaster, for instance, nearly half of Propp's elements are arguably present, and most of Campbell's stages are represented. In Jumpstart 5th Grade, about a third of Propp's elements are present, while only four of Campbell's stages are evident. In SimCity 3000,

however, the Propp and Campbell models are inappropriate for describing the narrative experience of the simulation. In Physicus, there is only the broadest correspondence between the program and either of the story models. In Carmen SanDiego, there are incidents and characters that bear some resemblance to those in the models, but this correspondence is ambiguous enough to undermine any certainty of the reliability of that correspondence. In Plato, the story elements are only suggested, so that there are situations which imply narrative without any narrative development. This finding suggests that the story models I chose for this study are not the only models being used in educational software, or that the narratives present there do not lend themselves to traditional models, or that the models are being used inconsistently.

A distinction can be drawn here between simulations and non-simulations. In a non-simulation, the user's interactivity is more narrowly constrained--the effective choices are reduced. In a simulation which is modeling a complex situation, the interactivity is increased, in order to more closely resemble the real world experience. This corresponds roughly to the ends of the continuum I have identified as *choice*. That is, the more choice given to the player, the more like a simulation the software becomes. This is most evident in SimCity 3000, but is also an aspect of the Plato software. The simulation, as a genre, does not lend itself to story structure as we are used to understanding it. This is because the more complex and lifelike a simulation becomes, the more it is opened up to the myriad choices that real life requires, and the more difficult it becomes to impose a single meaningful narrative across those many decisions. There is a conflict, then, between interactivity and linear narrative that is most clearly revealed in a simulation because the more successful a simulation is in capturing reality, the more choices will be mirrored there. This, of course, undermines the linear structure of traditional narrative.

The subversion of traditional story form in hypermedia is supported in the literature by a variety of sources (Coover, Landow, Bernstein, Bolton) when applied directly to the distinctions between hypermedia fictions and more linear stories. My

research leads me to believe that simulations offer a special case of the hypermedia experience when the simulation attempts to encompass a non-trivial real world complexity. All models are reductive in some sense, in that they abstract the modeler's ideas about the fundamental elements of a perceived reality. The less a model reduces, however, the more problematic becomes its conceptual validity--this despite the fact that the increase in complexity more accurately matches the perhaps infinite complexity of the world being modeled. The more this model, or map, of reality is allowed to approach the complexity of the world, then the more choices on the part of human interactors will affect the outcome. When simulation is at its most characteristic, therefore, and complexity and choice have been maximized, then traditional story form is less and less able to encompass it.

Where choice is didactic, story form is most linear. The more the story experience opens itself up to interactivity by the player, the less the story follows the traditional narrative structures. This is seen most clearly in Weather Disaster, Jumpstart, and Carmen SanDiego, where the possibilities for interactivity are generous in number but very limited in effect, and in SimCity 3000, where interactivity is powerful and ubiquitous. The former are most like traditional narratives--at any rate they show the most fidelity to the Propp and Campbell models--while SimCity resembles them the least. When the user's choices are all controlled, and their effects are shaped toward a predetermined end by the software designer, the story line can rely on fixed narrative moments for its structure more readily than when the choices are open-ended.

Is this necessarily so? Would it be possible to control choice without controlling the narrative structure? My experiences with the software and the literature indicate that it is not possible, since every choice in a narrative environment contributes to the narrative architecture. This is further supported by the efforts of the software designers to separate instructional presentation from story structure in the pieces studied. They are apparently trying to resolve this issue by sending the learner to a sub-set of the story for instructional purposes. The mentor in Weather Disaster, for instance, accesses a database

whose structure is unrelated to the story events. In Carmen SanDiego there is a similar situation, where the content knowledge is separate from the story line (though necessary to advance the story line).

Where story form is linear, instructional presentation is more teacher-centered. In the three stories that are most traditional in structure--Weather Disaster, JumpStart 5th Grade, and Carmen SanDiego-- instructional design is more teacher centered than not. In Weather Disaster, the instructional sequences consist of text with illustrations in short linear presentations. The various topics covered in the program may be accessed at the learner's discretion, but each one is presented in a straightforward linear style that would be at home in a textbook. In Carmen SanDiego, the instructional design is, as well, accessed whenever the player desires but, once accessed, is traditional in style. JumpStart 5th Grade is somewhat less traditional in approach, but only because it has no clear instructional presentations per se, but instead consists of opportunities to practice basic skills--one of Gagne's necessary instructional events.

This finding opens up issues about the basic terms of this study that must be addressed. Namely, what does it means for instruction to be teacher-centered or learner-centered? In the non-simulation pieces studied, instruction is presented in discrete modules that are linear in nature, but these modules are contained within a story universe that is more interactive and open-ended to varying degrees. In Physicus, for instance, the instructional sequences are linear presentations with clear boundaries presented in the database supplied to the user. But these sequences are contained within the highly interactive story landscape, where the user may wander freely (after solving certain puzzles). However, the user may access an instructional sequence at any time and may in fact access any part of the sequence at any time, so that the user is given a high degree of control over which part to consult. In one sense, then, this instruction is open to user control. What must distinguish this kind of instructional presentation from a truly constructivist pedagogical mode is that the nature of the user's exploration is curtailed within the narrow instructional bounds created by the program. While it is possible for

the user to choose which parts of the instruction to access, the end goal of that instruction remains fixed by the creators of the program.

These results have led me to make certain observations about the relationship between story and instruction.

S*tory is opaque, instruction is transparent*. Narrative, though it is entangled in every aspect of human purpose, may be said to exist for its own sake. It is opaque in the sense that it does not resolve into a more fundamental way of being understood--at least not in any way that enjoys widespread and long lasting agreement. We go to story for many reasons, but we need not go further than story to feel that we have arrived at significance. Instruction, on the other hand, is, in this same sense, transparent. It has a function that reaches beyond itself in a way that narrative does not. We go to instruction in order to learn something beyond instruction. Instructional aids are not, as far as I know, widely collected and savored for their own sake.

This observation, that story and instruction are essentially incommensurable, is applicable to the programs studied in this research, though it may not be universally applicable to all instances of story-based instruction. The programs studied here did not evidence a single instance where the two were seamlessly integrated, except for the possible instance of the SimCity simulation—and it is arguable that this was only possible there as a result of the non-traditional narrative experience resulting from the characteristics of a simulation. Discovery learning in a simulated environment might be an instance of "transparent" instruction, since the learner would theoretically be engaged in the process for its own sake.

This distinction has implications for the use of story as an instructional presentation tool. It is that the two modes, narrative and instruction, cannot be resolved into one. During the course of a story one may learn many things, but they are incidental to the structure and flow of the narrative. In Moby Dick, for instance, the attentive reader will undoubtedly pick up considerable knowledge about whaling in the nineteenth century, but this knowledge alone is not the point or the genius of that novel.

The instructional elements of the software program are, for the most part, situated outside the developing plot of the story, though the information contained therein is often necessary for the story to advance. A central concern of this research has been to determine just how closely instruction can be integrated into story. The results of this study indicate that instruction not understood as part of a simulation can be a necessary element for the story to progress but cannot be a necessary part of the story as such. The instructional elements of the story are generally pointed to by something in the narrative but are not identical with the flow of the story. In Weather Disaster, for instance, the instructional elements of the piece are accessed through the database. The story will proceed quite well without ever visiting this database if the player already knows the information contained therein. Furthermore, that information is fixed in content and experience no matter when during the story line it is accessed. It is a separate module of the software. It is true that the creation of a space within the story for that database helps integrate it within the story universe. This is, in fact, an integrative tactic present in almost all of the software, the exception being the Plato program. There the tools presented to the player, as well as the hints and scaffolding available at various levels of help modes, are generic and not situated within the scenario context presented there.

A simulation offers the most seamless combination of instruction and story. In an odd way, a simulation, which undermines story form with copious interactivity and embeds instruction directly into the situation, may be the most successful integration of story and instruction. It accomplishes this by making them one and the same, advancing knowledge of what to do by providing immediate feedback and having the user's action and its feedback constitute the narrative. In SimCity 3000, the user's efforts to build a viable city are constantly showing the consequences of actions taken. If the user doesn't provide enough municipal infrastructure in the form of underground water pipes, then he or she receives messages that parts of the city are getting thirsty. This in turn will decrease population if allowed to go on long enough. Consequently for the narrative, that episode then becomes the story--in this case, the sad story of a thoughtless mayor who

allows the population to get so thirsty that they move away from the city. But if at this point, noticing the population decline, the user now invests more money in water lines, then population will gradually return--and the story will take a different turn.

The kind of story possible in a simulation of this sort will not resemble very closely traditional story models, and will be very unlike Propp's model in particular. The number of incidents is too high, and a dramatic arc is missing from the experience. This latter will also reduce correspondence with the Campbell model. If the Mayor of the city is understood to be the protagonist, then there is no antagonist, no developing confrontation that will meet a final climax. There is only the progression through the increasingly complex simulation.

The transformation that the main character undergoes in the Campbell story structure is not persuasively presented in the software story. Character development may be said to be at the heart of most narrative experiences, though this is less true of the folktales analyzed by Propp. It is certainly true, however, of the monomythic structure explored by Campbell. There the transformation of the hero's character is central to the narrative. This aspect of the Campbell model is not convincingly displayed in the software studied, though it is hinted at in certain pieces.

There are two reasons for this. The first is that the protagonist is essentially located outside the story, since the user is the protagonist in an interactive adventure. In this case, the user is not undergoing the transformative adventure of the monomyth--he or she is playing a game that references it, and while that may give many of the same satisfactions that experiencing any work of fiction might offer, the transformation remains symbolic. In a traditional work of fiction the reader (or viewer) can establish an empathetic bonding with the character who is undergoing the experience, but this is more difficult when the user is the main character because a good author can make that transformation believable through expressive skills that the normal user lacks. Interactivity serves to distance the user rather than provoking engagement in a story because the higher the level of interactivity, the more control of the experience is given to

the user. Perhaps this effect partially explains the shallowness of many game experiences.

The second reason is that in an instructional environment the transformation is intended to be at least partially one of understanding. That is to say, the hero should complete the journey transformed by the acquisition of new learning. But this acquisition must necessarily be located in the user's understanding--whatever character in the game might be animated by the user's interactions can never demonstrate or enact any change of understanding.

For these reasons, then, the character transformation embodied in the monomyth finds only a thin representation in these interactive learning stories. In Weather Disaster, for instance, the user is the main character but undergoes only a superficial change in status near the end of the piece when he is "adopted" into the eXtreme Team as a "family member". In Carmen SanDiego it is true that, as the player progresses through the game, he or she progresses in rank, but this is not a substantial change. In Physicus, JumpStart 5th Grade, and Plato there is no sense of character transformation at all in the context of the story.

These ideas do not represent a theoretical advance for our understanding of the relationship between story and instruction in a hypermedia environment in the sense that I am now prepared to propose a theory for their interaction. Instead, they make apparent some of the problems and issues that designers in this field will necessarily face when creating narrative based educational software.

The use of stories to structure these environments is a juggling act, in which the designer must make compromises between the competing demands of story form, instructional design, and interactivity. Though I began this research with the hope that these elements could be theoretically integrated, I have been forced to conclude that this is an unlikely expectation. Though story form may be borrowed for non-narrative purposes, it will extract a payment for its services that may render its use impractical. Though instruction may be scaffolded by story form to engage and shape learners'

experiences, that structure will be appropriate for only a very limited number of instructional objectives. Though interactivity in both story and instruction offers new possibilities, those possibilities will undermine in significant ways the functions and agency of either.

The results of this study indicate some directions for future research and implications for practice. In light of my observations about the relationship between story and instruction, namely that the two are, in the deepest sense, incommensurable, what research agenda is suggested? If these observations are accepted as viable insights, then the question arises of how to make the best use of their distinct natures. One approach to this could involve designing stories based on different narrative models and testing the results of using them. In this study I have used only two models. There might be a "best use" model, which, while recognizing the exclusive characteristics of story and instruction, nevertheless would provide a superior fit between them. This, I believe, would most likely be a model that, like Campbell's stages, breaks the story into discrete sections. These sections could allow plentiful opportunities for interaction as long as the learner was required to finish each discrete section before going on to the next. This arrangement was somewhat present in the Weather Disaster software; however, in that program the stages were not correlated with any progressive narrative arc in the way that Campbell's model requires. An approach of this sort would open up the possibilities of joining a simulation to a powerful narrative model, in that one could provide maximum choice in limited modules.

A second research direction involves looking at stories from some entirely different viewpoint than plot structure. The approach followed in this study, which is based on a linear, syntagmatic analysis, could be supplanted or enhanced by a more paradigmatic analysis that examines the importance of "deep" structures in story design and their relationship to instructional opportunities.

Finally, there is a distinction to be drawn between story structure and "good" story structure. The power of narrative to hold our attention, engage our senses, and

supply the energy which we turn to narrative for as an instructional strategy, is qualified by just how powerful a given narrative is. That is to say, a well written story is a more powerful experience than a poorly written one; any given story used to scaffold instruction, no matter how cleverly it exploits structural strategies, will finally succeed or fail by the quality of its making. James Joyce and I might both employ the same story model when writing a story, but it is unlikely that the resulting tales will occupy the same aesthetic plane. One research direction might involve somehow distinguishing between stories that are well told and those that are poorly told, then presenting similar information with each. Of course, the theoretical difficulties of identifying a story as "good" or "bad" would be formidable.

Designers who accept the conclusions drawn from this research might reasonably be expected to hesitate before tying together story and instruction. The casual assumption that stories will engage the learner and lead to greater engagement with the learning content is only superficially correct. As long as the learning activities are essentially separate from the story itself, then one will be interrupting the other. Simulations offer a rich opportunity for combining story with content, since the user creates the story line within a content "universe".

There are different levels and kinds of learning outcomes. If an instructional goal is, for instance, to stimulate interest in a subject, or to introduce its broadest outlines, then a story environment might well be very useful. If the instructional goal is a rigorous, sustained, and thoughtful learning experience, then a story environment probably works against that outcome. The combination of this last observation—that story will work best as an aid to the understanding of simply related ideas, or as motivation—with the idea of modular interactivity based on an overarching narrative scheme such as Campbell's, holds the most promise for the integration of story and instruction. Designers should consider dividing the story into stages, with each stage offering copious interactivity, but requiring well defined behaviors from the user before the next stage can be accessed. This would offer the opportunity for combining the motivational and

structural powers of story with appropriate instructional goals in a choice-rich environment.

Though we learn from stories, they are in the end too powerful and mysterious in their effects to be entirely harnessed to the horses of instruction. Though instruction can be entertainingly crafted, its didactic nature can never allow it to be only entertainment. Choice erodes structure, but structure without choice stultifies. The use of story in instruction, particularly in interactive instruction, must necessarily be a balancing act.

REFERENCES

Aristotle. (trans. 1982). Poetics (James Hutton, Trans.). New York: W. W. Norton & Company.

Ausubel, D. P. (1968). Educational psychology: A cognitive view. New York: Holt, Rinehart and Winston.

Bal, M. (1997). Narratology: Introduction to the theory of narrative. London: University of Toronto Press.

Barron, A. E., & Atkins, D. (1994). Audio instruction in multimedia education: Is textual redundancy important? Journal of educational multimedia and hypermedia, 3/4(3), 295-306.

Barthes, R. (1967). Elements of semiology (A. Lavers, C. Smith, Trans.). London: Jonathon Cape.

Barthes, R. (1970/1974). S/Z (Richard Miller, Trans.). New York: Hill and Wang.

Barthes, R. (1977). Introduction to the structural analysis of narratives, Image-music-text. London: Fontana.

Bartlett, F. C. (1932). Remembering. Cambridge: Cambridge University Press.

Beasley, R. E., & Waugh, M. E. (1996). The effects of content-structure focusing on learner structural knowledge acquisition, retention, and disorientation in a hypermedia environment. Journal of research on computing in education, 28(3), 271-281.

Beaugrande, R. de. (1980). Text, discourse and process. Norwood, NJ: Ablex.

Beeman, W. O., Anderson, K. T., Bader, G., Larking, J., McClard, A. P., McQuillan, P., & Shields, M. (1987). Hypertext and pluralism: From linear to non-linear thinking. In J. B. Smith, F. Halasz, N. Yankelovich, M. Schwarz, & F. Weiss (Eds.), Hypertext '87 (pp. 67-81). Chapel Hill: University of North Carolina.

Bernstein, M. (1998). Patterns of hypertext. Paper presented at the Hypertext '98, New York.

Bolter, J. D. (1991). Writing space: The computer, hypertext, and the history of writing. Hillsdale, NJ: Erlbaum.

Bolter, J. D. (1996). Degrees of freedom. http://www.lcc.gatech.edu/~bolter/degrees.html.

Bransford, J. D., Sherwood, R. D., Hasselbring, T. S., Kinzer, C. K., & Williams, S. M. (1990). Anchored instruction: Why we need it and how technology can help. In D. Nix & R. Spiro (Eds.), Cognition, education, and multimedia: Exploring ideas in high technology (pp. 115-141). Hillsdale, NJ: Lawrence Erlbaum Associates.

Bruner, J. S. (1966). The process of education. Cambridge: Harvard Universtiy Press.

Bruner, J. S. (1973). Beyond the information given: Studies in the psychology of knowing. New York: Norton & Co.

Bush, V. (1945, July). As we may think. Atlantic Monthly, 101-108.

Campbell, J. (1949). The hero with a thousand faces. (2nd ed.). Princeton: Princeton University Press.

Clark, R. E. (1983). Reconsidering Research on Learning from Media. Review of Educational Research, 53(4), 445-459.

Clark, R. E., & Craik, T. G. (1992). Research and theory on multimedia-learning effects. In M. Giardina (Ed.), Interactive multimedia learning environments: Human factors and technical considerations on design issues (Vol. 93, pp. 19-30). Berlin/Heidelberg: Springer-Verlag.

Cognition and Technology Group (1992). Technology and the design of generative learning environments. In T. M. Duffy & D. H. Honassen (Eds.), Constructivism and the technology of instruction (pp. 77-89). Hillsdale, NJ: Lawrence Erlbaum Associates.

Collins, A. (1996). Design issues for learning environments. In S. Vosniadou, E. De Corte, R. Glaser, & H. Mandl (Eds.), International perspectives on the design of

technology-supported learning environments (pp. 347-361). Mahwah, NJ: Lawrence Erlbaum Associates.

Conklin, J. (1987). Hypertext: An introduction and a survey. IEEE Computer, 20(9), 17-41.

Culler, J. (1975). Defining narrative units. In R. Fowler (Ed.), Style and structure in literature (pp. 139). Oxford: Basil Blackwell.

Cunningham, D. J., Duffy, T. M., & Knuth, R. A. (1993). The textbook of the future. In D. McKnight, A. Dillon, & J. Richardson (Eds.), Hypertext: A psychological perspective (pp. 19-50). Chichester, England: Horwood.

Coover, R. (1992, June 21, 1992). The end of books. New York Times Book Review, pp. 1.

Dale, E. (1946). Audiovisual methods in teaching. New York: Holt, Rinehart & Winston.

Davies, I. K. (1997). Paradigms and conceptual ISD systems. In C. R. Dills & A. J. Romiszowski (Eds.), Instructional development paradigms (pp. 31-44). Englewood Cliffs, NJ: Educational technology publications.

Deleuze, G., & Guattari, F. (1987). A thousand plateaus: Capitalism and schizophrenia (Brian Massumi, Trans.). Minneapolis: University of Minnesota Press.

Denzin, N. K. (1997). Interpretive ethnography. Thousand Oaks, CA: Sage Publications, Inc.

Derrida, J. (1976). Of grammatology (Gayartri Chakravorty Spivak, Trans.). Baltimore: Johns Hopkins University Press.

Dickey, W. (1991). Poem descending a staircase: Hypertext and the simultaneity of experience. In P. Delaney & G. P. Landow (Eds.), Hypermedia and literary studies (pp. 143-152). Cambridge, MA: MIT Press.

Duffy, T. D., & Bednar, A. K. (1992). Attempting to come to grips with alternative perspectives. Educational technology, 31(9), 12-15.

Duffy, T. M., & Jonassen, D. H. (Eds.). (1992). Constructivism and the technology of instruction: A conversation. Hillsdale, NJ: Erlbaum.

Duffy, T. M., & Knuth, R. A. (1990). Hypermedia and instruction: Where is the match? In D. H. Jonassen & H. Mandl (Eds.), Designing hypermedia for learning (pp. 199-225). Berlin: Springer-Verlag.

Dundes, A. (1962). From etic to emic units in the structural study of folktales. Journal of American Folklore, 75, 95-105.

Eagleton, T. (1983). Literary theory: An introduction. Minneapolis MN: University of Minnesota Press.

Eliot, T. S. (1920). The sacred wood: Essays on poetry and criticism. London: Methuen.

Forrester, M. A. (1995). Indications of learning processes in a hypertext environment. Innovations in education and training international, 32(3), 256-268.

Foucault, M. (1977). Language, counter-Memory, practice: Selected essays and interviews (Donald F. Bouchard and Sherry Simon, Trans.). Ithaca, NY: Cornell University Press.

Gage, N. L., & Berliner, D. C. (1992). Educational psychology. Boston: Houghton Mifflin.

Gagné, R. M. (1985). The conditions of learning and theory of instruction. (4 ed.). New York, NY: Holt, Rinehart, and Winston.

Gagne, R. M., Briggs, L. J., & Wager, W. W. (1992). Principles of instructional design. Fort Worth: HBJ College Publishers.

Genette, G. (1972/1980). Narrative discourse: An essay in method (Jane E. Lewin, Trans.). Ithaca: Cornell University Press.

Glaser, R. (1991). The maturing of the relationship between the science of learning and cognition and educational practice. Learning and instruction, 1, 129-144.

Greimas, A. (1966). Semantique structurale. Paris: Larousse.

Greimas, A. J. (1971). Narrative grammar: units and levels. Modern Language Notes, 86, 793-806.

Grimes, J. E. (1975). The thread of discourse. The Hague: Mouton.

Guba, E. G., & Lincoln, y. S. (1994). Competing paradigms in qualitative research. In N.

K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research (pp. 105-117). Thousand Oaks: Sage.

Hawthorn, J. (1992). A glossary of contemporary literary theory. London: Edward Arnold.

Heraclitus. (1979). The art and thought of Heraclitus : an edition of the fragments with translation and commentary (Charles H. Kahn, Trans.). Cambridge: Cambridge University Press.

Huberman, A. M., & Miles, M. B. (1994). Data management and analysis methods. In N. K. Denzin & Y. S. Lincoln (Eds.), Handbook of qualitative research (pp. 428-444). Thousand Oaks: Sage.

Jacobs, G. (1992). Hypermedia and discovery-based learning: A historical perspective. British Journal of Educational Technology, 23(2), 113-121.

Jacobson, M. J., Maouri, C., Mishra, P., & Kolar, c. (1996). Learning with hypertext learning environments: Theory, design, and research. Journal of Educational Multimedia and Hypermedia, 5(3/4), 239-281.

Jacobson, M. J., & Spiro, R. J. (1995). Hypertext learning environments, cognitive flexibility, and the transfer of complex knowledge: An empirical investigation. Journal of Educational Computing Research, 12(4), 301-333.

Jameson, F. (1971). Marxism and Form. Princeton: Princeton University Press.

Jonassen, D. H. (1988). Designing structured hypertext and structuring access to hypertext. Educational technology, 28(11), 13-16.

Jonassen, D. H. (1989). Hypertext/hypermedia. Englewood Cliffs, NJ: Educational Technology Publications.

Jonassen, D. H. (1990). Semantic network elicitation: Tools for structuring hypertext. In R. McAleese & C. Green (Eds.), Hypertext: State of the art . Oxford, England: Intellect.

Jonassen, D. H. (1993). Effects of semantically structured hypertext knowledge bases on user's knowledge structures. In C. McKnight, A. Dillon, & J. Richardson (Eds.),

Hypertext: A psychological perspective (pp. 153-168). Chichester, England: Horwood.

Jonassen, D. H., & Grabinger, R. S. (1990). Problems and issues in designing hypertext/hypermedia for learning. In D. H. Jonassen & H. Mandl (Eds.), Designing hypermedia for learning (pp. 3-25). Berlin: Springer.

Joyce, M. (1990). afternoon, a story . Watertown, MA: Eastgate Systems, Inc.

Joyce, M. (1997). Nonce upon some times: Rereading hypertext fiction. Modern Fiction Studies, 43(3), 579-597.

Kozma, R. B. (1991). Learning with media. Review of educational research, 61(2), 179-211.

Landow, G. P. (1990). Popular fallacies about hypertext. In D. H. Jonassen & H. Mandl (Eds.), Designing hypermedia for learning (pp. 39-59). Berlin: Springer-Verlag.

Landow, G. P. (1997). Hypertext 2.0: The convergence of contemporary critical theory and technology. Baltimore: Johns Hopkins University Press.

Leshin, C. B., Pollock, H., & Reigeluth, C. M. (1992). Instructional design strategies and tactics. Englewood Cliffs, NJ: Educational Technology Publications.

Levi-Strauss, C. (1958/1963). The Structural Study of Myth, Structural Anthropology . New York: Basic Books.

Lodge, D. (1980). Analysis and interpretation of the realist text. Poetics Today, 1(4), 5-22.

Mandler, J. M. (1984). Stories, scripts and scenes: Aspects of schema theory. Hillsdale, NJ: Lawrence Erlbaum.

Mandler, J. M., & Goodman, M. (1982). On the psychological validity of story structure. Journal of verbal learning and verbal behavior, 21, 507-523.

Mandler, J. M., & Johnson, N. S. (1977). Remembrance of things parsed: Story structure and recall. Cognitive Psychology, 9, 111-151.

Mayer, R. E. (1999). Designing instruction for constructivist learning. In C. M. Reigeluth (Ed.), Instructional Design Theories and Models (Vol. 2, pp. 141-159). Mahwah, NJ: Lawrence Erlbaum.

Mayes, T., Kibby, M., & Anderson, T. (1990). Learning about learning from hypertext. In D. H. Jonassen & H. Mandl (Eds.), Designing hypermedia for learning (pp. 227-250). Berlin: Springer-Verlag.

McAleese, R., & Green, C. (Eds.). (1990). Hypertext: State of the art. Oxford: Intellect.

McCabe, A. (1991). Preface: Structure as a way of understanding. In A. McCabe & C. Peterson (Eds.), Developing narrative structure . Hillsdale, NJ: Lawrence Erlbaum Associates.

McDaid, J. (1992). Uncle buddy's phantom funhouse . Watertown, MA: Eastgate Systems.

McKnight, C., Dillon, A., & Richardson, J. (1990). A comparison of linear and hypertext formats in information retrieval. In R. McAleese (Ed.), Hypertext: State of the art (pp. 10-19). Oxford: Intellect.

McLellan, H. (1992a). Narrative and episodic story structure in interactive stories. Paper presented at the Association for Educational Communications and Technology.

McLellan, H. (1992b). Hyper stories: Some guidelines for instructional designers. Journal of Research on Computing in Education, 25(1), 28-49.

Merrill, P. (1978). Hierarchical and information processing task analysis: A comparison. Journal of Instructional Development, 1(2), 35-40.

Murray, J. H. (1997). Hamlet on the holodeck. New York: Free Press.

Nelson, T. (1987). Literary machines. Swarthmore, PA: Theodore Holm Nelson.

Olson, M. W., & Gee, T. C. (1988). Understanding narratives: A review of story grammar research. Childhood education, 64(4), 302-306.

Ong, W. J. (1982). Orality and literacy: The technologizing of the word. New York: Routledge.

Osborne, D. (1990). Browsing and navigation through hypertext documents. Interactive Multimedia, 1(1).

Paivio, A. (1986). Mental representations: A dual coding approach. Oxford: Oxford University Press.

Papert, S. (1990). Introduction. In I. Harel (Ed.), Constructionist learning . Boston: MIT.

Pask, G., & Scott, B. C. E. (1972). Learning strategies and individual competence. International Journal of Man-Machine Studies, 4(3), 217ff.

Perkins, D. N. (1991). Technology meets constructivism: do they make a marriage? Educational Technology, 31(5), 18-23.

Piaget, J. (1960). The language and thought of the child. London: Routledge & Kegan.

Pope, A. (1733/1966). An essay on man, Poetical works . Oxford: Oxford University Press.

Prince, G. (1987). A dictionary of narratology. Lincoln, NE: University of Nebraska.

Propp, V. (1928/1968). Morphology of the folktale (Scott, Laurence, Trans.). (2nd ed.). Austin: American Folklore Society, Inc.

Quillian, M. (1968). Semantic memory. In M. Minsky (Ed.), Semantic information processing . Cambridge, MA: MIT Press.

Reigeluth, C. M., & Curtis, R. V. (1987). Learning situations and instructional models. In R. M. Gagne (Ed.), Instructional technology: Foundations. Hillsdale, NJ: Lawrence Erlbaum.

Reigeluth, C. M., & Stein, R. (1983). Elaboration theory. In C. M. Reigeluth (Ed.), Instructional design theories and models: An overview of their current status. Hillsdale, NJ: Lawrence Erlbaum.

Rice, P., & Waugh, P. (Eds.). (1996). Modern literary theory: A reader (3 ed.). New York: Arnold.

Richey, R., & Nelson, W. (1996). Developmental research. In D. Jonassen (Ed.), Handbook of research for educational communications and technology (pp. 1213-1245). New York: Macmillan.

Rimmon-Kenan, S. (1983). Narrative fiction: Contemporary poetics. London: Methuen.

Rumelhart, D. E. (1975). Notes on a schema for stories. In D. G. Bobrow & A. Collins (Eds.), Representation and understanding: Studies in cognitive science . New York: Academic Press.

Rumelhart, D. E. (1977). Understanding and summarizing brief stories. In D. LaBerge & S. J. Samuels (Eds.), Basic processes in reading, perception, and comprehension . Hillsdale, NJ: Erlbaum.

Salomon, G. (1979). Interaction of Media, Cognition, and Learning. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Scanlon, E., & O'Shea, T. (1988). Cognitive economics in physics reasoning: Implications for designing instructional materials. In H. Mandl & A. Lesgold (Eds.), Learning issues for intelligent tutoring systems (pp. 258-286). New York: Springer-Verlag.

Schroeder, E. E., & Grabowski, B. L. (1995). Patterns of exploration and learning with hypermedia. Journal of Educational Computing Research, 13(4), 313-335.

Saussure, F. d. (1966). Course in general linguistics (Wade Baskin, Trans.). New York: McGraw -Hill.

Schank, R. C. (1990). Tell me a story. Evanston, IL: Northwestern University Press.

Schank, R. C., & Abelson, R. P. (1977). Scripts, plans, goals and understanding. Hillsdale, NJ: Lawrence Erlbaum Associates.

Shklovsky, V. (1917/1965). Art as technique. In L. T. Lemon & M. J. Reis (Eds.), Russian formalist criticism: Four essays (pp. 3-24). Lincoln: University of Nebraska Press.

Shumate, M. (1996). The art world of hypertext fiction . http://www.duke.edu/~mshumate/fiction/htt/world.html.

Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1991). Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains. Educational technology, 31(5), 24-33.

Spiro, R. J., & Jehng, J.-C. (1990). Cognitive flexibility and hypertext: Theory and technology for the nonlinear and multidimensional traversal of complex subject matter. In D. Nix & R. J. Spiro (Eds.), Cognition, education, and multimedia: Exploring ideas in high technology (pp. 163-205). Hillsdale, NJ: Erlbaum.

Spiro, R. J., Feltovich, P. J., Jacobson, M. J., & Coulson, R. L. (1991). Knowledge representation, content specification, and the development of skill in situation-specific knowlege assembly: Some constructivist issues as they relate to cognitive flexibility theory and hypertext. Educational technology, 31(9), 22-25.

Stein, N. L. (1978). The comprehension and appreciation of stories: A developmental analysis. In S. S. Madeja (Ed.), The arts, cognition, and basic skills. St. Louis: CEMREL.

Stein, N. L. (1979). How children understand stories: A developmental analysis. In L. Katz (Ed.), Current topics in early childhood education (Vol. 2,). Hillsdale, NJ: Ablex, Inc.

Stein, N. L., & Glenn, C. G. (1979). An analysis of story comprehension in elementary school children. In R. O. Freedle (Ed.), Advances in discourse processes (Vol. 2). Norwood, NJ: Ablex.

Stein, N. L., & Nezworski, T. (1978). The effects of organization and instructional set on story memory. Discourse Processes, 1, 177-193.

Sternberg, R. J. (1982). A componential approach to intellectual development. In R. J. Sternberg (Ed.), Advances in the psychology of human intelligence (Vol. 1, pp. 412-463). Hillsdale, NJ: Erlbaum.

Sternberg, R. J. (1996). Cognitive Psychology. Fort Worth: Harcourt Brace College Publishers.

Sutton-Smith, B., Botvin, G., & Mahony, D. (1976). Developmental structures in fantasy narratives. Human Development, 19, 1-13

Tennyson, R. D., Schott, F., Seel, n., & Dijkstra, S. (Eds.). (1997). Instructional design: International perspectives. (Vol. 1: Theory, research, and Models). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Tergan, S.-O. (1997a). Conceptual and methodological shortcomings in hypertext/hypermedia design and research. Journal of educational computing research, 16(3), 209-235.

Tergan, S.-O. (1997b). Multiple views, contexts, and symbol systems in learning with hypertext/hypermedia: A critical review of research. Educational technology, 37(4), 5-18.

Thorndyke, P. W. (1977). Cognitive structures in comprehension and memory of narrative discourses. Cognitive Psychology, 9, 77-110.

Todorov, T. (1977). The poetics of prose (Richard Howard, Trans.). Oxford: Blackwell.

Toolan, M. J. (1988). Narrative: A critical linguistic introduction. London: Routledge.

Verreck, W. A., & Lkoundi, A. (1990). From instructional text to instructional hypertext: An experiment. In D. J. Jonassen & H. Mandl (Eds.), Designing hypermedia for learning (pp. 263-276). Berlin: Springer-Verlag.

Vestergaard, T., & Schroder, N. (1985). The language of advertising. Oxford: Blackwell.

Vogler, C. (1998). The writer's journey: Mythic structure for storytellers & screenwriters. (2nd ed.). Studio City, CA: Michael Wiese Productions.

Wenger, M. J., & Payne, D. G. (1996). Comprehension and retention of non-linear text: Considerations of working memory and material-appropriate processing. American journal of psychology, 93-130.

Whaley, J. (1981). Readers' expectations for story structure. Reading research quarterly, 17, 90-114.

Whalley, P. (1990). Models of hypertext structure and learning. In D. H. Jonassen & H. Mandl (Eds.), Designing hypermedia for learning (pp. 61-67). Berlin: Springer-Verlag.

APPENDIX

Transcripts

JumpStart Adventure 5th Grade

Knowledge Adventure

Splash screen: We see an image of several characters drawn from the JumpStart series and a menu of buttons. These are: Play, help, exit, parent resource center, assessment, demo, JumpStart website.

Clicking 'Play' takes us through a promotional sequence and we end on a screen showing a typewriter where we can enter the player's name or choose a previous player's name. The image suggests a combination of science fiction and detective genres. After entering a name we begin the opening sequence of the story.

Story begins.

Silhouette of stereotypical mad scientist saying "With no one to stop me, revenge is mine!" There follows a sequence where the camera's point of view swoops through city streets at night and arrives at a street where a young girl is being chased through tunnels by apparent explosions. The scene changes to bedroom where the girl (Jo) wakes from the nightmare screaming. She remembers that there is a detective movie marathon on television and tries to watch it, but the screen shows only static.

Campbell I: Ordinary world
The normal life of this young girl.

The radio in the bedroom announces that someone calling himself Dr. X has destroyed the TV station and plans to blow up the entire city one building at a time. Jo leaves the house with her skateboard and rides it through the city in a plucky manner until she arrives at a schoolbus that will take her on a field trip to the city's museum.

Propp 1: One of the members of a family absents himself from home.
Jo leaves the house.

The city is Hooverville. The bus ride over, she enters the museum with a group of other people but quickly leaves them to look at a painting. She is alone in the room until a man in a scientist's lab coat backs into the room, apparently trying to escape someone in the next room. He runs into Jo and drops his dark glasses. He is captured by three apparent hoodlums with odd purple hair and led away. An elderly custodian enters the room pushing a broom and engages Jo in conversation. He wonders what is happening and says that the kidnapped man was his nephew.

Campbell II: Call to adventure
The kidnapping and the subsequent conversation with the janitor involve her in the adventure.

Propp 8: The villain causes harm or injury to a member of a family.
The kidnapped scientist is the nephew of the custodian.

After the custodian speaks, he and Jo are highlighted in a pair of sub-panels and a list of conversational replies for Jo are presented below their images. **(See scene 1 custodian)** The user may select any of them to hear Jo read the reply. The custodian replies with a different response to each of Jo's replies. Beneath this dialog there are icons for navigation and interactivity. These are: Exit arrow, help question, a grade sheet to access assessment information, police badges of differing sizes and types to set the difficulty level of play, a suitcase to hold found objects, a map of the city, and a notebook.

Some of the custodian's replies present information for Jo to follow up on, others are just chat.

The custodian reveals that his nephew, Martin, had been working for a scientist who believed that he could talk with animals, that in fact the scientist had people wearing sealife on their heads as a kind of communication medium. The custodian also reveals that the nephew was later involved with some thugs who might have been working with the scientist.

A large rat enters the room and is chased around by the custodian. The rat, B. F. Skinny, carries a note for Jo. The rat reveals that he is a lab rat and that he will carry messages from Martin to Jo. The note is a crossword puzzle which requires the user to visit the various rooms in the museum in order to find the answers.

Campbell IV: Meeting with the mentor.
Jo meets B.F. Skinny.

Propp 9: Misfortune or lack is made known; the hero is approached with a request or command; he is allowed to go or he is dispatched.
The note from the rat requires Jo to complete the crossword and search for clues.

The museum is arranged around exhibits of paintings from several historical periods: Symbolist, Romantic, Realist, Impressionist, Pre-Raphaelite, Renaissance, Baroque, Modern, Photography, and a Geography room containing a large globe. The paintings, when clicked, enlarge their image and display explanatory and historical information. The globe may be explored and various sites clicked on to reveal geographical information.

When the crossword is completed **(see scene 1 crossword)** it offers further clues about the destination in the city where Jo should go next. Arrows point to certain letters which may be rearranged to spell out an address. At the easiest level of difficulty, Jo rearranges the letters for the user. This first crossword spells out 'Oak & Main'. **(see Map)** The custodian reveals that he has a map of the city to give to Jo. This is then available throughout the rest of the program.

Jo opens the map and the city is revealed. When the cursor is passed over selected locations then their name pops up. Clicking on "Oak & Main' starts a sequence with Jo skateboarding to the location. The skateboarding sequences require the user to manipulate the arrow keys on the keyboard to keep Jo from running into objects and people in the street.

Campbell V: Crossing the first threshold.
Finishing the crossword and leaving the museum are the elements of the first threshold.

Propp 10: The seeker agrees to or decides upon counteraction.
This could constitute the first bit of counteraction by Jo.

Propp 11: The hero leaves home.
Since the base of operations for Jo during the rest of the program is the museum, then this departure from the museum may be understood as leaving home.

Jo arrives at 'Oak & Main' to find the electro-plating factory. It is locked. To unlock the door she must solve 24 simple math problems that are presented on the lock inscribed on triangles. These are 12 each of addition and subtraction; also, after the problems are solved, she must figure out how to rotate the triangles so that the answers line up to the numbers written around the triangle group. On completion, the door opens.

Campbell VI: Tests, allies, enemies
Propp 12: The hero is tested, interrogated, attacked, etc., which prepares the way for his receiving either a magical agent or helper.
Propp 14: The hero acquires the use of a magical agent.
Both the skateboarding sequences and most of the rest of the program reiterate these story elements. There follows from this point a series of tests or challenges that the user must meet.

She is inside the electroplating factory, where she finds Martin chained beside a control panel. He tells her that they must hurry before the minions of Dr. X return. Their conversation reveals that the sunglasses she recovered in the museum can be used to

decode the telepathic conversations of the bad guys, whose strange purple hair is actually an octopus that Dr. X has altered to connect the brains of the wearers through telepathy. Dr. X himself is a brilliant animal behavior psychologist whose brain has been fried by radioactivity. Dr. X wants revenge on the funding agencies that denied him money.

The minions arrive. Jo dons the glasses and watches as their words appear on the screen. However, certain words are missing. The space for the missing words is highlighted in sequence and the user is prompted to fill in the blank--the part of speech (noun, verb, etc.) is identified. The minions take turns suggesting words that might fit, and the user must select the appropriate word. When selected it is filled in and the next missing word is required.

After the problem is solved, Jo opens her notebook and we see the clues she has gathered from overhearing the minions' discussion. She has learned that a bomb has been planted in the city, and that in order to defuse it she must find an insulating material, something to lock down a control arm, and a conductor. She notes that there are places in the city she can go in order to find those things: Mine Shaft, Juice Bar, and the Junkyard.

Closing the notebook, we are back in the city map. User must choose where to go first. Skating sequence (each time Jo has to skateboard, the obstacles grow more challenging.)

Mine Shaft:

Jo arrives at the Mine Shaft, which is a park built around an abandoned mine, and meets Maggie Mead, the curator. Maggie says that the park has been closed a long time due to falling rocks, but offers to help Jo. Jo asks for a lock. Maggie says there is one that Jo can have if she first helps Maggie retrieve three items from the abandoned mine shaft. The mine has three levels that Jo can visit with an elevator. However, there is a danger of falling rocks.

Jo descends via the elevator. Arriving at a level she finds that there are a number of spots in the mine to examine--upon examination they will reveal themselves to be one object or another. When clicked, a pop-up will display historical information about the

object, and the user is given the choice of selecting it or not. Rocks continue to fall, though, and if enough rocks hit Jo (who may jump or duck to avoid them), then she will be booted back to the mine entrance and have to start over again.

By visiting all three levels of the mine, she can retrieve the three objects that Maggie wants. (**see Maggie and Jo, mine shaft, and inside mine**). On her return to the surface, she gets the lock from Maggie, puts it in her suitcase, and re-opens the map to choose her next destination.

Juice Bar:

At the Juice Bar she meets Bernie, a reporter who is working undercover as a bartender in order to get a story. She tells him that she needs an insulator, and he answers that he has some rubber shoes in the lost and found. But first, she will have to help him mix drinks. This opens a screen that shows a mixer, drink materials, and containers. She must mix the correct amounts of each drink (expressed in fractions). When the drinks are mixed, she runs the blender. (**see drink mixing**)

Finishing the assignment, Bernie gives her the rubber boots and she returns to the map.

Junkyard:

At the junkyard she meets Jimmie the Shadow. He agrees to give her some metal as a conductor if she first helps him rearrange some scrap in the junkyard. She must match the pattern of shapes that appears in the upper right corner (see junkyard shapes). The user manipulates the shapes of pieces of junk until they match the pattern. He gives her some scrap metal and she opens the map again. She now has all the items she needs so she returns to the electroplating factory.

The electrical engineer is running wildly about the premises, and informs her that she will need a conductor and an insulator in order to get to the bomb. She enters the factory, uses the skillet to make a connection, wears the rubber boots to cross the floor, and uses the lock to hold down the mechanical arm. She then opens the bomb case, revealing a puzzle that the user must solve. It is a circuit diagram with sums printed on

the transistors. User must visit appropriate transistors and turn them on and off to create a sum that matches one given. There are two circuit guards who try to prevent this from happening. Upon succeeding, Jo enters a few notes in her notebook, we see Dr. X saying that the game isn't over yet, and then Jo returns to the museum. The lab rat presents her with another crossword puzzle.

Solving the puzzle reveals that the next address to visit is Vail and Kent. She arrives there after another skating episode to discover the oil refinery. She must enter a lot in order to investigate, and in order to do that the user must first solve another math triangle puzzle. Upon entering she sees three henchman talking through their telepathic octopi. They reveal that she must create a support structure and lower herself down from it using a rope so that she can block the laser beams with reflectors.

She skates to Jimmy's junkyard. User must assemble junk parts into a suggested shape. This is rewarded with a coat hanger.

She skates to the Juice Bar. There she must solve a drink mixing puzzle, combining fractions, to get some reflectors from the bartender.

She goes to the Mine Shaft, where she must retrieve three objects for the caretaker: a bee, a ceramic vessel, a map of the thirteen colonies. Upon retrieving these, she is given a rope and pulley. She then returns to the oil refinery, where she meets a worker. He informs her that there is a bomb in the storage room. She uses the mirrors, the wire, and the rope to lower herself to the bomb and divert the lasers. The bomb opens to reveal another circuit puzzle. Solving this returns us to the map.

Choosing the Museum, Jo again meets the lab rat who gives here another crossword to solve. This leads her to go to Pico and Mill, where the chemical factory is. There is another lock to negotiate. Inside, she overhears the minions discussing the trap set for her. She will need to visit the familiar places in the city once more in order to get the items she will need to defeat the trap.

Going to the juice bar, user must fill glasses with appropriate fractions, and receives a pair of socks from the bartender.

Going to the mine shaft, user retrieves a shovel as a balancing pole after fetching three items for the park ranger from the mine.

Goes to junkyard where she gets a bandanna.

Going to gas works, she uses the socks to cross the acid, the shovel to balance herself with, and the bandanna to tie the bomb to her head. She can then move it to safety and defuse it by once again solving the circuit board math problem. This takes her back to the museum, for a new note from the lab rat.

Solving the puzzle leads her to Vine and Rye, where she finds the Spatula Manufacturing Plant. She must solve math problems to open the lock. She then overhears the minions discussing the latest bomb. She realizes that she will need giant tweezers, a catapult, and a soft cushion of some kind.

She goes to the junkyard after once more getting caught in the box problem.

She solves the tangram puzzle again and gets a giant catcher's mitt.

She goes to the Juice bar after being caught skating once again. She is offered some ice forks after mixing drinks successfully (fractions). She skates to the mine shaft (more box puzzles after being caught). The attendant offers her some rope, which she can use to tie down the giant spatula at the Spatula factory, which can serve as a catapult. She must first retrieve three items from the mine shaft. She does this, skates to the Spatula factory, and is informed by a panicked worker that she could get to the bomb if she could get to the giant spatula on top of the roof. He agrees to use a cherry-picker to help bring the spatula down, where it can be used as a springboard.

Getting the bomb, she has to solve the circuit puzzle to defuse it.

She skates back to the museum, where she is given a new crossword puzzle by the rat. Solving it, she skates to the clue provided: Pine and Bell. She here confronts another lock math puzzle to solve. After solving it she overhears the minions plotting, who reveal that she must go to an out of control printing press, equip herself with hooks, oil, and a rope, and defuse the next bomb.

Going to the juice bar she mixes drinks to proportions and gets some hooks. Going to the junkyard, she solves a tangram puzzle and gets some oil. At the mine shaft she gets some rope.

She returns to the printing press, where a worker tells her that she must turn the machine off in order to cut the power, thus stopping the printing press. She uses her items to do this, then retrieves the bomb and is confronted with another circuit puzzle to solve.

Correctly solving the circuit puzzle, she returns to the museum. She learns that the janitor has been kidnapped by the minions. She solves the next crossword puzzle and is directed to Dale and Nut where the steel mill is.

Here she confronts another puzzle lock, requiring her to solve math problems. Finishing this she enters the building where the minions are talking. She learns that she must find suction cups, a line, and a hook. She goes to the juice bar.

There she mixes drinks and gets a plunger from the bartender. She then travels to the junkyard where she solves the tangram puzzle and obtains a large fishing pole. She then goes to the mineshaft where she must obtain three items for the keeper, who will give her another plunger.

Getting these she goes to the steelmill again. There she finds a distraught worker who tells her that the bomb is suspended above a pit of molten steel. She enters the building, uses the plungers and line to reach the bomb, which she diffuses as usual by solving math problems.

At this point she suffers a crisis of confidence and wonders if she will ever stop Dr. X. We see Dr. X gloating. Then, she returns to the museum where the rat tells her that Dr. X has blown up the pumping station and plans to blow up the dam. She leaves and goes to the dam. This is the first time that the dam has been accessible to her during the game.

Campbell VIII: Supreme ordeal
Propp 18: The villain is defeated.
Propp 19: The initial misfortune or lack is liquidated.
The dam site is the scene of the final confrontation with the villain. Defeating him allows her to save the town and rescue the janitor's nephew, which was the initial misfortune.

When she gets there she tries to find some way of diverting the water from the city. She looks around and see a switch, which raises a secondary dam gate. She rescues the Janitor and his nephew from the bomb room where they have been tied, and then flees the scene with them. Dr. X is destroyed in the explosion, but the town is saved.

Title: Physicus

Company: Tivola

Notes:

This immersive world is not easily divided into scenes, since the user is free to explore several areas at once. However, there are certain areas that cannot be accessed until a task is finished or problem solved. Since the program takes place on an island, it makes sense to provide a map of the terrain and discuss the user's movement's through that terrain in terms of the places accessible at any given time.

The program opens with a scene of a sailing ship at sea while a voice over introduces the essential problem of the story. A meteor has hit the planet (not Earth) with just enough velocity to stop the planet's rotation completely. One half of the planet is thus freezing and the other half is broiling. The narrator's voice reveals that an attempt was made to build a huge impulse machine that, when fired, would restore the planet's rotation. Unfortunately, the inhabitants were not successful.

At this point, the narration ends, and we see a small space ship landing on the planet. It crosses the island where the action of the story takes place, and lands in the shallow water just off the end of the island. The door opens from the perspective of the traveler in the space ship. Here interactivity becomes possible.

On leaving the space ship the player must open a gate and move onto the shore, where there is a small hut.

Hut

On entering we see various items of furniture, cabinets, sundry scientific devices, and table on which sits some kind of television screen/recording device and a mysterious object. Picking up the object activates it and it is revealed to be combination of a database and repository for objects picked up in the game. As a database it contains tutorials about various basic scientific principles: optics, mechanics, acoustics, electricity, and heat. Having gotten this database, the player now finds that the television/recording device next to it is demanding attention with a buzzer and a red light. Activating the recorder plays a sound tape made by the narrator which gives further details about the nature of their problem with the impulse device. It is revealed that they didn't have quite enough electricity to finish the device. The narrator implores the player to finish his work by finding and activating three generators on the island by setting the correct values in the transformer that accompany them. The player is urged to consult the database as needed (the database is now easily accessed by an icon on the lower part of the screen).

There is nothing further to grab in the hut. On leaving, the player may move around the beach between the hut and the spaceship, but the only real move that can be made is away from both through some rocks and bushes. The player shortly comes to two buildings on the left.

House and Smithy

One is a house. Inside is, among other things, a mirror which can be picked up by the player, and a grandfather clock whose pendulum is a 2kg weight. This can also be picked up. On a table there is a vase with a parchment rolled up inside it. Opening this we see a (as yet) unexplained diagram of some device. At the top of the screen we are now given a hint. The following words appear: "The Science of Electricity and Electromagnetism" and "The Science of Heat". These are references to the tutorial sections in the database. At this point, the player is free to go and study the suggested tutorials, or to continue on without doing so.

Leaving the house, the other building presents itself. It is some kind of manufacturing structure. There are three large smokestacks coming from the roof, though none are emitting smoke. Upon entering we see a forge, which is apparently operated by a large lever.

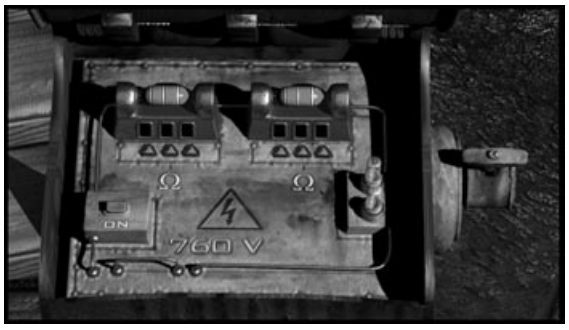
There are various weights about the room, and a ladder that leads to a second floor is visible. On a shelf there is a magnet, shaped like some of the elements seen in the diagram on parchment in the previous house. This can be picked up and added to the collection of items. Though the player can move upstairs, and manipulate the lever on the forge, there is nothing else to accomplish at this time in the building.

Forge

Going out of the building and down the path away from the beach, the player soon encounters a fork in the road. On the left there is a cliff face, and extending from its top there is an elevator-like contraption.

Elevator

At the base of the cliff is a control device that is missing some piece, so is inactive.



Elevator Control

To the right of the fork there is a small house, whose door is locked, and further on, a suspension bridge that leads to a large upended ship.

House

Suspension Bridge to Ship

Proceeding to the suspension bridge and crossing it to the ship, the player finds a locked door, a smaller portal, and a device that generates power from the wind. Opening the portal, the player sees what had been represented in the diagram in the house.

Ship Door Puzzle

The device indicates that something can be beamed into it from the database repository. Only the magnet will let itself be beamed. The player discovers that the device can be set to a three digit number. The clue about which number to be set was on the diagram in the house. Beneath the picture had been printed these words: "The boiling point of water."

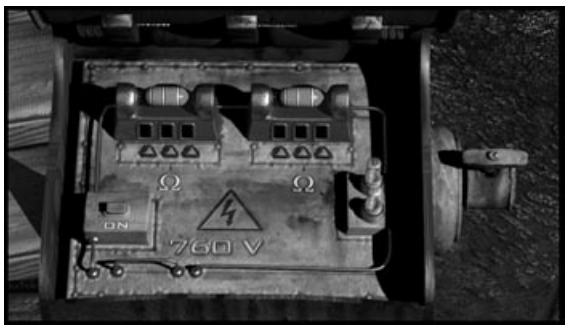
But which number for the boiling point of water should be inserted there? The Farenheit number of 212 degrees does nothing. At this point the player could visit the database tutorial about heat and discover that another way to represent the boiling point of water is on the Kelvin scale, resulting in the number 353. Entering this allows the door of the ship to open.

Inside the ship there is a dark corridor with a ladder. Climbing up the ladder one reaches an observatory room, which contains a telescope and various structures.

Observatory Room

The mirror can be placed on the frame, which illuminates the corridor. The telescope can be opened and a convex lens beamed out of it. Near the door is an electrical resistor, which can be added to the repository. Going back down the corridor ladder, the lighting now reveals that another 2kg weight is at the bottom and available for access. Leaving the ship, the player can now return across the suspension bridge and go to the small house near the fork in the road. On one side of the house there is a notice posted that says the following: "3040 Watts, 4 Amp (with a picture of the elevator)."

If the player now returns to the bottom of the cliff where the elevator would land if it were activated, the resistor picked up in the ship will fit the missing spot in the control device for the elevator.



Elevator Control

The device has two sets of buttons which input numbers. They must be set to a pair of numbers that equal 190. This allows the elevator to descend. This information can be worked out by visiting the tutorial about electricity.

Riding the elevator to the top of the cliff brings the player to two buildings, one of which is locked and obviously requires a key of some sort. This is a windmill. The other opens to reveal the first generator encountered of the three necessary for completing the game. However, there is little that can be done in this room at this point except for retrieving the third 2kg weight. With this in hand the player can descend via the elevator back to the ground and return to the smithy house where the forge waits.

Inside the smithy the lever can be adjusted so as to balance. The player can then ascend the ladder that leads to the second floor, where there is a furnace. The player must first turn on the gas valve that leads to the furnace, and then can start it. There is a hopper at the top.

Forge

The scale on which the hopper rests is measured in 2kg increments, and the top of the hopper indicates that something should placed inside. The player may drop all three 2kg

weights into the furnace and send them down to the forge. Returning to the first floor, the weights will be found melted into one large 6kg weight. This weight can be retrieved.

Returning now to the small house at the fork in the road, the player can discover on one side a barrel blocking entrance to a basement door. The barrel is attached to a pulley and lever arrangement, at one end of which is a magnet. By attaching the 6kg weight to this magnet, the barrel is lifted and the door revealed. The weight of the barrel is clearly marked on its side, and a visit to the database will provide the information about how to calculate the appropriate weight necessary for lifting it. The player might have tried to lift it before this with the 2kg weight, but would have found it impossible.

Small House

Descending into the basement, the player will find a key to pick up. Returning to the windmill on top of the cliff that needed a key to open its locked door, the player will find that this is that key. Opening the door, one can find a millstone that should be turned by the windmill--however, there is block preventing its rotation. This can now be removed. There is also a brake lever, which can be released. Leaving the windmill and walking to the other building on the cliff, the player will now find that the generator is rotating (it had been attached to the windmill as a motive source). Next to the generator is a transformer, which indicates an input voltage of 5500 volts. By consulting the database, the player may come to understand that it is necessary to adjust the turnings of the coil so that the power from the generator is stepped down. Also at this point the player must turn on a light switch associated with the small house with the basement.

Now that the generator is running, a door is opened which leads to some tracks. These tracks take the player down to the village, which had not been possible of access before this.

Village Square

Inside the village square we see a drawbridge which may be lowered to grant access to the area beside the small house with the basement and the landing spot of the elevator. Player may now cross this bridge and go once more into the small house's basement. Since there is now light on in the house, the player will see in a previously dark corner of the basement a battery. This can be captured.

Going back to the village square, there is a shop with a window, whose is door is locked with an electronic lock.

Optician's Shop

The lock presents rapid images of light refracting lenses. The player must push a matching button for each lens type as it appears in order to open the door. Inside is an optician's shop, and inside one of the drawer's in a desk there, the player will find a green lens that may be captured.

Back inside the village square there is an alley that opens off from it. Near the back of this small lane there is a dustbin that contains a hammer, which the player can scan into the repository. Returning to the village square, the player can cross to the large door which has a red button in the middle of it. When pressed, this button opens the door into the garden.

Garden

There is a path across the garden that goes two places: another locked door, and a table on which sits a battery charger. The battery recovered from the basement of the small house may now be inserted here and recharged, then returned to the item repository.

Back once more into the village, the player may now visit the well in the center of the square. There is a ladder inside which the player can descend, where a wooden box will be found at the bottom. Inside the box there is a place for a battery. The recharged battery can be inserted. This reveals a previously dark corridor which ends in a brick wall. If the hammer is beamed onto this wall, then a hole may be broken open in it. Inside there is a prison cell.

The prison cell is empty, but the door is locked when touched. There is a convenient stick of dynamite on the door. Using the convex lens recovered from the telescope, the player may beam light onto the fuse of the dynamite and so ignite it. This makes it possible for the player to leave via the door. Down a hall one finds that this is the interior of the police station. There are two room to explore. One is the police office, which house report books among other things.

Police Room

Opening one of the books displays the following information: "Speed of sound in iron=5170m/s" There is also a square wrench in one of the drawers in the room. This is picked up. The other room in this building is a darkroom for developing and printing film. By beaming the green filter obtained from the optician's office onto the light source, the red light is replaced with more normal light and the combination to a safe is revealed to be 2312.

Leaving the building and returning to the village square, the player may now go to a previously locked building and enter the combination 5170 in order to open the door. Inside we see it is a thief's house. There is a small golden ball in a bowl of fruit that may be picked up, and there is a safe behind a painting. The combination is 2312. Inside there is a concave lens to get.

At this point, the player can return to the ship's observatory, put the concave lens in the telescope, and see the back side of the door that leads out of the garden next to the village square. On the lock to that door there is visible a large letter "F". This is a clue that the player should return to the garden and try to work that lock again.

Returning to the door in the garden, the player may now insert the square wrench in the door and enter the following formula in the lock: "F=m*a". This is Newton's law of forces and may be found in the database. The gate opens, and the player enters the enclave on the beach.

Enclave

The enclave contains several houses with locked doors and another generator. Approaching the water at the edge of the beach there is visible a bottle floating in the water. Inside is a paper which advises the reader that the lock on the observatory can be opened if one remembers the density of chlorine. Returning to the beach and the enclave, the player may now enter the astronomer's house, where there will be found an orrery missing three planets.

Orrery

The golden ball rescued from the thief's house may now be used in conjunction with two other balls present to complete the solar diagram. This allows the chapel next door to be opened. Inside there is a tuning fork that can be captured.

Returning now to the optician's shop, the player can use the tuning fork to sound a tone that will shatter a glass container containing a crank handle. This can be picked up. Then leaving the village and walking past the observatory, the player can get to the submarine.

Submarine with Reflector

There is a large steel drum attached to the top of the submarine. It contains a metal pipe frozen in ice. There is a reflecting mirror beside the submarine. By using the crank handle the player may focus the reflection onto the steel drum, thus heating the water and freeing the pipe. Inside the sub, there is a valve on the ceiling. Now that the water is unfrozen, the player may turn this valve and activate a steam boiler. This causes the generator inside to start up. There is a nearby transformer which must be set to a particular winding in order to work correctly.

If the player now returns to the enclave and attempts to start the generator there, the lever to start it will break off. The pipe retrieved from the ice on the sub will substitute. There is a message in a bottle at the end of this jetty as well, which contains a note revealing the density of chlorine.

The player can now go to the observatory, enter the density of chlorine in the lock, and enter.

Observatory

There is a plan posted on one wall, which gives information about how to adjust the settings in the observatory, as well as a control panel for setting the voltage that must travel to the impulse device.

Observatory Interior

If the information here is correctly interpreted, then the settings will activate the impulse device, thus saving the world. The end.

PLATO Educational Software

Math Problem Solving

Transcription

The user is presented with a real world situation and required to solve a math problem in that context. The Smart Shopping scenario, for instance, opens with the user receiving a letter asking for help buying some of the supplies for a party. The letter details the recipe for S'mores, give the number of people expected at the party, specifies the number of S'mores that each person will receive, and sets a dollar limit on the purchase of supplies. The scene then shifts to the inside of a grocery store. The user sees a typical grocery aisle. On the left of the screen is a panel of tools to help the user decide about the correct purchases. There is:

There is only a suggestion of a story. The only character supplied by the story is the writer of the letter, whose presence is only revealed by the letter. The user may access any of the tools in any order, put them down and return to them, or not access them at all.

In the Car Buying scenario, the user is assumed to be a young person trying to figure out if the cost and upkeep of a car can be afforded based on a given salary from a part-time job. The user is given the necessary figures to make the calculation: cost of the car, cost of its upkeep (itemized), gas costs, salary, percentage of salary earmarked for upkeep of the car, etc.

The early screens of this scenario show a car parked in front of a suburban home. The scene that accompanies the calculation section is that of a typical student desk, with pencils, books, calendar, dessert, and a copy of the newspaper ad. Again, the story is implied rather than developed.

In the Playground Resurfacing scenario, the user is a volunteer at a community center. The user is asked to help with a project, which is to calculate the amount of supplies needed to resurface and fence a playground area. The user is shown information about the supplies. For instance, that the resurfacing material is sold only in cubic meters, that the fencing material is sold only in meters, that the ground is to be resurfaced to a depth of 15 centimeters, etc. There is a blueprint of the playground visible, which provides the minimum necessary mathematical information for calculating the area of the playground

The actual calculating is done while viewing a scene of a desktop set in a typical middle class living room. There is available also a copy of the blueprints and a notebook containing helpful information. The only character in the scenario is the director of the community center, who give the user the necessary information. There is no further story development.

Title: Operation: Weather Disaster

Company: Discovery Channel

Scene 1

Opening

A jet flies into view through clouds. Stratus is flying the plane, and Millibar, his infobot, is giving Stratus information about F-5 tornadoes that have been spotted in

Chinook, OK. Stratus heads there to destroy them. He talks by radio with Team Xtreme members at their headquarters, especially Josie, who warn him that these tornadoes are especially dangerous. Stratus and Millibar arrive in Chinook and destroy the tornadoes with some type of explosive. Millibar detects the presence of a person on the ground, and they land in order to help. An apparent lightning bolt strikes the jet on landing, which disappears, leaving a damaged Millibar on the ground. Communications with the Team are severed.

The Team discusses the problem, but the conversation is interrupted by a holographic visit from the Weatherman, who reveals that he has kidnapped Stratus, left behind the disabled Millibar, and will destroy Team headquarters if the Team members do not immediately leave. They do, separating to other weather centers around the world, leaving only Nimbo to hide in headquarters. Before they leave, one of the team members suggests that the person on the ground in Chinook might help Millibar. The Weatherman crows that no one can now stop his weather. The scene shifts to Chinook and becomes interactive.

Notes:

Characters:

The Weatherman: Villain

Stratus: Leader of the Team

Nimbo: Team member, lovable idiot

Josie: Team member, take charge personality

Millibar: Infobot, dry wit

Kahil: Team member, personality undefined

Alfred: Team member, personality undefined

Characters are introduced, plot is established, user's mission is engaged.

Some character names are weather related.

The user is immediately gender-typed as 'him'.

Propp: 1, 8, 9 Hero, villain.

Campbell: 1, 2 Hero

Chinook

Setting: Remains of a trailer park mostly destroyed by tornadoes. We see an intact trailerhouse. Detritus--a sock, a paper cup--blows by, each momentarily caught on a fence. We hear the voice of Millibar asking for help. Turning, we see the jet, Stormrunner, that Stratus flew. Nearby is Millibar beside some wreckage, with an electrical wire lying across her. One more turn reveals wreckage of some other structure. In all views we hear Millibar and see detritus fly by. Turning back to the original view, we see a bundle of colored wires on the ground.

Interface: At the bottom of the screen is a compass, which may be manipulated to change available views, a volume control, an area to show items that may be picked up, and a menu containing these items: database, hint, repeat, help, exit. Also, messages may appear here.

Exploration with the cursor, which changes shape to show interactive items and possible motion directions, shows that the door to the trailer is locked.

The user here has several options to explore, and may either go immediately to investigate Millibar's voice, pick up available items, or visit objects in each view.

Option1: The trailerhouse.

The door is locked, but a wooden pole beside it may be grabbed. The sock and cup may be grabbed, also the wire.

Option 2: Millibar

Moving to Millibar, she says that the electrical wire lying across her must be removed, and that her speech banks are shorting out. If the user tries to pick up the wire with his hand (cursor) he is shocked. After several tries, message box suggests that user find something to lift wire from Millibar.

The database is not available. Hints are unavailable until Millibar is repaired.

The wooden pole may be used to lift the wire. Millibar now says that user must re-wire terminals. Using the grabbed wire pieces on the terminals prompts Millibar to tell user that he must wire terminals in correct order. Sparks appear to reveal necessary connections, and the user must repeat the patterns he see.

Millibar then introduces herself, and finds that she can't access her database because its drawer is jammed. She suggests that if the user can help solve this problem, then she will be able to provide more information and also access her database. None of the user's objects can unjam this drawer, prompting further exploration of the scene.

Option 3: Stormrunner

Stormrunner is leaking oil, and the cabin is stuck closed. The wooden pole will pry open the cabin. Exploration inside reveals a tube, a wrench, and some spare chips--all can be grabbed. The insistent oil drop suggests that the user should do something with it. The cup may be filled with oil.

Returning to Millibar, the oil may be used to loosen the stuck drawer, enabling her to access and reveal the database--which is scrambled. Millibar says that her atmospheric guidance chips must be repaired. User may replace them with the found chips, thus revealing a chip for each of four atmospheric levels. These must be put in the correct order. The database may be accessed to learn the correct order.

The database: Contains weather related information, with text and graphics. There is a category list as well as an index. Clicking on 'atmosphere' reveals an entry about the structure of the atmosphere.

Using this info, user can fix the guidance system. Millibar now has to have repaired her wind direction device. Using the sock repairs it. She suggests a hasty exit because more tornadoes have been sighted. Millibar vanishes, but says she will now accompany user everywhere. She suggests visiting the Stormrunner. Once there, Millibar informs user that an alternate fuel source must be located. The ship is still leaking oil, and the cup may be refilled.

Option 4: Wreckage

Visiting the wreckage reveals a propane tank, but is held down by rusted bolts. The oil will loosen them, and the wrench will remove them. User may take the tank.

Returning to the Stormrunner, the user may place tank on the jet. Millibar prompts the user to use the tube to connect the tank to the jet, and then enter the jet. Millibar takes off with user inside for Team Xtreme headquarters.

Team Headquarters

Arriving at HQ we see a rocky terrain and, in the near distance, the HQ building. Thunder is heard continuously. A pile of rocks is in the foreground--clicking on them places them in the user's inventory. To the east is the Stormrunner. To the south, a shallow lake. To the west, the edge of a forest.

Option 1: HQ

Arriving at HQ building, we find a door guarded by a flying security robot. It zips back and forth in front of the door, a welcome mat, and some kind of security box beside the door. The message window instructs us to disable the bot, and clicking on the Hint button we hear Millibar suggest we find something to throw at it. Using the rocks, we can throw them at the bot. If it is hit three times then it falls in pieces, leaving only a triangular piece of metal in view on the ground. This may be placed in inventory. Clicking on the mat reveals a security card hidden beneath it, which is recoverable. The door is locked. The security box, when clicked, offers a puzzle to solve before the user can enter. This puzzle involves converting Fahrenheit to Celsius with the help of a calculator. Unless user already knows the formula, he must access the database. Solving this puzzle opens the door.

Entering the door places user in the elevator. Millibar says a security card is needed, and an extra can be found nearby (under the mat). Using this activates the elevator. On arrival, Millibar says there is some lifeform in the hangar.

We see: N: holographic projector

E: Wall safe, hangar door (which is locked), and main computer

S: Elevator

W: digital clock, Rec Room door (which is closed)

N: Holo projector

Here there is message from Stratus outlining the Team's history with the Weatherman. Stratus plays message from Weatherman, who extols the power and beauty of extreme weather. He promises to unleash the power of weather on the world. Stratus' message returns to say there are supplies in the Rec Room and money in the safe. "now it's all up to you." There is a can of super-freeze-it on the floor, which may be placed in inventory.

E: The main computer

The wall safe requires knowledge of the time of day. The hangar door is locked, but Nimbo appears behind the window inset in the door--he is locked inside without a key. Nimbo says he tied the key to his swimming trunks, but has lost both. The main computer asks the user to answer ten questions about weather in order to proved Millibar access to the increased database. Information useful for this task can be accessed from Millibar's database.

W: The Rec Room is open, and has several objects inside: a vial of mercury, a roll of paper, a pen, a vending machine which requires quarters. The digital clock is not set. The mercury, paper, pen can all be added to inventory.

Option 2: Shallow lake.

Here we find Nimbo's missing trunks and an alligator with the missing key in his mouth. We can't get the key with out feeding him something else.

Option 3: Forest

In the forest is the remote Team Observation Station. We find a hammer that can be picked up, an air compressor, and a sundial that is missing a part. The piece of metal from the security bot repairs it, showing the correct: 6:30.

Returning inside HQ we can now set the correct time on the wall safe and retrieve a quarter. This allows us to use the vending machine in the Rec Room, and get a candy bar. Going back to the alligator we can feed him the candy bar---he drops the key. However, we must still figure out that we have to use the wooden pole to pick up the key. Returning to HQ, we can open the hangar with the key.

In the hangar we talk with Nimbo. We see the other Stormrunner, which Nimbo has broken. There is a locked locker with a pad lock. The user must figure out to freeze the lock and smash it. Inside is: copper wire, a turbomercabulator, and a glyph reader.

Going to the Stormrunner, the user must replace the turbomercabulator by exploring to find its slot. Millibar programs the ship to fly to England, from which come reports of disastrous weather. During flight a message is received from a team member in England.

Stonehenge

MB takes off for England, where there are reports of flooding. Alfred sends message to MB saying that Stonehenge is the center of the weather. MB lands there. We see from inside the Stonehenge monument:

N: A stone table

E: A large stone from the perimeter fallen across another stone--they suggest a lever, or see-saw

S: Stormrunner

W: A sign on a pole, a medium size rock--both may be added to inventory. And a hotspot on one of the perimeter stones.

The wind is blowing.

Option 1: N, the stone table. It is too heavy to open by hand.

Option 2: E, the see-saw stone. The see-saw may be tilted by putting the medium size rock on one end. This allows user to climb to top of the adjacent monolith. On the top of this structure there is a sliding box puzzle to solve. Solving the puzzle reveals a compass, which MB informs the user is related to wind direction. There is a convenient

hole in the center, suggesting that something should be placed there. The sign pole fits. The user is then required to identify the direction that the wind is blowing from. Correctly identifying the direction causes the stone table to move, revealing an entrance into the ground.

The stone altar entrance is now guarded by a bot that shoots off electrical bolts. Throwing wire at the bot shorts it out, allowing access. The room thus entered contains, according to MB's voiceover, technology that could only have come from a pre-Druidic advanced race.

We see:

A table, which when approached, shows a device for controlling barometric pressure in the area. It's numbers are in an unknown language. The glyph reader reveals that it may be activated by entering the barometric pressure.

A gridded door. Each square on the grid, when touched, reveals a glyph. This is a matching puzzle--concentration. Solving this opens a room where there is a stool (grab) and a translation for the numbers in the unknown language.

A crooked piece of metal on the wall (grab). It is handle shaped.

A damaged barometer. It may be partially repaired with roll of paper, handle shaped metal. This info is available in database. It is still missing something to plug a hole in the bellows.

Returning outside for more exploration, user may visit the hot spot on the perimeter. There he finds a piece of gum stuck on the underside of the top piece--just out of reach. By using the stool and the wooden pole, he may retrieve it. Going back to the hidden room beneath the table, the user can now finish repairing the barometer and determine the barometric pressure. This allows us to return to the table with manual barometric pressure device. Entering the correct pressure is now possible since we know the pressure and can decipher the glyphs.

This activates a twitch game/puzzle which involves grabbing stray air molecules to keep the pressure high. MB says solving this causes the storms to clear. She suggests you return to headquarters.

MB and user re-enter jet, but while in flight receive message from Cairo, Egypt where the temperature is rapidly dropping. MB lands and says this is another weather control spot similar to Stonehenge.

Giza: The Pyramids

Weatherman has lowered the temperature at the pyramids. MB lands and says we must find the control center and correct the problem.

We see:

N: Great Pyramid

E: Archeological dig

S: Frozen oasis

W: Sphinx--a shovel is available to grab.

Option 1: The Great Pyramid

A door is set in the ice-covered pyramid. It is locked. Beside it is a scarab shaped indentation.

Option 2: The archeological dig.

We find a chisel, a magnifying glass and a partially dug pit. The chisel and glass may be grabbed. The hint button suggests that the pit may contain something if we had a digging tool to reveal it. Using the shovel, we find half of a scarab shaped medallion.

Option 3: Oasis

There is something buried beneath the ice. The chisel frees it--the other half of the scarab is revealed. There is also a salt shaker and a thermos with the remains of picnic spread. The thermos and shaker may be grabbed.

Option 4: Sphinx

No obvious entrance.

Returning to pyramid door, we place the scarab in the indentation. The door opens. Inside we see a hallway empty except for a scroll which crumbles when touched, but leaves the wax seal intact. We grab the seal. Continuing down the hall, we come to a room with a closed door. Beside it is an Ankh shaped keyhole, and a puzzle on the floor. The puzzle requires the user to arrange different forms of ice crystals into the temperature order in which they are created. The glyph reader says this is the Sphinx access panel. Going to the database we can find the info to arrange the crystals. Solving this puzzle prompts a message that says something has happened outside.

Returning to Sphinx we now see steps going up to its head, but blocked by a bot. The hint suggests we should throw something at it. The only throwable items are the ice cubes inside the thermos. This disables the bot, but the steps are too slippery with ice to climb. User must figure out to sprinkle them with salt. The info is in the database. This melts the ice.

Climbing the steps, we enter what MB calls the control room. She suggests that only the ancients could have had this level of technology.

We see: An alcove, which MB says is a manual temperature override device. However, it is too dark in the alcove to see anything useful.

A stone altar, with an Ankh shaped depression in its top. Using the water in the thermos to fill it, we obtain an ice key, which we can add to inventory.

An ancient, broken thermometer. The wax seal repairs it. Putting the vial of mercury in it re-activates it.

A curious device which crudely pictures the earth and sun. MB informs us that there are mirrors on the tops of two pyramids that might be aligned by this device. Using the glyph reader, we determine that it should be set to mimic the Winter Solstice. Consulting the Database gives us the proper orientation of the sun. This aligns one of the mirrors.

Above our entrance is a 3D model of the Sphinx and the pyramids. Rotating the Sphinx's head moves the real Sphinx's head. However, nothing is changed. We rotate it back in order to leave.

Returning to the pyramid and down the hall to the puzzle room, we are now able to use the ice key to open the door. We can now enter a room which contains an elaborate light and mirrors puzzle, which we must solve in order to enter the king's inner chamber.

Entering the king's chamber brings us to a passage to the roof, where we find another solstice device which must be positioned at the summer solstice. A visit to the database reveals this info. Both mirrors are now aligned. MB prompts us to look for what the mirrors might activate. Leaving the pyramid we see that the beams of light are shining on the Sphinx's head.

Returning to the chamber of the Sphinx head, MB suggests we need a way to focus the rays of sunlight. Turning the model of the sphinx head, we see the rays of light illuminate the dark alcove. The light reveals a hole in the obelisk inside. Placing the magnifying glass in it shows a circle on the wall. Touching this brings down the temperature control override, but it needs the correct code in order to work. Visiting the thermometer we see that it is -25 C. With our knowledge of the code system and this info, we can re-set the temperature.

This brings up a puzzle that requires us to track high energy particles. Solving it reverses the freezing. MB suggest we return to HQ. In flight a message is received from HQ that Nimbo is scared. MB tells him to take a weather balloon to the observation station and inflate it. This will enable MB to get info about the electrical storm that is now raging in the Pacific Ocean.

Headquarters2

On arriving, Nimbo is not there. MB suggests he may be at the remote weather observation station. We leave the HQ building and go there. We see Nimbo trying to blow up the weather balloon--without the air tank. Nimbo says the tank is broken

because he used the knob for a toy and also used the batteries from the radio which should be launched with the balloon. MB says we must find his toy. Nimbo has carved a message on one wall with a knife, which is still stuck in the wall. We grab it.

We return to HQ to search. Inside the rec room is his toy. We get the knob.

The batteries are inside the toy (a model of the Hindenburg), but we need something to pop them free with. The knife works.

Back to the observation station, where we repair the pump and replace the batteries. The balloon inflates and is launched. The message box suggests that we should return to HQ and now check the main computer.

We find that the Weatherman has infected the main computer with a virus which prevents MB from accessing it. We will have to answer correctly 10 weather-related questions before it will open for us. The database can be accessed for help in answering these. Solving these gives MB access to the weather satellite balloon information. We can monitor these at the holo tank. We find that there is a hyper-hurricane in the pacific. MB locates the source at an underwater location in the Pacific. Fortunately, the Stormrunner can become a submersible. We return to the SR and leave for the Pacific.

Atlantis

Josie contacts MB from Okinawa where the hurricane is causing great distress. The SR descends beneath the sea near the hurricane where we find the lost city of

Atlantis. We enter the dome that protects it and see:

N: A door which is sealed but half-translucent--something is inside. There is a flag next to it, which we grab. There is also a coded lock next to the door. MB says it must be re-activated.

E: A room of some sort in the center of a body of water. There is no bridge but there is a pedestal that has controls for affecting the local weather.

S: An elevator. Within it is a control pedestal.

W: Where we landed with the Stormrunner. There is another vessel there belonging to the Weatherman, but the gangplank does not stretch out to it. There is a pole at one end of the gangplank. The swim trunks may be attached to the pole.

Option E: The room. The control pedestal has three knobs which represent humidity, heat, and pressure. If we set heat and pressure low, but humidity high, then the water freezes into an ice bridge. (Database may be consulted for this.)

Inside we find an energy center for the city, but there is no energy operating. We see: a turbine with a control pedestal. If we set pressure low and the others high, then the turbine begins to create energy. (The database may help here.) There is a breaker missing beneath the turbine, however, so that power is not reaching the rest of the city. MB suggests the Weatherman took it. Also in the room is a power device of some sort that emits electrical sparks. If we stick the flag into it, the flag catches fire. We also see in this room a freezer.

Returning to the elevator, we manipulate the controls to produce high pressure, humidity and heat. This makes the elevator rise (Database).

Inside we can see through a window to our Stormrunner and the Weatherman's vessel. There is a flag (not waving) and a control of some sort--apparently controls pressure. Using the controls we can create a pressure gradient that controls wind in the plaza where the ships are docked. MB suggests we might use the wind to blow the gangplank to the Weatherman's vessel. We see that the swimtrunks are acting as a sail on the pole that is on the gangplank. By setting the pressure gradient to high in the direction we want the wind to blow, we blow the gangplank to his vessel. (Database could help here.)

We return to the plaza and go to the vessel. We can now go to the vessel, but there is a code to be broken before we can enter. There are four buttons labeled with names of weather disasters. The database helps us rank them in order of most deadly to least deadly (we have been prompted by the lock to do this). We enter his vessel and retrieve a magnifying glass and a breaker.

We can now replace the breaker in the energy control room, which makes energy flow to the city. We return to the locked door with the coded access plate. It is now a functioning puzzle, requiring us to enter four correct colors matching the appropriate glyphs. Opening the door, we see the Weatherman with his back to us. We enter.

The Weatherman says he is working on understanding the machinery here which will give him absolute power over the world's weather.

In the rest of the room we see:

NW: a mysterious panel and two empty sockets. The glyph reader reveals that it is the manual override terminal power flow. The burning flag fits one of the slots. The magnifying glass goes in the other. Putting these two objects in the slots makes the light of the burning flag shine through the magnifying glass, and casts five color bands on the panel, each beside a button. The glyph reader deciphers the correct order of buttons by color. Inside is a breaker we can grab. This stops the Weatherman from his work by halting power to the computer.

MB says Atlantis is now flooding as a result of the Weatherman's work.

SE: An ancient hygrometer (see Database). We grab the bucked in it.

N: The main terminal, which controls humidity. We must replace the breaker for it to work.

We return to the plaza where we see Weatherman leaving in his vessel. He has dropped something. It is a key, which we pick up. We can fill up the bucket here with water. If we return to the room with the freezer we can freeze the bucket of water and take it back to the hygrometer. This gives the humidity: 99.6. Knowing this we can se the humidity on the main terminal. This reveals a twitch game about grabbing particles blown outward from a hurricane. Solving this corrects the humidity.

MB suggests we return to HQ and try to track the location of the Weatherman. We return to Stormrunner, where we find that the Weatherman has been tracked to Chinook. We go there instead.

Chinook2

Weatherman is reported by MB to be back in Chinook. We land and see the trailer house that we first saw at the beginning. The key we picked up in Atlantis can open the door.

Inside we see: An umbrella stand, a classical bust, a refrigerator, and various items of furniture. We grab a rubber-handled umbrella from the stand. The bust opens to reveal a button. Pushing it moves the fridge and reveals a secret stairwell going down. We enter.

We are immediately blocked by a 'lightning door'. The hint menu suggests that we find something to short-circuit the door with that won't electrocute us. The rubber-handled umbrella does the trick.

We see: N: Inside we find a small weather broadcasting studio with a world map and cameras arrayed around it. On the map are three crystals located where the weather disturbances were: Stonehenge, Giza, Atlantis. The Weatherman has taken these crystals from those locations. The crystals will not come loose.

NE: a script of the Weatherman's broadcast lying on a table.

SE: A jail cell with Stratus inside. He informs us that there is a key to the cell that looks like a tornado and urges us to find it.

W: There is a computer which the Weatherman has used to program the weather bots into evil guard bots. Next to this computer is a door guarded by bots. MB says we can re-reprogram the bots back into weather bots. The computer presents a puzzle to solve in order to do this. It is a networking puzzle that requires connecting nodes in the right sequence. Solving this causes the guard bots to move away from the door.

MB tells us that we must be very careful--there is no telling what might be behind the door. We enter.

We find the Weatherman inside. He informs us that the weather crystals will allow him to control global weather. We must, he says, play a game of weather domination with him. This is similar to the other twitch games, involves clicking on a

map which highlights different countries for a brief instant. We must click in the highlighted country before the Weatherman does.

Winning this game, we see the Weatherman again. He says he will destroy the world anyway. When exits the room he confronts the reprogrammed bots which now attack him.

Exploring room, we find a hidden compartment behind a painting. It holds the cell key, which we can now use to free Stratus. Stratus says he will take the Weatherman away. MB receives a mysterious message commanding us to replace the crystals to where they belong.

We can now grab the crystals and return to the Stormrunner. MB says the Stormrunner will fly us to each location where we can replace the crystals. We watch a video of the Stormrunner replacing each crystal and then returning to Team HQ. The abnormal weather is re-balancing.

HQ3

At HQ we re-join Status and the other Team members in a celebration. Status compliments our work. The user is made a full-fledged member of Team Xtreme.

Propp's Analysis

1. One of the members of a family absents himself from home.

   The Team Xtreme considered as a family. Stratus absents himself from 'home' to destroy the tornadoes. Stratus is the oldest team member, the 'father' to the team. Propp explicitly identifies the absent family member as sometimes being of the older generation.

2. An interdiction is addressed to the hero.

   The user is the hero through all of the program except this opening scene, since he has no choices to make here. Stratus fills this role in the opening scene. The warning from the team members about the danger of the mission functions as the interdiction.

3. The interdiction is violated.

   Stratus proceeds anyway. Propp points out that the villain often makes his or her presence known at this point. The Weatherman shows up on the holograph at headquarters.

4. The villain makes an attempt at reconnaissance.

   N/A

5. The villain receives information about his victim.

   N/A

6. The villain attempts to deceive his victim in order to take possession of him or of his belongings.

   N/A

7. The victim submits to deception and thereby unwittingly helps his enemy.

   N/A

8. The villain causes harm or injury to a member of a family.

   The possibilities for types of villainy here are varied. Stratus is abducted (VIII.1). Chinook is nearly destroyed by tornadoes (VIII.5). Millibar is stranded and injured (VIII.6).

8a. One member of a family either lacks something or desires to have something.

   Millibar lacks access to her database and is losing speech--she needs the electrical wire recovered near the trailer. Propp points out that this lack can take many forms. Often, it is the lack of a wondrous object. Millibar's database fills this role.

9. Misfortune or lack is made known; the hero is approached with a request or command; he is allowed to go or he is dispatched.

   User leans of Millibar's misfortune. She says her speech banks are shorting out and that the wire must be lifted. She asks for help. "This function brings the hero into the tale." (Propp, p. 36) Propp divides heroes into two types: seekers, and

victimized heroes. This is an example of the seeker type, since the user and Millibar must go seeking for Stratus.

[At this point, there is a break in the presentation of Propp's elements. User must solve several puzzles or problems before the story can proceed. This serves as an opportunity to introduce the user to the capabilities of the database. Solving these puzzles doesn't require weather related knowledge. Many of the following elements are repeated throughout the episodes of the story. For instance, the user is tested for his ability to solve several problems and will receive his 'magical agent or helper' in the form of Millibar and her database, as well as the continued use of the wooden pole which he has retrieved from the trailer. Once the database has been made accessible, then there is presented a puzzle which does require weather knowledge--the names and positions of the four atmospheric levels. These can be found in the database. This is the first opportunity to integrate content material, story line, and interactivity. Following this, the user must use the sock he placed in inventory to repair the wind direction device. This also requires content knowledge. Millibar now serves as a guide and source of suggestions for the user's behavior. At her prompting the user can now solve several problems that will repair the broken StormRunner ship.]

10. The seeker agrees to or decides upon counteraction.

    User implicitly agrees to accompany Millibar by continuing to interact with the program.

11. The hero leaves home.

    User enters the jet and takes off with Millibar. 'Home' may be considered Chinook, where the user first enters the storyline.

[The following four elements are repeated in varying ways in each of the sub-sections of this story as the user and Millibar must solve problems that lead to the use of a 'magical agent' that helps with the next problem. The sub-sections (or as Propp would describe them, the *moves*) end with a jet trip to the next locale.

12. The hero is tested, interrogated, attacked, etc., which prepares the way for his receiving either a magical agent or helper.
13. The hero reacts to the actions of the future donor.
14. The hero acquires the use of a magical agent.
15. The hero is transferred, delivered, or led to the whereabouts of an object of search.