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EXPLORATION OF CHINESE ART USING A MULTIMEDIA CD-ROM:
DESIGN, MEDIATED EXPERIENCE, AND KNOWLEDGE CONSTRUCTION

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree of Doctor of Philosophy in the Graduate
School of the Ohio State University

By

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* * * *

The Ohio State University

2000

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Approved by

Art Education
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by

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This study consisted of two phases: (a) research instrument development, and (b) research instrument implementation and exploration of its effects. In the first phase, the researcher designed and produced the research instrument—the Chinese Dragons multimedia program. Before the final version of the program was created, four prototypes with different organizational pathways were developed. The final version of the Chinese Dragons program provided a constructivist, case based, and situated multimedia learning environment. When interacting with the program, users actively engaged in virtual tasks by playing the role of a news reporter assigned to write an article about Chinese dragons. They did research by exploring three artworks with the Chinese dragon motif. Since the Chinese dragon is the most pervasive symbol in Chinese culture it can serve as entry points to different venues of Chinese history and culture. Three artworks, a Han dynasty silk banner, a Qing dynasty dragon robe, and a Tang dynasty bronze mirror, were chosen to represent the different meanings of Chinese dragons.

In the second phase, the researcher studied the interactive learning experience and knowledge construction affected by the program. Fourteen students (third to ninth graders) were recruited to participate in this research. Data were collected through interviews, observations, and written documents. The researcher coded the data with the
QSR's Nud*ist program to find evidences of the participants' learning experience and knowledge construction affected by the Chinese Dragons program.

The data suggests that, computers, like any other previous technology, not only facilitates students' learning experiences but also fundamentally reshapes and transforms that experience. The Chinese Dragons program, which is constructivist, situated, and case based, evidently engaged and immersed the learners in simulated contexts to build up a complex understanding of Chinese dragons through multiple cases of exploration. In addition, the organizational structure of the program appeared to impact the learners' structure for constructing their articles. Evidence of cognitive equilibration (accommodations) of the learners was observed in versions of the participants' articles about Chinese dragons (through changes in titles or content). Among the four types of knowledge transfer (i.e. *duplicate, paraphrase, integration, and application, generalization and synthesis*) identified in the participants' articles, the integration transfer was the least observed. In conclusion, the researcher shared and reflected on her experience of designing and implementing the Chinese Dragons program.
DEDICTION

I dedicate this work to

My

Mom and Dad

who have nourished me with their everlasting love and support.
ACKNOWLEDGEMENTS

I wish to thank my dissertation committee members, Dr. Arthur Efland, Dr. Michael Parsons, and Dr. Raylene Kos, for their input on designing the research instrument—the Chinese Dragons CD-ROM. Further, I wish to thank Dr. Arthur Efland, my advisor, for his support throughout my Ph.D. study. His knowledge in cognition helped me greatly in the design of my research and the analysis of my data. I also wish to thank Dr. Michael Parsons for his insights on assessment and to thank Dr. Raylene Kos for her advice on methodology and data analysis. I would also like to thank Dr. Julia Andrews for her advice on the content research of the research instrument.

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CHAPTER 1
INTRODUCTION

Background of the Study

The genesis of this study had two parallel origins, which both coincidentally date from 1995. One has to do with my teaching experience at the Columbus Chinese School, Columbus, Ohio, and the other one was related to my first encounter with multimedia technology. My experience, as a teacher, at the Columbus Chinese School incubated my initial research question whereas my encounter with multimedia, to me, posited a promising solution to that initial research question. Because the research question for this study has evolved significantly since the conception stage of this study, it is logical first to discuss the context of my initial research question—the Columbus Chinese School teaching experience—before discussing the question.

One Origin

From 1995 to 1997, I was a language teacher at the Columbus Chinese School. The Columbus Chinese school was one of the activities organized by the Chinese community in Columbus, Ohio to continue and promote Chinese culture in the United States. The School provided a formal opportunity for American born Chinese youngsters to learn Chinese language and cultural heritage. Parents who sent their children to the Chinese School were comprised of mostly first generation immigrants. They believed
that having their children learn Chinese language and have contact with Chinese culture
would help build their children's self-identity and lead to better channels of
communication with their children as well. Students of the School came mostly from the
Columbus suburban areas. The School rented a middle school and operated on Sundays
from 1:30 to 4:30 p.m. with the first two hours consisting of two sessions of language
classes and the last hour consisting of one session of extra-curricular classes. Students
could elect from different classes, including traditional Chinese dance, martial arts,
Chinese yo-yo, drawing, Chinese calligraphy, and painting.

As part of my duty, I attended regular school meetings twice every semester.
During the meetings, I routinely heard the parents pleading for Chinese culture and
history to be taught at the Chinese School in addition to language. Below is a typical
story told by parents who asked the School for actions:

My daughter (or son) told me: Being a Chinese, in class, my teachers and
classmates assume that I know Chinese history and culture and often ask
me to share my understanding of Chinese heritage with the class.
However, I was embarrassed because I don't really know Chinese history
and culture. Why didn't you teach me about Chinese history and culture?

Although the request was brought up many times, the school administrators, citing
a lack of school time, took no action on these requests. In addition to time limitations,
another concern was that, in the experience of most people, the teaching of Chinese
culture and history using the traditional lecture approach could bore even the self-
motivated students. This situation prompted me to think about other alternative ways to
teach Chinese history and culture to the students at the Chinese School and to other non-
Chinese American students as well. Therefore, I asked the initial research question: Is
there a better alternative, other than the conventional lecture approach, to teach students Chinese history and culture.

Second Origin

After entering the Ph.D. program, I was looking for a focus for my study. The program of art education at OSU provided many options. I ventured into arts administration, art history pedagogy, and community based art education. In 1995, I had my first encounter with multimedia technology and saw its great potential in education. After testing the water for one year, in 1996, I formally enrolled in technology classes, including multimedia authoring, animation, and programming, at the Advanced Computing Center for the Arts and Design (ACCAD) of OSU. ACCAD is an interdisciplinary program that brings educators, artists, and programmers together.

I studied literature about the use of multimedia in education in which many scholars claim a great educational promise for multimedia technology in learning. They believe there are many benefits that multimedia can bring to education. They state that multimedia mediated teaching and learning can provide interactivities, non-linear exploration, immersed context, choices, connections, multi-sensory information delivery, and learning empowerment. It also is constructivist and self-paced. Many art educators, such as Diane Gregory (1995), Phillip Dunn (1996), and Karen Keifer-Boyd (1996) echo such sentiments. The strengths and benefits of multimedia technology are advocated by these three art educators.

"[T]he real power of integrated media lies in its non-linear design that enables the user to go through a program in any order. This characteristic frees the user to proceed through the program at a comfortable, individual pace; to satisfy intellectual tangents; to meander
serendipitously through a program... These programs can put the power of learning in the hands of the student and can change the role of the teacher from a detached dispenser of information to the exciting and challenging role of manager, facilitator, or guide. It can change the role of the student from a passive observer to an active participant. It encourages a different view of knowledge, learning, and teaching. It encourages the constructivist view of learning by providing rich technological resources for students to use as they constantly seek to re-define their personal knowledge bases” (Gregory, 1995, p. 9).

“What is it about interactive technology that encourage children to persevere in the quest for new knowledge; and what is it about schooling that often does just the opposite?... The answer to this question revolves around active versus passive participation in the learning process... Rather than bound by some sequence designed by the teacher, interactive integrated media allows the user freedom of choice within the confines of the program in use” (Dunn, 1996, p. 7).

“Nonlinear construction [facilitated by integrated hypermedia] develops critical thinking skills. Specifically, it enhances one’s ability to examine the richness of disparate data, to discover relationships, to synthesize ideas to form new understandings, to imagine new possibilities by transforming existing images, and, especially, to recognize the plausibility of more than one correct answer or response” (Keifer-Boyd, 1996, p. 40).

In addition, learning theory and empirical research lend support to the educational use of multimedia technology. For example, Paivio’s (1978) dual coding theory suggests that there are two general types of information, environmental and communicative, and that there are two distinct symbolic systems to process information, imagery and verbal. The imagery system processes information through “the interpretation of scenes and the generation images” (p. 40) whereas the verbal system specializes in “processing linguistic information, that is, interpreting language and generating speech” (p. 40). Information about the environment is represented and processed by the imagery system. On the other hand, the verbal system represents and processes communicational information. The two
coding systems are independent of each other but interconnected to each other as well (Paivio, 1978). Based on empirical studies, Paivio (1978) concluded that the imagery and verbal dual coding of items results in an additive effect on free recall. Although information recall is not equal to learning, "if things are not remembered, no learning can take place" (Kearsley, 1994, [on-line]). Multimedia technology provides multi-sensory modalities to represent information, such as audio (verbal), text (verbal), graphics (imagery), video (verbal and imagery), and animation (imagery). If a piece of information is coded in more than one way learners will more likely remember and retain the information. In other words, multi-sensory instructions delivered through text, audio, video, and animation can suit the different learning styles of learners.

However, educational multimedia software is a niche waiting for cultivation. This can be seen by the unbalanced picture of the software development industry where the game sector has grown exponentially and saturated the consumer market. On the other hand, well-produced educational software are few and hard to find (Feldman, 1997). As an educator, I wanted to transform my ACCAD technical skills for educational use. I pondered: How could I make the best use of multimedia technology to create a constructivist environment for teaching and learning?

The Two Origins Meet

In 1997, the two origins of this study met, and a new research question emerged as the result of this meeting: How can I create a multimedia program, based on a constructivist approach, for learning Chinese history and culture? I embarked on the
research by creating prototypes of a multimedia program for learning Chinese history and culture.

According to Wasson, Stuhr and Petrovich-Mwaniki (1990), culture refers to “people’s way of perceiving, feeling, believing, evaluating, and behaving which can be affected by the environment, the economical system and modes of production” (p. 235). Webster’s New World Dictionary, Third college edition, defines history as “what has happened in the life of development of a people, country, institution, etc. . . . [A] systematic account of this, usually in chronological order with an analysis and explanation” (p. 640).

Chinese culture is over five thousand years old. The Chinese people consist of more than fifty-six ethnic groups and speak more than eight major dialects. Since the advent of Chinese history, the values, symbolism, social perceptions, customs and political systems have evolved tremendously and continuously. Culture and history are pluralistic and evolving. It is a challenge to develop a multimedia CD-ROM that can provide students with an opportunity to understand the complexity of Chinese culture and history.

In the field of art education, different approaches to art education differ in their definitions of art. The formalist approach “emphasize form, how objects look, what materials are, and what skills and techniques the artist has demonstrated . . . [Art] is intrinsically important. Art is for art’s sake. Art . . . should not have a primary concern with anything outside itself—-not politics, not economics, not community concerns” (Anderson & McRorie, 1997, p. 9). The contrary, contextual approach contends that “the
meaning and worth of art can only be determined in the context in which it’s made and
used . . . [A]rt is communication that requires a shared code within a specific cultural
matrix . . . [T]here are not universal forms or meanings (Anderson & McRorie, 1997, p.
10). [N]ot only is there no predetermined meaning for visual and linguistic symbols, but
that meanings for the same symbol can be different in different cultures and times
because meanings are assigned” (Goodman as cited in Anderson & McRorie, 1997, p.
10).

Works of art are cultural products of a specific historical period. Art is the
window of a culture and its contextual history. Chinese culture and history are explicitly
manifested in various Chinese arts, such as its calligraphy, bronze, jade, painting, crafts,
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architecture, operas, and music. The formalist approach, which emphasizes art’s intrinsic
value and disregards its political, economical, and social context, does not agree with my
understanding of Chinese art. My definition of art and its function favors the
contextualist view that “there is no one set of qualities that can be found universally in all
works of art. Instead of looking to the work, then, [philosophers like] Dickie looked for a
definition [used by] the people who made, viewed, and used the work” (Goodman as
cited in Anderson & McRorie, 1997, p. 10). In this sense, art, culture and history are
interwoven and connected together. Thus, teaching students about Chinese culture and
history can be approached through a study of works of art since these works are the
embodiment of the culture in which they were produced.
Purpose of the Study

Although there are many educational multimedia titles available on the market, I have found that these titles mainly target mass education and they do not have all the benefits and strengths of multimedia claimed by educators (discussed earlier). Moreover, the materials for teaching non-Western arts, cultures and histories are far sparser than their mainstream Western counterpart. This statement is not only true about the traditional media, such as textbooks, posters, but is also true about the emerging new media, such as Web and CD-ROM titles. The hyperlink, Lesson Plans & Curriculum Ideas, at the Getty Center for Education in the ArtsEdNet web site (http://www.artsednet.getty.edu) gives us a glance at this unbalanced picture.¹

I could not find a multimedia title—based on a constructivist approach for learning Chinese history and culture through art— which would met the needs of this study; thus, I had to create one myself. After the multimedia program was completed, I studied its effects on students’ interactive learning experience and knowledge construction. Therefore, there were two distinctive phases in this research. The first phase was to develop a research instrument to learn Chinese history and culture through art. In the second phase, I had students interact with the CD-ROM; I was interested in knowing the effects of the multimedia CD-ROM on their interactive experience and knowledge construction.

¹ The use of ArtEdNet web site as an example of the unbalanced picture of materials does not mean to undervalue the Getty Center’s effort in making more multicultural materials available.
Terminology

A number of terms, which may have differing definitions or are technical jargon that may be unfamiliar to the general reader, need to be discussed. Further, this study involves employing digital technology to design a research instrument, a multimedia CD-ROM. Although the field of digital technology was not popularized until after the introduction of personal computer in 1976 the progress of this field is moving at a rate of speed that few other fields can compare. Some definitions of terms used in digital technology are changing as rapidly as the progress of technology itself. Thus, the reader should be aware that the digital technology and related definitions provided here can only best represent the time of this study.

Art. In this study, the scope of art is not confined to the conventional meaning of fine art. Art is a socio-cultural product and encompasses all cultural artifacts including crafts.

Bandwidth. Bandwidth refers to the data transferring rate of a digital device or a communication channel. The unit of measure of bandwidth is bytes per second or bits per second.\(^2\) For example, a single speed CD-ROM's bandwidth is 150 kilobytes per second. Bandwidth can also refer to the data transferring rate requirement of a particular software or hardware.

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\(^2\) There are eight bits in one byte. A bit is the basic element of digital data, representing a value of either 1 (on) or 0 (off).
CD-ROM. CD-ROM stands for compact disc-read only memory, a storage and off-line data or multimedia delivery medium that can contain a maximum of 650 MB of data. CD-ROM technology was initiated by the Phillip and Sony companies in 1985.

Computer Assisted Instruction (CAI), Computer Based Instruction (CBI) and Computer Mediated Instruction (CMI). This study treats these three terms, which refer to the use of computer in education, as virtually synonymous. Among these three terms, CAI, CBI and CMI, this project prefers CAI over the other two. Many CAI projects done in the 80s were not multimedia projects (albeit interactive and offering a user choices most CAI projects only used a combination of simple graphics and text). CAI projects done in the 90s, especially within the last couple years, are almost all full-blown multimedia projects.

Multimedia. In the history of multimedia development since the late 1980s, many definitions were crafted to denote this term. The term multimedia was originally used to mean macro computing which makes a use of a combination of multimedia data types, or the system package that delivers it. This study adopts the more inclusive definition coined by Tony Feldman (1997) in his recent book, An Introduction to Digital Media, which states that “‘multimedia’ is the seamless integration of data, text, sound and images of all kinds (including video and animation) within a single digital information environment” (p. 24). There are other popular terms that were the predecessors of the term multimedia, such as interactive integrated media, or
This study treats these other terms to mean the same as the term multimedia.

In general, there are two ways of delivering multimedia content to users, on-line and off-line. There are a number of pros and cons either with on-line or off-line distribution. On-line (Web) distribution can reach more users worldwide and create a larger interest group community; however, due to the current technical limitations of on-line bandwidth (the result of a relative low transferring bandwidth for consumer wired services), those types of rich multimedia demanding a high data transferring rate can not be delivered on-line to users within a reasonable time for a successful interactive experience. On the other hand, CD-ROM, as the predominant media for off-line distribution, which is capable of containing 650 MB of information on each disc and has at least a 150X kilobyte data transferring rate, is a better media to distribute visually rich, high quality and data demanding multimedia. Although the bandwidth aspect of technology favors off-line CD-ROM media the experience of off-line multimedia has been criticized by some as isolated and confined (Feldman, 1997).

The multimedia program created for this study included the integration of intensive graphics, sound, text, and animated features and required high data transferring rate (bandwidth). To accommodate this end, off-line media, CD-ROM was a more

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3 a. Gregory (1995) defines interactive integrated media, or hypermedia as “a new electronic medium usually developed for the micro-computer, CD-ROM, laser video disc, or any combination of all three technologies that ideally involves the holistic integration of a variety of media such as text, graphics, animation, still photos, video, music and voice” (p. 8).

b. Dunn (1996) defines interactive integrated media, or hypermedia as “computer applications that incorporate text, graphics, sound voice, animation and video in a seamless, multifaceted presentation” (p. 7).
suitable media for this study than its on-line counterpart. In addition, for the purpose of controlling the variables in this study, the generally regarded negative traits of CD-ROM medium, isolation and confinement, were desirable features for this study.

**Director.** Director, developed by Macromedia, Inc., is a popular high end multimedia authoring software, which can integrate different media, such as text, graphics, audio, video and animation into a multimedia production.

**Lingo.** The Macromedia Director's scripting language that adds interactivity to multimedia.

**Interactivity.** Interactivity is a feature of software (including multimedia) which responds to the choices and commands of the user.

**Interface.** Interface is the screen display (standing between a user and computer) through which the software or multimedia offers choices, interactivity, degree of control, and access to data to users. However, in the case of interface for the visual impaired, the interface is not a screen display but a hardware device that prompts the user through sound/touch with choices to command the computer.

**Overview of Research Methods and Data Analysis**

This study used qualitative research methods, including observation, interview, and document analysis. The documents included participants' interaction history, versions of notes and articles. I programmed a tracking function in the research instrument to record the participants' interaction with the program (see Appendix A). From the participants' interaction history, I could see the sequence of their exploration
and how long they spent on each “frame”, which in part helped me to evaluate the
interface and navigation design of the program. To take snapshots of participant’s
knowledge construction process, I scripted the program so that versions of their notes and
articles were saved to an external storage media. My intention in this study was to
explore the effects of the multimedia learning tool I created and provide an account of
how this tool affected students’ interactive learning experience and shaped their
knowledge construction.

The design of the research instrument was influenced by constructivist, situated
learning, and cognitive flexibility theories. Constructivist theory states that learning is an
active process and the learner, relying on a cognitive structure, selects and transforms
information to construct knowledge (Kearsley, 1994). Situated learning states that
learning is mediated and is associated with its context. Cognitive flexibility theory
stresses that the content of complex knowledge needs to be presented in multiple cases
with multiple perspectives and connections to preserve its complexity.

When I analyzed the research data, I used constructivist, situated learning, and
cognitive flexibility theories to see the relationship between the design of the research
instrument and the participants’ multimedia mediated learning experience. I also used
grounded theories to sort out the sources of information and knowledge as well as types
of knowledge transfer in the writing produced by the students in the multimedia program.
In addition, Piaget’s cognitive equilibration theory was used to analyze the organizational
structure and evidences of accommodations in the participants’ writing.
Limitations of the Study

The participants of this research were not representative of the entire American student population. Although the participants included boys and girls from various ethnic backgrounds and with different academic achievement levels, they all came from middle socio-economic class families and had educated parents. I tried to collect data from students of a more diverse range of socio-economic classes. For that part, I obtained access to a learning center located in a less affluent district. A fifth grade boy from the center interacted with the multimedia program for one session and I interviewed the boy before and after his interaction. I observed that the boy showed enthusiasm for the program and demonstrated similar interaction behaviors with the program to the other participants in the study from middle socio-economic class families. Unfortunately, I had to suspend the data collection at the center because of time constraints. Therefore, to transfer the findings of this research to students from different socio-economic classes other than those in this study would require further study.

Significance of the Study

This research contributes to the understanding of multimedia interaction and learning. Multimedia and learning is a topic of concern in education. Educators worry about costly computer technology being blindly pushed into classrooms based on over-exaggerated claims without the support of systematic studies (Ravitch as cited in NAEA News, August 2000). The results of this study provide an account of how the multimedia
exploration based on the constructivist, situated learning, and cognitive flexibility theories affects students’ learning experiences and shapes their knowledge construction.

In the literature of situated literacy, Barton and Hamilton (2000) state that the physical characteristics of the literacy works of students are disappearing because of the growing use of technology. More and more students use technology to compose their work. In the multimedia program created for this study, the interaction history and versions of notes and articles provided snapshots of the students’ knowledge construction process. Through these features, not only can teachers see the end result of students’ learning but they also can see what information interested the students and how they used the information in knowledge construction. These features would provide insights to instructional designers for future content organization and design and give teachers insights about providing assistance to students to help them achieve their learning potential.
CHAPTER 2

LITERATURE REVIEW

This research is about the instructional design of a multimedia CD-ROM and its effects on the interactive learning experience and knowledge construction with a group of users. Theory and technology are two intertwined aspects of the research instrument development. Cognitive learning theories provide a conceptual framework and foundation for the decision making of the instructional design of the research instrument. On the other hand, technology transforms the instructional design into tangible products and interactivities. In this chapter, I discuss three bodies of literature: (a) the cognitive learning theories that have influenced this research, (b) multimedia CD-ROM titles relevant to this research, and (c) research related to the use of interactive multimedia in teaching and learning.

Among the cognitive learning theories, constructivism, cognitive flexibility, and situated learning are most significant to this research. I review these three theories not only because they undergird the design of the research instrument but also because they provide the lenses through which the research data is analyzed. I then review commercial CD-ROM titles for teaching Chinese history and culture or history to illustrate the trends of educational CD-ROM titles for teaching history. I also review research that
investigates the use of interactive multimedia in teaching and learning to contrast the approach taken in this study with other research products. The discussion of these three bodies of literature—learning theories, multimedia CD-ROM titles, and related research—is done to help readers better understand the research instrument design, the purpose of this research, and the significance of the research.

**Cognitive Learning Theories**

**Constructivism**

Constructivism as a theory has as its central idea the view that knowledge is principally constructed by the individual learner and not passively received. Glaserfeld (1996) states that what sets constructivism apart from other learning theories, such as behaviorism and maturationism, is Piaget's genetic epistemology. In Piaget's view (as cited in Glaserfeld, 1996), knowledge is not "a copy of the reality" to be discovered but is invented (p. 4). Knowledge is "a mapping of actions and conceptual operations that have proven viable in the knowing subject's experience" (p. 4). For Piaget, knowledge "arises from actions and the agent's reflection on them" (p. 4). "The growth of knowledge is a progressive construction of logically embedded structures superseding one another by a process of inclusion of lower less powerful logical means into higher and more powerful ones up to adulthood" (The Archive of Jean Piaget, [on-line]). In other words, in the constructivist view, there is no ultimate truth but rather a constructed reality. Knowledge is not a collection of facts. It develops "through the actions we carry out upon our perceptions, ... It is not only our knowledge of the world, but even more important,
mastery of these operations, that must be constructed in the course of cognitive growth” (Gruber & Voneche, 1982, p. xxi).

Piaget’s constructivist views influenced the cognitive revolution arising in the mid-1950s along with Vygotskian psychological theories. In what follows, I first discuss the theories of Jean Piaget followed by Lev Vygotsky. Then I discuss Jerome Bruner and Howard Gardner’s theories, which supplemented Piaget’s theories of developmental stages.

Jean Piaget. Piaget (1896-1980), the famous Swiss child psychologist, has had a strong impact on modern psychology. His research spans over fifty years but it is mainly the later works of the last ten to fifteen years of his life that are considered by scholars as contributions to constructivism (Fosnot, 1996). Piaget’s early studies, based on naturalistic research, suggested that there are four developmental stages in children’s intellectual growth: (1) sensorimotor stage (age 0 to 2): The development of this stage takes the form of motor actions; (2) preoperations stage (age 3 to 7): The development of this stage is characterized by the development of more concrete thinking skill such as language; (3) concrete operations stage (age 8 to 11): Children develop logical thinking with dependence upon concrete references; and (4) formal operations stage (age 12 to 15): Children develop abstract thinking ability (Efland, in press; Kearsley, 1994).

Piaget believed that individuals develop cognitive structures or schema with which they respond to stimuli with relative consistency or predictability (Efland, in press). A schema, as Richard Anderson defined it, is “an abstract structure of information. It is abstract in the sense that it summarizes information about many different cases. A schema is structured in the sense that it represents the relationships
among components” (Anderson as cited in Efland, in press, p. 35). Cognitive structures or schemata change throughout the life of an individual and through the processes of equilibration, a concept derived from biological observation; the development of cognitive structures indicates the individual’s growth process (Fosnot, 1996).

Equilibration is “a dynamic process of self-regulated behavior balancing two intrinsic polar behaviors, assimilation and accommodation” (Fosnot, 1996, p. 13). Assimilation is “the cognitive process by which the person integrates new perceptual matter or stimulus events into existing schemata or patterns of behavior” (Wadsworth as cited in Efland, in press, p. 36) or in short, “the organization of experience with one’s own logical structures or understandings” (Fosnot, 1996, p. 13). On the other hand, accommodation is “comprised of reflective, integrative behavior that serves to change one’s own self and explicate the object in order for us to function with cognitive equilibrium in relation to it” (Fosnot, 1996, p. 13) or in other words, “the creation of new schemata or the modification of old schemata” (Wadsworth in Efland, in press, p. 37). In the process of equilibration, it is the contradictions which cause learners to search for accommodations. According to Piaget, when learners encounter contradictions, their ways of accommodation may fall into one of the three types:

(1) They might ignore the contradictions and persevere with their initial scheme or idea; (2) they might waver, holding both theories simultaneously and dealing with the contradiction by making each theory hold for separate, specific cases; or (3) they might construct a new, more encompassing notion that explains and resolves the prior contradiction. (Fosnot, 1996, p. 16)
Further, equilibration is not “a sequential process of assimilation, then conflict, and then accommodation” (Fosnot, 1996, p. 14) but is a dynamic process of continual “equilibrium, adaptation and organization, growth and change” (Fosnot, 1996, p. 14).

American educational philosopher, John Dewey (1859–1952), exhibited constructivist thinking in his educational philosophy. Piaget’s view of contradiction in the process of equilibration is in part similar to Dewey’s view of reflective thinking. Reflective thinking occurs when a person is in a state of doubt or uncertainty and then she or he willfully takes actions to resolve it (Szuberla, 1997). Kohl states, “ultimately, we would like to be able to create the conditions that will give rise to reflective thought” (Kohl as cited in Szuberla, 1997, [on-line])

Piaget’s equilibration and Dewey’s reflective thinking are relevant to this study in that the multimedia program was designed to evoke students to question and should create opportunities for them to find and apply solutions to their questions. The research instrument, the Chinese Dragons CD-ROM, was developed to do that. When asked to write an article about Chinese dragons students started asking themselves what Chinese dragons represented. The program engages students in active exploration to search and construct answers to that question.

In the same vein, Szuberla (1997) states “the product of learning is thinking”. If we can know how children think in the process of the program interaction we will have a better sense of how to improve the program design. For that purpose, the program was built in a way to track student interactions by saving versions of students’ notes and articles. Thinking is complex and is in a state of constant flux and change, although not
all of the thought process is, or can be, recorded. These built-in functions provide snapshots of the students' thinking/learning process.

In general, Piaget's theories have many implications for teaching and curriculum design, that are relevant to this study. Piaget's developmental stages serve as a general guide, not a strict rule, to devise suitable content, interactivities and design for target users, middle school level students (sixth to ninth graders). His notion of equilibration (assimilation and accommodation) and cognitive structure, functioning in continuous knowledge construction, influenced not only the design of the research instrument but also the way I analyzed the process and result of the students' knowledge construction.

_Lev Vygotsky._ Vygotsky (1896-1933), a Russian psychologist, suggests that cognitive development is dependent on social interaction. Scholars often contrast the theories of Vygotsky with Piaget's. Piaget placed the mind within an individual and believed that cognitive development is the result of the continual internal process of assimilation and accommodation. On the other hand, Vygotsky noted that the mind goes beyond the boundary of an individual, that "understanding is social in origin" (Cole and Wertch, 1996, [on-line]). He believed the relationship between the individual and the social context is dynamic instead of a simple dual division (Cole and Wertch, 1996). Further, in Vygotsky's view, the developmental level is what an individual can achieve independently while the potential level is what an individual can reach with the assistance of able adults. The zone of proximal development (ZPD) is the distance between an individual's developmental stage and his or her potential level.

Cole and Wertch (1996) suggest that "the importance of culture, in particular, the role of mediation of action through artifacts, on the development of mind" ([on-line]) is
central to Vygotsky's theory. In the same vein, Lock (1998) explains that “within Vygotsky's conceptualization of human psychology, a basic notion is that of mediation... Humans in their history have invented cultural tools, both material and psychological, that constitute a 'cognitive technology' whereby we have restructured our abilities and reconfigured our 'nature' ([on-line]). In short, Vygotsky believed artifacts or tools transform our mental processing in fundamental ways. He stated:

The inclusion of a tool in the process of behavior (a) introduces several new functions connected with the use of the given tool and with its control; (b) abolishes and makes unnecessary several natural processes, whose work is accomplished by the tool; and alters the course and individual features (the intensity, duration, sequence, etc.) of all the mental processes that enter into the composition of the instrumental act, replacing some functions with others (i.e., it re-creates and reorganizes the whole structure of behavior just as a technical tool re-creates the whole structure of labor operations) (Vygotsky as cited in Cole & Wertch, 1996, [on-line]).

Clearly, Vygotsky says to us: Any tools, artifacts, or technology, which we utilize do not simply facilitate our mental processes; they fundamentally shape and transform our experience, reconfigure our human ability and nature of us as human beings (Cole and Wertch, 1996; Lock, 1998).

Vygotsky’s theories are also relevant to this study. For example, the ZPD implies the importance of able adults' assistance in helping individuals to reach their potential level. In this study, “the adults’ assistance” took the form of verbal prompts or feedback from a virtual agent or the researcher. In the multimedia program, the culture editor provided students with prompts after they finished each artwork exploration and before they wrote their articles about Chinese Dragons. In addition, after I seated each student at a computer in his or her third session, I gave the student feedback on his or her article.
Vygotsky's view of culture mediation points out the prominent role of a medium—in this study, multimedia computing—in shaping and transforming the learning experience of students.

*Jerome Bruner.* Bruner, an American psychologist, who was actively involved in math and social science curriculum reform in the 1960s, introduced Piaget's concept of developmental stages, as a factor in curriculum development. He believed that "the main difference in the stages of learning was in the forms of representation available to the learner for use in constructing knowledge" (Efland, in press, p. 88). Learning is an active process and involves construction and manipulation of symbols. Intellectual growth is characterized in increasing competence in symbolic abstraction. Bruner advocates "any subject can be taught effectively in some intellectually honest form to any child at any stage of development" (Bruner as cited in Efland, in press, p. 87). He proposes a spiral curricular model in which key concepts of each discipline are identified and introduced to children several times in the curriculum with the use of increasingly abstract symbols. No discipline is too complex for children to learn. The key to learning any knowledge domain is curriculum sequencing. An early foundation prepares a students' readiness for subsequent learning. Students are encouraged to discover principles by themselves. In discovery, students gain new insights and increase problem solving ability by engaging in selecting and transforming information, decision making, and building hypotheses based on their cognitive structures (Kearsley, 1994; Marlowe & Page, 1998).

This study adopts Bruner's concept of learning by discovery but sees his spiral curriculum model problematic for the organization of a history domain (see the discussion of the cognitive flexibility theory section).
Howard Gardner. Gardner, who is noted for his theories of multiple intelligences (MI), found a problem in Piaget's developmental stages, namely that they cannot explain why a person demonstrates different intellectual competences in different domains (Efland, in press). To get around this problem, Gardner proposed the theory of multiple intelligences. In his view, there are seven distinct forms of symbolic competence (intelligence). They are linguistic, musical, logical-mathematical, spatial, body-kinesthetic, intrapersonal (e.g., insight, metacognition) and interpersonal (e.g., social skills) (Efland, in press; Kearsley, 1994). Each individual possesses these seven intelligences in varying degrees. For example, a person may write very well and excel in sports but have poor logical or mathematical ability. The MI theory helps explain why an individual can operate at different developmental stages in different knowledge domains.

Gardner’s MI theory speaks to this study because individuals have their preferred intelligence as well as learning modalities. Instruction and assessment of learning need to be presented in ways that support persons with multiple forms of intelligence. In this study, the forms are visual, linguistic, and logical.

To summarize, constructivism implies that there is no objective reality that can be fully known; we construct representations of reality which become increasingly reliable through processes like assimilation and accommodation. At the same time we are being transformed by our own constructs of reality. Glaserfeld (1996) put constructivism in simple terms: “Learning is a constructive activity that the students themselves have to carry out” (p. 7) and teachers do not dispense knowledge but “provide students with opportunities and incentives to build it up” (p. 7). Fosnot (1996) concludes that general learning principles of constructivism as follows:
• Learning is not the result of development; learning is development. It requires invention and self-organization on the part of the learner. Thus teachers need to allow learners to raise their own questions, generate their own hypotheses and models as possibilities, and test them for viability.
• Disequilibrium facilitates learning. "Errors" need to be perceived as a result of learners' conceptions and therefore not minimized or avoided. Challenging, open-ended investigations in realistic, meaningful contexts need to be offered, thus allowing learners to explore and generate many possibilities, both affirming and contradictory. Contradictions, in particular, need to be illuminated, explored, and discussed.
• Reflective abstraction is the driving force of learning. As meaning-makers, humans seek to organize and generalize across experiences in a representational form. Allowing reflection time through journal writing, representation in multisymbolic form, and/or discussion of connections across experiences or strategies may facilitate reflective abstraction.
• Dialogue within a community engenders further thinking. The classroom needs to be seen as a "community of discourse engaged in activity, reflection, and conversation. The learners (rather than the teacher) are responsible for defending, proving, justifying, and communicating their ideas to the classroom community. Ideas are accepted as truth only insofar as they make sense to the community and thus rise to the level of "taken-as-shared."
• Learning proceeds toward the development of structures. As learners struggle to make meaning, progressive structural shifts in perspective are constructed-in a sense, "big ideas" (Schifter & Fosnot as cited in Fosnot, 1996, p. 30). These "big ideas" are learner-constructed, central organizing principles that can be generalized across experiences and that often require the undoing or reorganizing of earlier conceptions. This process continues throughout development. (Fosnot, 1996, pp. 29-30)

**Situated Learning**

Situated learning asserts “thinking and learning as the process of enculturation and dependent for their proper functioning on the immediate situation of action” (Brown as cited in Bredo, 1997, p. 31). Brown, Collins, and Duguid (1989) state “knowledge is situated, being in part a product of the activity, context, and culture in which it is developed and used” (as cited in Efland, in press, p. 103). Brown et al. advocate
cognitive apprenticeship, that is, to learn in authentic practices and place content in context. Learning and context are bonded together very closely. As Wertch (1991) put it, "[a]ction is mediated and cannot be separated from the milieu in which it is carried out" (as cited in Nicholl, 1998).

Situated learning has its roots in Vygotsky's thoughts about the social development of the mind or higher mental functions, which occurs through social interaction (Bredo, 1997). Social interaction has a fundamental role in cognitive development. Vygotsky stated, "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)" (as cited in Kearsley, 1994, [on-line]). For example, the meaning of crying to an infant was first learned in the context with an adult-child interaction and then became internalized as a means of expression. Social context in which the interaction takes place is critical to learning.

Jean Lave. Scholars often associate anthropologist Jean Lave with situated learning. Lave and Wenger (1991) develop their situated learning theory, characterized as legitimate peripheral participation in communities of practice through the metaphorical concept of apprenticeship. In apprenticeship, learners, from the beginning, participate with others in peripheral tasks and at the later stage, move to central tasks, all in the context of actual production (not isolated from actual production). Learning in apprenticeship is not located within an individual but is placed in a wider social context, because "it involves changes in activity in an environment coconstructed with others" (Bredo, 1997, p. 37). In the sense of situated learning, the everyday social practices or
tasks that we perform and participate in are learning themselves, and knowledge and
skills should be learned through social interaction and in everyday practice.

Lave and Wenger’s idea of situated learning goes beyond the concept of learning
in context or learning by doing. It emphasizes that “learning is an integral and
inseparable aspect of social practice” (Lave and Wenger, 1991, p. 31). Situated learning
posits to this study that creating a (virtual) environment that is conducive for social
participation and interaction is the key to learning. To connect with this study, the
definition of social participation and interaction is augmented to have a broader meaning
than what is implied by Lave and Wenger. In other words, the members of participation
are extended to include virtual agents, not limited to human participants, and similarly,
forms of interaction also include virtual tasks, not limited to real life production.

**Cognitive Flexibility Theory**

Spiro & Jehng (1991) state that cognitive flexibility is “the ability to
spontaneously restructure one’s knowledge, in many ways, in adaptive response to
radically changing situational demands... This is a function of both the way knowledge is
represented (e.g. along multiple rather single conceptual dimensions) and the processes
that operate on those mental representations (e.g., processes of schema assembly rather
than intact schema retrieval)” (as cited in Kearsley, 1994, [on-line]). This theory focuses
on learning in complex and ill-structured domains\(^1\), such as medicine, biology, and
history and knowledge transfer issues beyond the initial learning setting. Spiro, Vispoel,

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\(^1\) Spiro et al. (1987) suggests that there are two types of knowledge: well-structured, such as math and
physics and ill-structured, such as biomedicine. In well-structured knowledge “laws, axioms, and theorems
link together to form deductive explanation of given phenomena. Individual cases or examples which
illustrate that phenomenon are likely to be uniform with predictability and consistency across cases. (On
Schmitz, Samarpungavan, and Boerger (1987) observed that many medical students were unable to transfer knowledge to various contexts, resulting in misdiagnosis; the development of medical students’ systematic misunderstandings were largely due to medical knowledge being mis-represented in teaching (as cited in Efland, in press). The solution to these problems is to present knowledge “from multiple perspectives and (make) use of many case studies that present diverse examples” (Kearsley, 1994, [online]). In addition, cognitive flexibility theory also stresses that knowledge is context-dependent and that students need to be given opportunities to construct their own knowledge representations. Spiro et al. (1988) suggest that because of its interconnected nature, hypermedia has the potential to support case representation with multiple perspectives and connections among cases (as cited in Efland, in press). What follows are the four principles of the cognitive flexibility theory concluded by Kearsley (1994)

1. Learning activities must provide multiple representations of content.
2. Instructional materials should avoid oversimplifying the content domain and support context-dependent knowledge.
3. Instruction should be case-based and [should] emphasize knowledge construction, not transmission of information.
4. Knowledge sources should be highly interconnected rather than compartmentalized ([online]).

Cognitive flexibility theory was inspirational to this study, especially to the knowledge representation in the multimedia program. In the program, Chinese history and culture were represented through three cases with connections among them—three artworks with Chinese dragons motifs. In the following two sections, I discuss the inspiration from the cognitive flexibility theory in more detail.

the other hand, ill-structured knowledge required attention paid to) the particular details of individual cases rather than to knowledge in the abstract” (as cited in Efland, 1995, p. 143).
Lattice Model for Cognitive Flexibility Theory

When I conceived the research instrument I was searching for an appropriate presentation of Chinese history and culture as well as a constructivist approach to learning. I found the knowledge representation of the early cognitive theory (in 1960s)—the spiral model by Jerome Bruner—not satisfactory. On the other hand, the cognitive flexibility theory posited a feasible and promising alternative. As discussed earlier, the spiral model arranges knowledge by hierarchy—starting from simple concepts with concrete examples and moves gradually toward more complex ones that require abstraction; early learning is the foundation for later learning. Bruner believes that the spiral structure can be applied across all disciplines. However, educators like Spiro et al. (1988) and Efland (1995) disagree with Bruner. They argue that although well-structured domains such as physics can be represented by the top-down hierarchical spiral model, ill structured domains such as biomedicine, art, and humanities can not be adequately represented by the spiral model.

Instead the proponents of the cognitive flexibility theory propose a lattice-like structure (see Figure 1) to represent knowledge in a web-like relationship. They argue that oversimplified analogies used in early learning can cause misunderstandings which will impair later advanced knowledge learning. The materials of an ill-structured domain should be presented in their complexity but not so as to overwhelm students all at once. Spiro et al. suggest that multiple representations of the materials should be used as the solution--“a clear picture of the criss-crossed patterning of a lattice, where concepts are . . . revisited (as cited in Efland, 1995, p. 146).” Efland (1995) concurs with Spiro et al. and
calls for the lattice\(^2\) as the curriculum representation of the arts and humanities domains. A representation, used in this way, could mean different things in teaching different subjects or topics. It could mean a "schema, organizational logic, line of argument, prototype, analogy, etc." (Spiro et al., 1988, p. 5). In teaching Chinese history and culture through art, an artwork, which reveals a certain perspective, is a representation; diverse examples of artworks mean multiple representations because these artworks can reveal different historical and cultural contexts, symbolisms, functions, styles, and mediums, and so forth. Based on the lattice model, I developed the third prototype of the research instrument (details of the prototype development are discussed in Chapter 3: Methodology).

**The Hub Network**

The third prototype, based on the lattice model, was close to my satisfaction, but it still needed further revision because of its unconstrained complexity. Efland proposes the city metaphor to improve on the lattice model. In theory, the lattice model for structuring an ill-structured domain appears to be very attractive; however, in practice, the lattice model is difficult to be literally translated into practice because of its complexity. Efland (1998) is well aware of the weaknesses posed by the lattice structure. He points out three of its weaknesses as: too complex, too many choices, and lack of constraint. To remedy these weaknesses, Efland proposes a city metaphor that improves on the lattice. In the city metaphor, there are discrete zoning areas, such as commercial, residential, historical and entertainment areas, and there are areas overlapping differing zones, such as an area for both commercial and historical purposes. The overlapping zones serve as bridges to

\(^2\) Alexander uses the term, "semi-lattice," as a metaphor to illuminate natural (unplanned) city structure.
connect and expand neighborhoods. In Efland’s city metaphor, the expansion of a neighborhood means the expanding of a person’s life knowledge.

I came up with a hub network model as a metaphor for the organizational structure for my research instrument. The hub metaphor shares some of the same connecting features as the lattice but can control the undesirable complexity of the lattice. In addition, it is tailored to meet the specific needs of the multimedia organization of this study.

The hub metaphor was inspired by the hub systems of airlines. Let us look at airline hubs first. Figure 2 is a 1996 Northwest Airline route map for its United States/Canada/Mexico service. To reach every place in these service areas, Northwest strategically chooses large cities as their hubs, such as Boston, Detroit, Memphis, Minneapolis/St. Paul, Seattle, and Portland. Hub cities, selected by the airline, are the transfer and connecting points to other cities. From each hub, people can be connected to other cities. For a person taking Northwest Airline to travel from a non-hub city like Columbus, Ohio, to another non-hub city like New York, the person will first fly to a hub city like Detroit or Minneapolis/St Paul, and then transfer to New York. Although flying to New York through Detroit would be a shorter distance route in this case, a traveler can travel to New York through either city.

Different airlines choose different cities as their hubs; in turn, the connecting/transferring service routes of individual airlines are different. All large cities have the potential to be chosen as a hub. For example, Columbus, Ohio is not a hub city of the Northwest Airline but is a hub city of the AmericaWest Airline. For a person taking AmericaWest Airline to travel from Columbus, Ohio to New York, the person can
just take a direct flight. The combination of hub cities and their resulting transferring/connecting routes of all airlines present travelers with multiple route choices to travel from one place to another.

How does the hub metaphor work as an organizational model for the multimedia in this study? The hub metaphor is similar to an airline hub but with some variation. In the hub metaphor, there are two types of hubs, i.e. artwork hub and context hub. The multimedia is about teaching history and culture through art. Artworks are the tangible things a learner has to “face”. From artworks, a learner is connected to the contextual information associated with the artworks. A teacher like an airline company can choose artworks for a lesson or lesson unit. The artworks are like the hub cities in the airline case. In this study, a hub formed by an artwork is called an artwork hub. Hub cities connect travelers to places, whereas artwork hubs connect learners to different sources of contextual information, i.e. time, function, style, symbolism, etc.

In addition, a specific source of contextual information, such as the symbol of perseverance, may be contained in many different artworks. Therefore, a source of contextual information can also be a hub; from the contextual source learners can be connected to different artworks. In this study, this kind of hub is called a context hub. For example, in Figure 3, Artwork Hub A enables learners to be connected to different Context Hubs, like 1, 2, 3, 4, and 5; whereas Context Hub 5 enables learners to reach Artwork Hubs A, B, C, and F.

Artwork hubs and context hubs together form a hub network. Learners may make different learning routes of travel based on their choice. The learner may start his or her learning from an artwork hub and connect through a context hub and end up making a
transfer on another artwork hub (i.e. applying knowledge learned from one artwork onto another one). The same can be done by starting from a context hub to make a transfer. The hub network implication to teachers would be that teachers can base their lesson or lesson unit on either artworks or contexts as long as artworks and contexts are eventually interconnected together like a network.

The hub network like the lattice model can better represent the complexity of an ill-structured domain such as the art or the humanities as well as offer “connecting points” for knowledge transfer. As many art educators have suggested, knowledge transfer occurs when there are common elements existing between two learning contexts. The more “connecting points” (common elements) the more likely the knowledge transfer will occur (Efland, 1995; Koroscik, 1992; Parsons, 1990). The hubs in a hub network represent the “connecting points” which learners revisit many times throughout their multi-directional intellectual traversals that, consequently, lead to the gradual comprehension of a complex domain or concept over time. The hubs provide common elements for facilitating knowledge transfer.

Review of Multimedia CD-ROM Titles

Multimedia CD-ROM publishing has been thriving since Sony and Philips initiated CD-ROM technology in 1985. According to Tony Feldman (1997), a leading digital media expert in Europe, in 1986, there were only 50 commercial CD-ROM titles available worldwide. Between 1986 to 1994, the number of CD-ROM titles published has rapidly increased. By the end of 1994, there were about 8,000 titles produced.
There is a gap between the number of CD-ROM published and the number of CD-ROM reviewed. For example, there were 8000 CD-ROM titles published by the end of 1994 but only 800 out the 8000 titles were reviewed in Media Review Digest (MRD), a reference guide for reviews of non-print media publications. Due to shelf space, there is even a greater gap between the number of CD-ROMs published and the number that actually makes it to the store. “In the United States, where the market is the most advanced, even the most committed CD-ROM retailers are stocking only 300-400 titles and, from retailer to retailer, they tend to be the same 300-400 titles (Feldman, 1997, p. 59)”. Feldman’s observation was borne out by my experience. I tried to purchase CD-ROM titles relevant to my study and shopped from store to store. Almost all stores carried more or less the same titles, which were targeted at the home entertainment market. Most of the titles that I needed could not be found at local stores. Instead, I had to purchase them from the producer or educational software distributors.

With the great number of CD-ROMs published each year, it seemed to be reasonable to assume that one could find a CD-ROM about any subject under the sun. I searched around and found very few titles about teaching Chinese history and culture manifested in art. To review CD-ROMs relevant to my study, first I needed to search for them. I looked at different review sources of CD-ROMs on the World Wide Web, software review guidebooks, journals, and software distributor catalogues. Content relevancy and or receiving good reviews from multiple sources were my focal concerns when looking for titles to review. The following criteria were set for the search. The CD-ROM needed to meet one of them.

- The CD-ROM title is about teaching Chinese history, culture, or art.
- The CD-ROM title is intended to teach history and culture through art.
- The CD-ROM title is about teaching history and culture other than Chinese with good reviews.

After reading reviews from different sources, I selected thirteen titles for further reviewing. The titles that met the first criterion were: *Silk Road, History and Culture of China, China: Home of the Dragon, First Emperor of China, China! The Grand Tour Including Tibet, Fine Arts of China, and Splendors of Imperial China*. The titles that met the second criterion were: *Early American History through Art* and other titles in the *History through Art* series. The titles that met the third criterion were: *The Oregon Trail: Pioneer Adventures (3rd Edition), Africa Trail, Castle Explorer, My First Amazing History Explorer*, and *Where in Time is Carmen Sandiego?* Although there were more titles that would meet the third criterion, my budget limited me to these titles.

To draw my own conclusions about these titles, I interacted with the CD-ROMs and read reviews about them. In addition, I also observed three children interacting with some of the titles and asked them about their experience with these CD-ROMs after their interactions. Please see Appendix B for an example of the description of a CD-ROM title, published reviews, and the three children’s reviews about the title.

The purpose of reviewing these titles was to learn what principles they used that would be useful to consider in my research instrument development. In the following, I will present analyses of these titles in searching criteria groups (see page 34-35). My analyses focus on the approach, information organization, interface, and pros and cons of the CD-ROMs.
(1) Criteria One Titles: The titles in this group were *Silk Road, History and Culture of China, China: Home of the Dragon, First Emperor of China, China! The Grand Tour Including Tibet, Fine Arts of China, and Splendors of Imperial China*. They were titles that teach Chinese history, culture or art. Without exception, all these titles were produced in a similar approach, which I called a “reference or database” approach. These titles organized their content into topics and each topic was further divided into sub-topics. In addition, I usually found reference tools, like an index or glossary in these titles. The structure of these titles was hierarchical and their interface/navigation was straightforward—from main menu to a topic and from each topic to a sub-topic. These CD-ROMs were the digital version of reference books, which contain rich bodies of information. Their advantages over a conventional reference book were few except that the information was presented in an interactive multimedia form.

*Silk Road* (see Figure 4) was an outstanding title in this group. It contained excellent graphics, photos, sounds, music, narration, maps, slide shows, simulation games and tests. Best of all, the rich information was backed up by rigorous research and scholarship. My criticism of this title is that its assessment was flawed. The assessment (University of Dunhuang) was an independent section from the five main topics: religion, people, explorer, language, and history. Most CD-ROM users usually enjoyed the challenge of taking CD-ROM tests to try out their newly acquired knowledge. However, it was not so in this case. This title was labeled for users sixth grade and up. I observed a ninth grader interact with the CD-ROM. She felt inferior and intimidated by the test. The reason was that the information presented in each topic was very rich and the array of multiple choice questions generated was quite large. Although the user could take the
exam as many times as he or she wanted, the questions might be different each time (questions were randomly selected from an array). The ninth grader recognized the rich information and educational purpose of this title. However, she thought the value of this title was degraded by the intimidating test and lack of fun. The producer intended this CD-ROM to be regarded as an ultimate knowledge provider on the subject of the Silk Road. The assessment and knowledge aspect of the CD-ROM were separated, not integrated. The tests assessed the user’s ability to recall pieces of “facts” but did not assess whether the user can apply or transfer the knowledge across contexts.

(2) Criteria Two Titles: The titles in this group were *Early American History through Art* (see Figure 5) and other titles in the *History through Art* series. These titles were designated to teach history and culture through art. The *History through Art* series included the following titles: *Early American History through Art, Ancient Greece, Ancient Rome, The Middle Ages, The Renaissance, The Baroque, The Enlightenment, Romanticism, and The Pre-Modern Era.* All these titles shared an identical approach and interface/navigation format. The interface/navigation of these titles was like the controls on a VCR—play, forward, reverse, and stop—but with additional controls to access reference tools. I called the approach used in this title series a lecture and slide presentation approach. It was similar to the conventional art history lecture approach seen in the classroom across the United States, (i.e. an art history professor lectures using a slide presentation). After starting the CD-ROM the user can just sit back and listen to the lecture. In a classroom, at an appropriate point, a student can interrupt the lecture and ask the professor to explain a term or reiterate lecture content. In the same vein, during the interaction, the user can interrupt the lecture and slide presentation and look up some
terms in the CD-ROM reference tools—glossary, encyclopedia index, dictionary, or reverse or forward to desired lecture and slide presentation. In addition, at any point, the user can choose to take a quiz. This approach was linear. The topics presented, such as origin, material, style, and artist, were in a pre-defined order though the user could choose to go to a topic through the index function.

The titles of the *History through Art* series were the digital version of an art history lecture. Students could “receive” important information built in the CD-ROM, which the producers considered important. The advantages of these titles over a conventional lecture were few except that information was more accessible—a professor at your disposal. Similar to the problems of the *Silk Road* in the previous criterion group, the CD-ROMs of this criterion group were not constructivist but played the role of knowledge dispenser. They assessed students’ memorizing ability but did not give students opportunities to construct their own knowledge.

(3) Criteria Three Titles: The titles in this group were *The Oregon Trail: Pioneer Adventures (3rd Edition)*, *Africa Trail*, *Castle Explorer*, *My First Amazing History Explorer*, and *Where in Time is Carmen Sandiego*?. These titles were about teaching history and culture other than Chinese and have received good reviews. The approach taken by these titles were similar, and I call it a role playing game approach. These titles asked the user to assume a character in the title and carry out a mission or journey.

*Africa Trail* and *The Oregon Trail: Pioneer Adventures (3rd Edition)* (see Figure 6, 7) used a travel metaphor. Pieces of history and culture were “planted” along the trail. Depending on the take-off day, the events and people the user encountered would vary. Like in real travel, on the way to the destination, the user stopped to ask for directions,
purchase supplies, rest, and chat with other people. By doing what one was supposed to
do on a journey, the user absorbed pieces of history and culture. The information
structure of the trail metaphor was web-like and nonlinear. The interface/navigation of
these two titles was intuitive because it simulated a real journey. For example, the user
clicked on people to talk to people, clicked on a shotgun to go hunting, or clicked on a
wagon wheel to hit the road. Both young and old users had fun with this way of learning
history and culture. But, watch out! Users are warned by Bill Bigelow (1997) to exercise
their critical computer literacy and be aware of the hidden biases (in this case, sexism,
racism, and cultural insensitiveness) behind the pieces of history and culture planted by
the producer.

Castle Explorer (see Figure 8) used a space metaphor. Pieces of history and
culture were revealed through people and things located within a cross-section of space.
Depending on which cross-section of the castle one visited, the events and life of people
the user witnessed would vary. The interactive experience of this CD-ROM was like
touring a historical village, that is, the user moved from place to place, observed, asked
questions of people from different walks of life; and participated in hands-on activities.
By being attentive, curious and participatory, the user gained insights about history and
culture in its virtual spatial context. The spatial structure of the castle provided a
framework for information networking. The information structure of the space metaphor
was also web-like and nonlinear. The interface/navigation of this type of structure was
also intuitive because it created a spatial experience similar to real life. The different
arrow cursors were used to indicate the direction of the user’s movement.

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My First Amazing History Explorer and Where in Time is Carmen Sandiego?

used both temporal and space metaphors. However, the time and space were artificial. Through the time tunnel or machine, the user could travel back to different cultures in time. In My First Amazing History Explorer (see Figure 9), the history of a culture was collapsed into one plane; cultural information pieces resided on spots within a “space.” When entering a culture’s space, the user clicked on different spots (represented by icons) to learn pieces of cultural information. Although it was easy to navigate on the flat space, this interface sends the wrong message to a user. It seems to tell the user that all of the cultural pieces occurred at the same time in history because they are all on the same two-dimensional space. But, did they? I thought that this title could be criticized for stereotyping cultures and causing a misconception of time.

In Where in Time is Carmen Sandiego? (see Figure 10) the pieces of history of different civilizations to be visited were arranged in the following order:

Queen Hatshepsut in Egypt (1490 B.C.E.), Julius Caesar in Rome (50 B.C.E.), Vikings in Vinland (1002 C.E.), Murasaki in Japan (1015), William the Conqueror in Feudal England (1086), Khan in Mongol China (1271), Musa and the Mali Empire (1324, Gutenberg in Germany (1454), Inca Empire (1466), Columbus and the New World (1493), da Vinci and the Renaissance (1505), ztec Empire (1519), Shakespeare in Elizabethan England (1599), Thirteen American Colonies (1776), Lewis & Clark in the Pacific Northwest (1805), Beethoven in Vienna (1808), Edison in the Industrial Era (1879), Yuri Gagarin & the Space Race (1961) and the Final Chase (present day) (Velgos, 1998).

Although the pieces of history from different civilizations were arranged according to correct chronological order, the chronological order may mislead the user to think this order was also the birth order of different civilizations, especially when a user was not knowledgeable about these civilizations. For example, since the user visits
China after Egypt, Rome, Japan, and England, the user might think the Chinese civilization was born after all these civilizations. However, the dialoguing interface and explorative activities within each culture were innovative and had worthwhile techniques to study.

The reasons why Criteria Three titles received good reviews were because they not only contained rich information but also challenged the user's problem solving and or knowledge application. Best of all, they were fun.

It was informative and educational to review CD-ROMs and their literature, especially the Criteria Three titles. It was clear to me that a good title for teaching Chinese history and culture had not yet been developed. I hoped to borrow the multimedia experiences of others to nurture the production of my research instrument so that users would have fun while learning about Chinese history and culture.

**Related Research—the Use of Interactive Multimedia in Learning**

In this section, I discuss the use of interactive multimedia in teaching and learning. Multimedia is used for teaching and learning in many subjects such as social work, writing, history, nursing, art, and science. There are two approaches to the educational use of multimedia. One approach uses multimedia as a knowledge construction tool and the other approach uses a pre-designed interactive multimedia program for learning and teaching. As many educators such as Jonassen, Peck, and Wilson (1999) suggest, using multimedia to construct reality involves students in meaningful learning because students play the active role of knowledge producers and engage in real world problem solving such as creating an information kiosk for a
museum. Based on my teaching experience, I concur with Jonassen et al. and believe in the power of using multimedia as a knowledge construction tool. However, this study investigates the effects of a particular multimedia program, the Chinese Dragons CD-ROM, on the users' interactive experience and knowledge construction and it falls into the second approach to the educational use of multimedia mentioned above. Therefore, the discussion of related research in this section is about the research using a pre-designed interactive multimedia program for learning and teaching.

Within this second approach to the use of multimedia for teaching and learning, there are different foci of study. Some studies focus on the effects of multi-sensory delivery. For example, Barbara Ottaviani (1994) studied the effects of multimedia presentation formats on the recall of a narrative. A story was presented to 64 middle school students in one of four media formats: "(a) talking head, (b) voice-under-text, (c) voice-under-video, and (d) multiformat (combination of talking head, voice-under-video, and text)" (p.3). Ottaviani found that students remembered more details of a story that was presented primarily in visual formats, i.e. multiformat and voice-under-voice styles because visuals "seemed to enhance cue recognition for information processing and retrieval" (p. 6). Ottaviani concluded that information recall is strongly influenced by the format of presentation.

There is research that has studied the effectiveness of multimedia as a knowledge provider. For example, Thurston, Cauble, and Dinkel (1998) at the Kansas State University, collaborated with other programs in the University to develop an instructional multimedia program, "Building Family Foundations", which provides rural social worker training in child welfare practice. The result of their study demonstrated that use of
instructional multimedia increased students’ knowledge in the subject areas studied. In
the same vein, David Yearwood (1999) compared the effectiveness of teaching
networked computer operations through multimedia interaction and the conventional
lecture method. He concluded that learning through the multimedia interaction was as
effective as traditional teaching methods “while eliminating the variability of teacher
knowledge and experience” (p. x).

One of the strengths of multimedia is interactivity. There are different degrees of
interactivity through different organizational pathways. As Keifer-Boyd (1996) suggest
there are five different hypermedia pathways for organizing and connecting information,
i.e. “a linear pathway with one option, a linear pathway with multiple options, a
hierarchical pathway, hierarchical associative pathways and non-linear multi-
option/multidirectional linked pathways” (p. 29) (see Figure 11). On the interactivity
scale, “a linear pathway with one option” is at the low end of interactivity level and “non-
linear multi-option/multidirectional linked pathways” are at the high end of interactivity
level. The other pathways are in between these two ends.

Derek Reamon (1999) studied the impact of interactivity level on learning.
Students in his control group learned the fundamentals of “direct-current motor physics
and selection” with a low level interactivity version of the “Motor Workshop”
multimedia program, i.e. materials of the program was organized by topic—students read
text and watch video. On the other hand, students in the experimental group studied the
same material with a high level interactivity version of the “Motor Workshop” program.
In this version, students were required to design a motor driven virtual vehicle with help
from the advice of virtual experts and other contextual information in the program. The
study results showed that the two versions of the multimedia program were effective in different types of learning. The low-level interactivity version was more effective in learning concepts and terminology whereas the high-level interactivity version was more effective for learning the application of engineering knowledge.

There is also research about the use of multimedia that has focused on whether the use of a multimedia program could result in higher order understanding. Larry Gleeson (1996) at the University of North Texas, with assistance from other faculty members and graduate students, produced an interactive multimedia program for a Western art history survey course. The use of the interactive multimedia program was to replace the slide study in the art history survey course. In the main menu of the multimedia program, there was a table of content that included an introduction, a list of cultures or periods and an exit button. The distinct feature of this program was the "nine topics buttons" that appeared on the top of each artwork. The nine topics were: *catalog* (caption of an artwork), *time, place, style, content, medium, patron, use, and other art then* (other art of that time). These nine topics were intended to provide students with a framework to study the art objects in the program and to apply to the learning of other artworks beyond the course.

Students were evaluated with two formats of examination: one was a machine scored test and the other was a written essay about an unknown artwork from the period studied. Although the test score of the students who used the interactive multimedia program to study was not significantly higher than those who studied with slides, students using the program demonstrated marked enthusiasm about learning art history. Further, the students' essay writing about an unknown artwork demonstrated that "the use of
interactive multimedia programs can influence the development of higher-order understandings and reduce misunderstandings by suggesting ways in which complex and often unfamiliar information can be associated to existing knowledge” (Cason as cited in Gleeson, 1996). Based on Carol Stavropoulos’s “diagnostic profile of art understandings”, Nancy Cason analyzed Gleeson students' essay answers to measure the effectiveness of multimedia against slide study. Based on the analysis, Cason (1998) concluded that multimedia is an effective instructional format for acquiring higher- and lower-order knowledge.

While Gleeson and Cason investigated whether the use of a multimedia program could result in high-order understanding Karen Swan studied whether the open landscape of a multimedia program (because of non-linearity) brought about historical thinking. Karen Swan (1994) stated that “historical thinking involves being able to conceptualize historical events from multiple perspectives and to relate historical data within these” (p. 2). Because of its non-linearity, multimedia has the potential to represent the critical understanding in ill-structured domains and has the potential for developing historical thinking. In Swan’s study, students used a multimedia program, “Set on Freedom”, to study the meaning of civil rights and its movement. Comparing students’ answers before and after the program interaction, she found that after using the program, students not only had a clearer understanding of civil rights and its movement but also “perceived more linkages between people, places, issues, and events” (p. 6), which were the evidences of the development of historical thinking.

Concurring with Feldman (1997) and my findings discussed in the review of CD-ROM titles section, many educators such as Gregory (1996), Jonassen, Peck and Wilson
(1999) have stated that multimedia programs have not significantly affected K-12 education. The reason is simply that a significant amount of multimedia titles that support educational objectives are not available. Jonassen et al. further suggested why so few quality educational software is available because "most commercial multimedia producers do not know how to be educators and because multimedia technologies have no implicit or explicit structure for teaching" (p. 87).

I agree with the first half of the above statement but the second half of the statement needs further clarification. As Keifer-Boyd suggested there were five different pathways for organizing a multimedia program and connecting information. The structure of any given educational multimedia program is not innate to multimedia but is given by the instructional designer of the program. In addition, I am in agreement with Jonassen et al. (1999) in that the use of multimedia for teaching and learning should go beyond merely multisensory representations of ideas even though multisensory delivery is a very powerful tool for creating an immersed virtual learning environment. I believe when designing an educational multimedia program, the instructional designer needs to first decide the educational goals of the program and also decide what structure is the best way to organize the materials and realize those goals. At the same time, the designer should think about what forms of multimedia are suitable for presenting the content and ideas. Very importantly, from the very start—while deciding the educational goals and organizational structure for a program, the designer needs to consider how to assess students' learning affected by the program interaction. Assessment should not be the last issue to consider when designing an educational software or any other learning and teaching activities.
Most of the related research discussed above (except Swan's study) were quantitative and offered generalized findings. These research primarily focused on the end result of using a multimedia program and offered a few accounts as to how a multimedia program affects a users' learning, and the process or interactive experience of using a multimedia program. To be able to effectively control variables, these quantitative research narrowed their foci and only provided a limited picture of using a multimedia program for learning. In contrast, this research studies the instructional design of a multimedia CD-ROM and its effects on the users' interactive learning experience and knowledge construction. By using qualitative research methods—interview, observation, and written documents, this research offers a more comprehensive picture of how the use of a multimedia program affects learning. It offers accounts on a user's program mediated learning experience, the process as well as the result of knowledge construction affected by a multimedia program—the Chinese Dragons CD-ROM.
CHAPTER 3
METHODOLOGY

Computer technology has permeated many aspects of our life. Education is no exception. The goals we set for education, the way we plan and design curriculum, teaching and learning, and evaluation of students' achievement are affected by this 20th century technological innovation. Issues related to technology and teaching or learning have received continuous attention from educators because of technology's omnipresence and fundamental impact. This chapter discusses the methodology of this study and related issues.

Research Paradigm

Guba and Lincoln (1994) state that paradigm consideration should take precedence over methods because a paradigm affects the researcher's choice of methods in "ontologically and epistemologically fundamental ways" (p. 105). Guba and Lincoln (1994) define paradigm as "the basic belief system or worldview that guides the investigator" (p. 105). There are two distinctive paradigms—positivist and interpretivist (constructivist) (Glesne, 1999). Positivists believe that the world is "made up of observable, measurable facts" (Glesne, 1999, p. 4) and assume that "a fixed, measurable reality exists external to people" (Glesne, 1999, p. 5). On the other hand, interpretivists
"portray a world in which reality is socially constructed, complex, and ever changing" (Glesne, 1999, p. 5) and believe that “social realities are constructed by the participants in those social settings” (Glesne, 1999, p. 5). In general, the positivist paradigm supports quantitative methods, which through careful sampling and experimental design reduce data to numbers in order to produce a generalizable result. By contrast, the interpretivist paradigm supports qualitative methods, which emphasize obtaining multiple perspectives of the research participants, interpreting them and retelling these stories (Glesne, 1999).

My views on the nature of knowledge and reality are in line with those of the interpretivist (constructivist) paradigm and my views are embodied in both phases of this study: (1) Designing the research instrument. Knowledge is constructed by individual learners and is not a package of facts to be transmitted to learners. An instructional instrument plays a role similar to the teacher. It should not be only the knowledge provider but should also facilitate students to engage in active learning or knowledge construction. (2) Exploring the research instrument’s effects on students’ interactive learning experience and knowledge construction. This study is interested in the participants’ perception of the interactive experience. When exploring the effects of the research instrument on knowledge construction, this study did not measure how much information research participants could recite or memorize but explored how various design aspects of the research instrument, such as structure, sources of information, affect the participants’ knowledge construction, i.e. cognitive equilibration—balance between assimilation and accommodation (discussed in Chapter Two)—as well as types of knowledge transfer. The dominant data collection methods used in this study were qualitative research methods—observation, interview, and written documents. However,
when numbers, charts, and tables helped to tell the stories of the research data, they were used as well.

Design of the Study

This study was conducted through two major phases, i.e. Phase I: Research instrument development and Phase II: Research instrument implementation and exploration of its effects. In each phase, there were several steps. The steps for Phase I were: (a) content research and organizational design; (b) storyboarding, interface, and navigation design; (c) prototyping; and (d) production, pilot user testing, and revision. The steps for Phase II were: (a) data collection; (b) data analysis; and (c) development of conclusions, implications, and plan for future research (discussed in Chapter 5).

Phase I: Research Instrument Development

Since a multimedia CD-ROM that could meet the needs of this study to teach Chinese history and culture through art was not available, one was designed and produced. In the instrument development phase, I used actual development tools (i.e. software such as Macromedia Director, Adobe PhotoShop, and Illustrator) and related computer tools to develop visual prototypes of the Chinese Dragons program.

The development process of the research instrument from winter 1997 to winter 2000 was a learning and growing process for the researcher. In the process I was learning technical skills, and through trial and error I learned how to transform available multimedia technology into an instructional design which would warrant a constructivist learning experience about Chinese history and culture through art. At the inception of the instrument development process, technical issues were more visible to me than the
concern for instructional design and learning theories behind it. As time progressed and I persevered in advancing my technical skills, concerns for instructional design and learning theories emerged to the foreground and demanded more of my attention and energy. The technical skills and learning theories embedded in instructional design were interrelated, and the progress in one area interacted with and brought about the improvement in the other area. The evolution of the instrument development was the result of growth in both areas.

Because of my teaching experience at the Columbus Chinese School (discussed in Chapter 1), and my interest and training in multicultural art education and art history, I knew from the very beginning that my research instrument would be about learning Chinese history and culture through art and that the artworks used in the research instrument would be those with dragon motifs. Why dragons? The dragon is the most pervasive symbol in Chinese culture and history. For example, because dragons are believed to control rain and water the Chinese dragon is associated with agriculture and represents the force behind the source of life. In Chinese history, the dragon was also a political symbol and was equated with the emperor, imperial family and/or noble class. The first emperor of the Han dynasty (c.a. 200 BC), Liu Bang, claimed himself as the offspring of dragons. Since then the dragon was adopted as a symbol by the Chinese emperor, who claimed to be the “true dragon”, the son of heaven. In addition, the dragon is also a symbol incorporated into the Buddhist pantheon. In Buddhism, dragons are associated with water and prosperity and are held to be the protectors of Buddhist treasure, i.e. the teachings that lead one to enlightenment. Moreover, to the people in the West the dragon has become a symbol of Chinese culture.
The dragon in Chinese culture has many more layers of symbolism and is unmatched by any comparable symbol in Western culture. The different meanings of the dragon's symbolism are profusely manifested in various Chinese cultural products, i.e. artworks. Therefore, Chinese art with dragon motifs is a perfect vehicle for reaching out to various avenues of Chinese history and culture. In the research instrument the Chinese dragon, the grand context hub, connects learners to different dimensions of Chinese history and culture, represented by three artworks (i.e. the silk banner, the dragons robe, and the bronze mirror).

In addition, knowing the rich meanings behind Chinese dragons may help deconstruct the stereotype of Chinese dragons which have arisen because of a limited perspective and oversimplification. Besides, dragons have a great deal of popularity among children, especially after the release of Disney's animated motion picture *Mulan*.

This study developed four prototypes before the final version of the Chinese Dragons program was created. In other words, during the conceptual development stage, the first three steps in the Phase I of this study were repeated in four cycles. What follows is a brief discussion of the four prototypes; their development and respective underlying structure.

**Four Prototypes**

*Prototype 1.* In this prototype the content of the program was organized in a linear structure. The diagram B in Figure 11 can illustrate the structure of my first prototype. For some students, this structure is straightforward and less confusing. However, a program of this type is like a collection of electronic storybooks. The
interface of my first prototype can be seen in Figure 12. I was not satisfied with this prototype.

**Prototype 2.** In this prototype the content of the program was organized in a “hierarchical pathway” as termed by Keifer-Boyd (1996). The diagram C in Figure 11 illustrates the structure of my second prototype—a hierarchical structure. Figure 13 shows the interface of my second prototype. At the top of the hierarchy was “Chinese Dragons” that then branched out to five sub-topics, i.e. Dragons in Chinese Writing, Dragons and Chinese Painting, Dragons and Chinese Bronze, Dragons in Chinese Music, and Dragons and Chinese Religion. Each sub-topic then branched out to sub-sub-topics. Within each sub-sub-topic, there were examples of that sub-sub-topic organized in linear order. This organization reflected the tendency in art history to organize works of art according to medium. It is also mirrored in the table of contents of books. A program with this structure has more connections but this prototype, at best, created a multimedia electronic reference book. However, it did not take advantage of the nonlinearity that multimedia can offer. For this reason, I was not satisfied with this prototype, either.

**Prototype 3.** I moved on to the development of my third prototype in 1998. I knew the problem lay in the organizational structure; I needed a conceptual model that could help me break away from the confinement of the conventional organization of art history. Spiro, Coulson, Feltovich, & Anderson (1988) state that ill-structured knowledge is such that it requires attention to be paid to “the particular details of individual cases rather than to knowledge in the abstract” (as cited in Efland 1995, p. 143). To address the issue of ill-structured knowledge, Spiro et al. and Efland (1995) proposed a lattice like model to better represent the complexity of an ill-structured domain. Efland (1996) states
“a lattice or web like structure which invites the learner to pursue meaning in multiple
directions along many routes of intellectual travel. For example, in the realm of computer
assisted instruction, hypertext curricula organize knowledge in way that enable students
to explore multiple representations of phenomena” (p. 115). I took the lattice model (see
Figure 1) as the inspiration for the design of my third prototype. In Keifer-Boyd’s terms,
this prototype was organized as a “nonlinear multi-option/multidirectional linked
pathway” (see diagram D in Figure 11). The interface of my third prototype can be seen
in Figure 14.

A user first chose an image of their interest from the strip of images at the
bottom—and dragged it to the circle under the arrow (see Figure 14). The user then made
two choices: first, chose an information layer, such as style, theme, medium, or function,
and “examples” or “non-examples”. The program then displayed “non-examples” or
“examples” of the chosen information layer along with the image. Next, the user would
click and explore one image at a time. After exploring each image, a little quiz game
prompted the user for an answer. If the user answered the question correctly he or she
gained 100 points or otherwise lost 50 points. After all the images were explored, a grand
quiz game appeared on the screen with a final question. If the user answered the question
correctly he or she gained 200 points or otherwise lost 50 points. At all times, the user’s
total score was kept on the screen. After completing the grand quiz, the user could
choose another image and start a new cycle of exploration.

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1 Chanda (1994) used “example” and “non example” in her article—Cross-cultural comparative studies.
“Examples” of a jade artwork are other jade artworks; “non-examples” of a jade artwork are artworks in
other media.
To some students, this structure may be too complex. This prototype was close to my satisfaction, but I doubted whether this program could sustain students' interest because it did not provide a situated context.

**Prototype 4.** Although prototype three broke away from conventional art history organization it still did not grant me the faith to develop it to a full version. I had questions about the purpose of having students “click around”. Would they find it interesting to use the program? How long could the program sustain their interest?

During my candidacy examination in 1999, I was asked to review commercial CD-ROM titles similar to my CD-ROM content—Chinese history, culture or history in general. I found the software titles that interested students most were the “role playing” types of simulations because they gave students a “purpose” to interact with the software. For example, the purpose could be to find the scraps of a map to reveal a secret or rescue a person. In addition, programs like *Castle Explorer* and *Where in Time is Carmen Sandiego*, create a virtual setting which “situated” students. From the CD-ROM review, I concluded that “purpose” and “situated context” were the keys to an educational program that would also be fun to use. With these keys in mind and also to resolve the complexity problems in the prototype three, I came up with a Hub Network structure (see Figure 3) for my fourth and final prototype. This structure is non-linear, has connections, and is less complicated. I provided a context—a reporter simulation—for this structure and developed the fourth prototype.

In the fourth prototype, the user played the role of a news reporter and was assigned a task—to write a special monthly column article about Chinese dragons (see Figure 15). The reporter then started research on Chinese dragons through exploring
works of art. Each time, the reporter examined two artworks of his or her choice side by side (see Figure 16). After the examination, the reporter answered “Chinese Dragon Challenge” questions (see Figure 17). These questions included close-ended questions, such as fill-ins or multiple choices, and activities, such as grouping, matching, and jigsaw puzzles. A multiple-choice question (with multiple correct answers), which asked the reporter for the similarities between the two examined artworks, was always one of the “Challenge” questions for any pair of artworks. These questions were meant to help the reporter make connections between artworks and, eventually, build a web-like relationship out of the many artworks explored.

When all of the questions were answered correctly, the user would be asked an open ended, broad question before moving on to the next pair of artworks. The artwork examination and questions were all meant to help the user with the assignment—writing an article about Chinese Dragons.

As you may see, regarding the first and second prototypes, I was still in the process of learning multimedia technology, and there was a big gap between my ideal research instrument and the technical skill that I possessed. In the third and fourth prototypes, I demonstrated technically competency and became more concerned with instructional design and learning theories. Further, in the development of the later two prototypes, my technical skills and understanding of theory interacted with each other and resulted in the evolution of the prototype. After developing four prototypes, it became clear to me that there were three emerging and integral underlying concepts for the research instrument (a) situated context is integral to learning, (b) presentation of Chinese dragons must be case-based, and (c) this research must utilize cognitive
equilibration to account for the knowledge construction process. In addition, the research instrument must take advantage of multimedia's strengths, i.e. interactivity, immersed context, non-linearity, and connections (links).

**The Chinese Dragons 1.0**

This final version of the research instrument was largely based on prototype four with modifications. The "Chinese Dragon Challenge" question component was eliminated and the user explored only one artwork at a time in lieu of a pair of artworks. The user, again, played the role of a news reporter assigned to write an article about Chinese dragons (see Figure 18). The user was of course required to research Chinese Dragons before writing the article. The user did this by exploring three Chinese artworks with dragon motifs one at time (see Figure 19). After exploring each artwork, the user was prompted to write a version of the article (see Figure 20), which would turn into the final production of their article. Versions of each user's writing were saved to an external storage medium for analysis of how each participant was constructing his or her knowledge. The simulation allowed the user to learn about Chinese history, culture, and art in a situated and constructivist environment. The individualized tasks of each artwork exploration gave the user a purpose to explore artworks, which kept them attentive to the information presented. On the other hand, the user had to make mindful decisions as to what information to include in their meaning making—writing the article.

**Content Research and Organizational Design**

Before the prototype development, preparations and research took place. The subject of the research instrument was history and culture as examined through Chinese art with dragon motifs. I started with content research and image gathering. I acquired
literature and images of Chinese art with dragon motifs. The images were then scanned into a computer. Each image as well as related historical and cultural data were entered into a Chinese Dragon Database\(^2\). The database added to the expandability of the project in the future. Images were also categorized\(^3\) to visualize content organization (see Figure 21) by coding them with five sources of contextual information—time, medium, theme, functionality, and style. Based on the organizational framework of each prototype, I chose images and content for that prototype.

As to the research on Chinese dragons, culture and history, I consulted Dr. Julia Andrews, a specialist in Chinese art history at The Ohio State University. Dr. Andrews recommended books about general Chinese history and reference material related to the artworks I chose. I also conducted content research myself in the United States and in China. In the autumn of 1999, partial funding from an OSU Graduate Student Alumni Research grant allowed me to travel, research, and take documentary photos in China for two months. I planned a trip route (see Figure 22) that enabled me to stop at many significant historical sites, such as the Forbidden City, Temple of Heaven, Jin Ci, and Mawangdui, and some of the ancient capitals of China, such as Beijing, Datong, Nanjing, and Luoyang. During the two months, I acquired reference materials, took slides (about 60 rolls of film), and shot video (eight 60 minutes tapes). The most valuable experience of this trip was the opportunity it gave me to experience Chinese culture in person.

I did not rely on one single reference work for my content development, but referred to multiple sources of information. The references used for the Chinese Dragons

\(^2\) The database program used for this study is FileMaker Pro 4.0 by Claris.
program are listed in the Bibliography section. Among these references, I found the book, *Dragons and Chinese Culture (Long Yu Zhongguo Wenhuà)*, by Zhixong Liu and Jingzong Yang, to be valuable for its extensive research on Chinese dragons. I also referred to the book, *Illustrated History of China*, by Patricia Ebrey, for developing the contextual information on Chinese history and culture included in the program. For an example of the text in the Chinese Dragons program please see the Appendix C.

**Storyboarding, Interface and Navigation Design**

To visualize the organization of a prototype, I designed a storyboard. Based on the storyboard, I mapped out the interface and navigation design. For the interface design, I had to decide on the user's choices, interactivity, and degree of control, and how the user received feedback. For example, what kind of interaction would a user have when selecting an image? How did a user make a choice? By clicking on a button or dragging an object. What kind of control did the user have, such as narration control or the ability to zoom in and out on an image? For the navigation design, I had to decide on its links and access routes. I not only had to decide where each link led but had to map out the layers of access for the whole project (e.g. how many clicks before reaching a desired linked page).

**Prototyping**

After issues concerning the design of the interface and navigation were resolved, I decided on a style for the layout and interface elements. The general rules I followed were aesthetic considerations and style consistency. Aesthetic considerations were about

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3 The software used to categorize images is GraphicConverter V2.8.
making the layout and interface elements, i.e. buttons, visually appealing to the users. Stylistic consistency was to make the layout and interface elements consistent throughout the program such as design and location of navigation buttons, so users could learn how to navigate through the program quickly. Using Macromedia Director, I developed a prototype of the multimedia CD-ROM. A prototype was “a preliminary, incomplete, on-screen version of the product” (Kristof and Satran, 1995).

Production, Pilot User Testing, and Revision

When I was satisfied with my fourth and final prototype, I developed the Chinese Dragons CD-ROM. After the program was developed I looked for middle school aged students to test the program. Three volunteer pilot testers tried out the draft version of this prototype. All were sixth graders, children of a friend. They gave me suggestions for improving the CD-ROM program and also helped me to find defects in the program. Overall, the testers’ feedback was positive toward aspects of the CD-ROM, including interface and navigation design, ease of use, attractiveness of the layout and interface elements, and interactive learning experience. Based on their suggestions, I made revisions and debugged the program. For example, the notepad function was a significant suggestion made by two of the three pilot testers. In fact, the notepad function significantly improved the user’s experience while exploring an artwork and writing an article during the program interaction.

Phase II: Research Instrument Implementation and Exploration of Its Effects

After the multimedia CD-ROM production was completed, this study proceeded to the second phase—research instrument implementation and exploration of its effects.
Participants

The pilot testing confirmed that the target users of the Chinese Dragons program should be middle school aged students, but I was curious about the upper and lower age limitations of the program. I recruited fourteen students to participate in this study. The fourteen participants included five girls and nine boys. They ranged from third to ninth grades and were American children with different ethnic backgrounds including African-Americans, Asian-Americans, and Caucasian-Americans as well as international students. To protect the identities of the participants, all the participants’ names in this study are pseudonyms. The following table shows the demography of the fourteen research participants.

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Grade</th>
<th>Ethnicity / Nationality</th>
<th>Favorite Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna</td>
<td>9</td>
<td>3rd</td>
<td>Asian American</td>
<td>math, science</td>
</tr>
<tr>
<td>Johnny</td>
<td>11</td>
<td>5th</td>
<td>African American</td>
<td>science, arts</td>
</tr>
<tr>
<td>Jenny</td>
<td>11</td>
<td>6th</td>
<td>Asian American</td>
<td>soccer</td>
</tr>
<tr>
<td>Clark</td>
<td>12</td>
<td>6th</td>
<td>Asian American</td>
<td>math, science</td>
</tr>
<tr>
<td>Steve</td>
<td>12</td>
<td>6th</td>
<td>Caucasian American</td>
<td>math</td>
</tr>
<tr>
<td>Billy</td>
<td>12</td>
<td>6th</td>
<td>International</td>
<td>social studies</td>
</tr>
<tr>
<td>Matt</td>
<td>12</td>
<td>6th</td>
<td>international</td>
<td>social studies</td>
</tr>
<tr>
<td>Nina</td>
<td>11</td>
<td>6th</td>
<td>International</td>
<td>art</td>
</tr>
<tr>
<td>Aaron</td>
<td>12</td>
<td>6th</td>
<td>Caucasian American</td>
<td>math, science</td>
</tr>
<tr>
<td>Mark</td>
<td>12</td>
<td>6th</td>
<td>Asian American</td>
<td>math, science</td>
</tr>
<tr>
<td>Bruce</td>
<td>12</td>
<td>7th</td>
<td>Asian American</td>
<td>math, science, language arts</td>
</tr>
<tr>
<td>Denny</td>
<td>14</td>
<td>8th</td>
<td>African American</td>
<td>science</td>
</tr>
<tr>
<td>Amanda</td>
<td>14</td>
<td>8th</td>
<td>Asian American</td>
<td>language arts</td>
</tr>
<tr>
<td>Missy</td>
<td>14</td>
<td>9th</td>
<td>Caucasian American</td>
<td>history, English</td>
</tr>
</tbody>
</table>

Table 1: Demography of Research Participants

4 The international participants spoke English as a second language.
Recruitment Process

In spring 1999, while I initially considered schools as a place to gather research data I realized that the time necessary for students to thoroughly explore the Chinese Dragons program and to engage in interviews would be prohibitive in a school setting.

In April 2000, I telephoned my friends, and acquaintances with children to explain my project and made appointments to show the program to them. During these appointments, I used an Apple G3 PowerBook to provide a portable means of showing the program as I visited people at their offices, homes, schools, and a learning center. Students did not see the program before they came to the first session. Nine participants knew about the program and the research from their parent’s account. I explained the research to the other five participants when I visited their home or school. My recruiting effort resulted in eight parents of more than twenty students signing up to participate in the study.

Setting

It was obvious to me that the place to conduct my research would be my apartment, where I would have access to computers anytime and I could reduce the technical problems to a minimum.

My apartment was located west of the OSU campus area on the second floor of a two-story building. The apartment was compact and had two bedrooms, one living room/kitchen area, and one bathroom. For this study, I set up four computers— one on each side of the four walls so that I could have a maximum of four participants interact with the program at the same time. Four Apple Macintosh computers were used in the study, and included the following models and memory specifications (a) Power
Macintosh 8500/150 with 80 MB RAM, (b) Power Macintosh 7300/200 with 128 MB RAM, (c) iMac special DV edition with 128 MB RAM, and (d) Apple G3 PowerBook/500 with 384 MB RAM. The Chinese Dragons program was loaded on to the computer hard drives for maximum speed performance.\textsuperscript{5} When interacting with the program, the participants directly faced each wall to avoid distraction. In addition, when there was more than one participant interacting with the program, they were asked to wear earphones so that they would not interfere with each other.

**Timeframe**

The data gathering started on Sunday, March 26, 2000. On Sunday, May 21, 2000, because of redundancy found in the collected data, I terminated my data collection. The data was collected on fifteen dates. The table in Appendix D shows the scheduling of the fifteen dates of data collection. I asked those students who had not yet participated to participate in the next stage of my CD-ROM testing in the summer. Therefore, the total number of my spring 2000 research participants was fourteen.

In most cases, each participant came to three sessions to complete the program interaction and committed a total of about six hours to this study. The table in Appendix E shows the scheduling of each participant. The time needed for session I and session II ranged from one to two hours and session III ranged from two to three hours. Most sessions were scheduled on weekends or on a holiday (Easter); a few were scheduled during after-school hours. In each session, they explored one artwork and wrote a

\textsuperscript{5} In addition, although the Chinese Dragon Program was intended to be distributed in CD-ROM format, during the study, I made minor changes, mostly to debug problems encountered by participants, along the way. Therefore, it was practical to load the program on to the computer.
version of their article. However, not all of the fourteen participants finished their interaction with the three artworks and article writing in three sessions. Anna, a third grade student finished the interaction and article writing in one session; Nina, a sixth grade student finished in two sessions; and another sixth grade student, Aaron, who was very engaged with the Tang bronze mirror piece, spent four sessions to finish the requirements of this study.

**Data Collection Methods**

Data were collected through interviews, observations, and written documents. This study investigates the effects of the research instrument—the Chinese Dragons program—on the participants’ interactive experience and knowledge construction. To acquire data about the perception of one’s experience, the interview method is most suitable for that purpose. Interview is “a human interaction” (Glesne, 1999, p. 67). Experience is a holistic thing. Through questions and follow-up probing, a researcher can solicit accounts about specific aspects of a study participant’s experience that are central to a research’s concerns. In contrast, a questionnaire survey can efficiently get a large quantity of demographic data but it is not a suitable method for getting useful data about the individual’s perception. Observation is a good supplement to the interview method for collecting data about one’s perception because sometimes people do not verbalize what they feel but show it through non-verbal means such as facial expressions and or behaviors. Hence, this study employed interview and observation. As to knowledge construction, knowledge can be embodied in written and verbal forms; some people are more verbal and some express better in writing. In order to assess the
participants' knowledge construction externalized through different modalities, this study collected the participants' writing as well as oral answers to assessment questions.

Eleven out of fourteen students came to three sessions to interact with the Chinese Dragons program. As discussed above, the participants had different paces of exploration, three of the participants required fewer or more than three sessions; Ana and Nina completed the project requirement in less than three sessions and Aaron took four sessions. I interviewed the participants during each of these sessions. During the interview, I audiotaped the interviews. Afterwards, the audio tapes were transcribed. I also observed and took field notes while the participants were interacting with the program. My observations were used to triangulate findings from interviews and often helped to generate additional interview questions to ask the participants after the interaction. For example, if a participant went back and forth between “pages” and looked like he or she was looking for something I would ask the participant, why were you going back and forth and what were you looking for? The written documents collected for this study included each participants’ interaction history (where they had been in the program and how much time they spent on each “page”) and versions of each participant’s notes and written article collected while interacting with the program.

In what follows I briefly discuss the typical sequence of the three sessions for most research participants. In the first session, I first welcomed the participant, explained about the project (i.e. to know how they feel about the Chinese dragons program and how it affects their learning), the time commitment (approximately six hours), the confidentiality issue (i.e. their identities will be protected), the rewards (see reciprocity in Ethics section), and their right to withdraw at any time without any prejudice to them or
their parents. Next, I interviewed the participant to gather biographical information, their prior experience with computers, and knowledge about Chinese dragons. The participant then interacted with the program. After completing the first artwork exploration, I interviewed the participant about that first interaction with the program. In the second session, I welcomed the participant and seated the participant at the computer. After completing the second artwork exploration, I interviewed the participant about their second interaction with the program. In the third session, I welcomed the participant, seated the participant at the computer and gave the participant feedback about his or her article. After completing the third artwork exploration, I interviewed the participant about his or her overall interaction with the program and the participant also answered a scenario question that was intended to assess their knowledge construction verbally.

**Interview.** In this study, I interviewed most of the participants four times. The interviews of the participants occurred between March 26, 2000 to May 20, 2000. The dates when each participant came for the interaction and interview(s) are shown in the table in Appendix E. The first two interviews of each participant took place during the first session, and I interviewed each participant the third time in the second session, and the fourth and last time in the third session. I used the interview guide approach for all of the interviews. Interview guides (see Appendix F, G, & H) for all four interviews were prepared beforehand. After the pilot testing, Matt, one of the pilot testers, inspired me to ask questions about computer mediated learning (see the discussion in Chapter 4). Thus I added two more computer mediation questions to the interview guides. The interview guide approach allowed me to collect data systematically and still keep the interview conversational and situational (Patton, 1990). Also because the participants' age ranged
from nine to fourteen years old, I had to vary the wording of the interview questions to accommodate the comprehension level of each participant. When I detected a participant who might misunderstand an interview question I rephrased the question or asked a confirmation question afterwards to ensure that the participant understood the question the way it was intended. In addition, depending on their answers, if necessary, I asked the participant follow up questions.

First Session Interviews. In the first session, I interviewed each participant twice, once before and once after the program interaction. Participants were interviewed one at a time. The purpose of the interview before the program interaction was to build rapport, to gather data about each participant’s biographical information, prior computer experience, understanding of Chinese dragons, history and culture in general, and disposition toward participation in the research. After the initial interview, the participant then interacted with the program. When they completed their interaction, I interviewed each participant about their interactive experience with the program. I asked them what they felt about the Chinese Dragons program and asked their opinions on aspects of the program design such as the timeline, narration, notepad, and text. In addition, I asked them what their preference was if they had a choice between learning from a teacher and interacting with a computer program. Please see Appendix F for the first session interview guides.

Second Session Interview. At the second session, the participant went straight to the computer to continue interacting with the program and article writing. Afterwards, I interviewed the participant about their second interaction experience with emphasis on comparing it to their first interaction. I asked them whether they noticed any new
features in today's exploration and I also asked them to compare today's exploration and the one in the first session. I asked about their article progress. Please see Appendix G for the second session interview guide.

Third Session Interview. In the third session, I seated each participant individually and gave feedback on his or her article about Chinese Dragons. After each participant finished exploring the third artwork and writing their article, I interviewed each participant the last time for their collective experience with the program. This interview lasted longer. I asked about their understanding of Chinese dragons after the completion of the program exploration so that I could compare their answer to the one before the program interaction. I asked them to talk about the pros and cons of the program. In addition, each participant also answered a scenario question, which was stated as the following: "You are a famous scholar and are invited to make a presentation about Chinese and Western dragons. Now you are to prepare for the presentation. You need to outline your presentation and use some or all of the visuals (see Figure 23) provided here to illustrate the points you want to make. Please take a few minutes to outline your presentation and pick the visuals that you would like to use in your presentation. I will then ask you to give a short oral presentation".

The participant's article about Chinese dragons was the main source for analyzing the participants' knowledge construction affected by the program whereas their answers to the scenario question served as a supplement to the assessment in writing. Please see Appendix H for the third session interview guide.

Observation. The observation data collection method was used to collect non-verbal data from each participant. The observation data was mainly collected during the
time when the participants interacted with the Chinese Dragons program. During interviews, in addition to the participants' verbal responses, I noted their demeanor and non-verbal expressions.

**Written Documents.** Three major written products used as data were (a) interaction history of each participant, (b) versions of notes from each participant, and (c) versions of the article from each participant. All documents were generated from the built-in functions of the program and saved to an external storage medium.

**Interaction History.** The interaction history is a record of each participant's interaction sequence. To track the whereabouts of each participant during the interaction, I used the Macromedia scripting language, Lingo, to script a tracking function into the program. In addition to the exploration sequence, the tracking function recorded the time when a participant entered a "page" and how long the participant stayed on that page. After a participant exited the program, an interaction history report was saved automatically onto an external storage medium. An example of an interaction history report may be seen in Appendix A. If the interaction history showed that a participant went back and forth between frames, I asked the participant why they made those movements in the subsequent interview to determine if the participant was confused or if there was a purpose behind their actions.

**Versions of Notes.** During the program interaction, whenever the participant encountered information of interest, the participant could open the notepad, a built-in function of the program to take notes. Whenever the notepad was closed, the program saved to an external medium the date and time when it was opened along with a version of the participant's notes. A newer version of the notes was appended after the previous
version of the notes. The comparison of each participant's interaction history and versions of his or her notes was intended to reveal what information in the program was of interest to the participant.

Versions of the Article. Similar to the notepad function, every time the article pad was closed, the date and time along with a version of the participant’s article were saved to an external medium. A newer version of the article was appended after the previous version of the article and each version of the article remained intact. Comparing each participant’s notes and article was intended to reveal how each participant transformed information in their knowledge construction. Versions of each participant’s article showed their process of cognitive equilibration in the changes of their article titles and content as well as showed the organization structure of their article (see the discussion in Chapter 4).

Data Analysis Methods

My analysis of the data was mainly guided by the three cognitive learning theories discussed in Chapter 2—constructivism, situated learning and cognitive flexibility. Among the learning theories, Piaget’s equilibration theory helped me to see my participants’ knowledge construction process as they strove to create a balance between assimilation and accommodation; Vygotsky’s concept of culture as mediation directed me to see the participants’ responses to the learning experience mediated by computers from a critical perspective.

I used QSR Nud*ist’s index nodes to organize my coding categories, subcategories and code all of the data. All soft copies of the data were formatted for Nud*ist coding—saved as “text only with line breaks”. Each category or subcategory was given a
code name and a code number. The text unit for my Nud*ist coding was “a line of text”.

As I read the transcription of interviews, observation field notes, versions of notes and articles I selected line(s) of text and coded them with one or multiple categories or subcategories. During and after the data gathering, I read the data and looked for emerging themes, patterns, and categories. In the process of data coding, sub-subcategories emerged, which I also assigned a code name and number. The final coding system includes two main categories: interactive experience and knowledge construction.

The first category was about the interactive experience pertaining to the design and application of the research instrument and the sub-categories under the category, interactive experience, were based on interview questions. The following were sub-categories and sub-sub-categories which were under the first coding category of the interactive experience.

- **Opinions on aspects of the Chinese Dragons program.**

  Participants were asked to talk about their opinions on aspects of the Chinese Dragons program design such as the timeline, narration, note taking, text, and navigation.

- **Overall experience.**

  To learn the participants’ overall experience with the program, participants were asked to (a) rate the exploration of the three artworks, (b) talk about the potential application of the program in a classroom, and (c) give favorite points and suggestions to the program.

(a) Rating the exploration of the three artworks.
Please rate the three artworks you explored and explain why you rate them in this order.

(b) Application of the Chinese Dragons program.

What subjects can the Chinese Dragons program be used for?
What grade range is the Chinese Dragons program suitable for?

(c) Good points and Suggestions for Improvement.

Can you give me three good points about the Chinese Dragons program and three suggestions to improve the program?

* Computer mediation.

Do you prefer learning through program interaction or from a teacher? Why?
If the information that you got from a computer conflicts with the one from your teacher which source of information will you trust? Why?

The second category was about the participants’ knowledge construction affected by interaction with the Chinese Dragons program. There were four sub-categories under this category of knowledge construction. The first two sub-categories, i.e. selection and transformation of information, sources of information and knowledge, emerged from constructivist learning theory. Knowledge is not a compilation of facts; instead learners select and transform to construct knowledge. The third sub-category, cognitive equilibration and organizational structure, emerged from Piaget’s notion of cognitive equilibration—balance between assimilation and accommodation. The forth sub-category, types of knowledge transfer, emerged from assessment literature (see discussion in Chapter 4). The following are the explanation of the four sub-categories under the second coding category of knowledge construction.
• Selection and transformation of information.

Analyze each participant’s notes and see what information in the Chinese Dragons program interested the participants.

• Sources of information and knowledge.

Analyze each participant’s articles and see what information and knowledge are incorporated in each participant’s knowledge construction—article writing.

• Cognitive equilibration and organizational structure.

Analyze versions of each participant’s articles and see the cognitive equilibration shown in the participant’s article (title and content changes) and the structure used in organizing their articles.

• Types of knowledge transfer.

Versions of each participant’s article were analyzed to find what type(s) of knowledge transfer occurred in their knowledge construction. The four types of knowledge transfer include: (a) duplication; (b) paraphrase; (c) integration; and (d) synthesis, application, and generalization of information.

Ethics

As stated before, the main purpose of this study was the design of a multimedia CD-ROM, which met the specifications set by the researcher, and to study its effects on the participants’ interactive experience and knowledge construction. I have read about and participated in other multimedia research projects. My personal agenda for this research was to experience the design of an instructional CD-ROM and see its effects first hand from start to finish. I am aware that computer technology has already made its
way into American schools. The International Society for Technology in Education (ISTE) announced the educational technology foundation standards for all preservice teachers. The National Council for Accreditation of Teacher Education (NCATE) endorsed these standards (ISTE, 2000). These signal the coming big leap that technology will make in teacher preparation. Although, personally, I was pleased with the design of my research instrument, I am cautious about the impact of computer technology on the young minds in today’s society since I witnessed its impact first hand. The ISTE standards stress basic computer operating skills for personal and professional uses and the application of technology in instruction though the standards do not stipulate the critical literacy of computer technology in its guidelines.

I handled the confidentiality of the participants with the following measures. I kept all the materials in my home and did not allow other people to have access to them. When interview tapes were transcribed and written documents were formatted for Nud*ist coding, I replaced all of the participants’ real names with pseudonyms. In other words, the participants’ identities on all of the digital files were concealed and protected.

Reciprocity. When I was planning to recruit participants, I carefully considered the issue of reciprocity. Students and their parents had busy schedules, and this study required a time commitment of about six hours for each participant. I accommodated the schedules of parents and students; they were welcome to schedule a session whenever they could come, whether it was on a weekend, holiday, or afterschool. I arranged transportation for participants if parents were unable to provide transportation for their child(ren). Two third of participants’ parents provided the transportation for their children to and from my apartment; I provided one third of the participants’
transportation. Half of the parents stayed in my apartment while their children were interacting with the program or being interviewed. Drinks and snacks were provided in all sessions to participants and parents who stayed. Participants could take breaks whenever they felt like it. Upon completion of the research participation requirements, each participant was rewarded with a participation certificate, a color copy of their article, and a choice of a book, either *The Forbidden City: Center of Imperial China* by Abrams or *Dragons and Silk: A Close Up Guide* by Odyssey. Also, a summary of the research findings was sent to each participant.

**Trustworthiness**

There are many procedures that researchers can employ to increase the trustworthiness of a qualitative research. Crestwell (1998) lists eight such procedures: (a) prolonged engagement and persistent observation; (b) triangulation; (c) peer review and debriefing; (d) negative case analysis; (e) clarification of researcher bias; (f) member checking; (g) rich, thick description; (h) external audit (as cited in Glesne, 1999). It is not necessary to conduct all of the procedures in a qualitative research. In this study, I used the following means to increase the trustworthiness of my research (a) keeping the researcher bias in check, (b) multiple-session interviews, (c) triangulation, and (d) audit trail.

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6 There were exceptions to the book reward given to most participants. The parents of Matt, Billy, and Nina declined any gift reward. Instead, I took them out for a dinner. Aaron and Missy were recruited.
Keeping Researcher Bias in Check

In this study, I designed and produced the research instrument and was interested in knowing its effect on the participants’ interactive experience and knowledge construction. It was obvious that I, as the research and designer, had a very intimate relationship with the research instrument. The research instrument could be read by the participants as an extension of the researcher. Criticizing the Chinese Dragons program was like criticizing the researcher. In addition, because I used multimedia-computing technology to create the research instrument, it might imply to the participants that I had a favorable view of technology. In addition, I might be prone to hear favorable opinions about the program and technology and less willing to hear opinions that spoke unfavorable of the program or technology.

To ensure my study participants would speak their minds freely, when the participant came for the first session, I emphasized to them that their opinions were very important to this research and I would use them to improve the Chinese Dragons program so that other students would have better interactive experiences with this program. I told them “I would like to hear your honest opinion”. I restated this phrase through out the study when I saw it appropriate. These statements made my research participants feel honored and important. They felt comfortable to tell me their true feelings. After Bruce told me about his suggestions to improve the Chinese Dragons program, he footnoted, “Do you mind that I’m kind of tearing out on it (the Chinese Dragons program)?” I assured him, “No I don’t… In fact, I appreciate that you said that. You tell me the

Before my book reward policy was set; they were rewarded with a bookstore or MediaPlay certificate.
truth...” To counter against my personal bias, during the interviews, I made a conscious effort to solicit criticism and suggestions about the program; I played devils’ advocate—by asking probing questions contrary to their opinions. I reviewed and reflected on my interview guide and wordings throughout the study and tried hard to keep my subjectivity in check. For example, the teachers vs. computers and knowledge from teachers vs. knowledge on computers (discussed in Chapter 4) were questions that I did not plan to ask in the interview but were integral to this study. I discovered these issues when I played devils’ advocate to counter against the participants’ favorable opinions about the research instrument. I ended up adding the teachers vs. computers and knowledge from teachers vs. knowledge on computers questions onto my interview guide for session one and session three.

**Multiple-Session Interviews**

“Validity of the data may be threatened by the accuracy of participants’ testimonies” (Glesne, 1999, p. 33). Sometimes the participants might say what I wanted to hear instead of what they really had in their minds. I conducted an average of four interviews with each participant. I developed a very good rapport with each one of them and the participants felt comfortable to talk during the interviews. Some participants, such as Matt, Bill, Bruce and Clark, were even looking forward to doing the interviews; they felt that they were doing something very important—giving suggestions to improve the program. I repeated the question about their interactive experience with the program in the interviews of all three sessions to check the validity of their answers. Multiple-session interviews also gave them opportunities to think more deeply about their opinions regarding their experience with the Chinese Dragons program.
**Triangulation**

This study collected data from different sources, including interview, observation and written documents. The findings from different data collection methods were used to triangulate the validity and accuracy of the data collected from the different methods. For example, to verify my observation, I asked the participant questions about what I had observed when they interacted with the program. The answers to the scenario question were used to triangulate findings about the knowledge construction found in the article of each participant.

**Audit Trail**

In addition to the measures discussed above, I have tried to provide a rich description of the research methods and techniques to give readers a good understanding of the research context. I have also archived the materials of this study, which include a digital copy of the Chinese dragon database, a digital copy of the prototypes and final versions of the Chinese Dragons program, a hard copy of the demographic information that each participant filled out, observation field notes, signed consent forms, audio tapes, digital copies of the interview transcriptions, interaction history, versions of notes and articles, a hard copy of the Nud*ist data coding system and data analysis files, which are ready for external audit at any time. All of the data are to be kept in my home for five years.
CHAPTER 4
WE ARE—
WHAT WE USE,
WHAT WE LEARN,
AND HOW WE LEARN

In this chapter the data collected for this study is analyzed. Ideally the reader should have an opportunity to see or interact with the research instrument to have a more concrete understanding of it. However, most readers will not have access to the program. Consequently, to familiarize the reader with the research instrument, I discuss the sequence that participants encountered when interacting with the Chinese Dragons program. Following this I then discuss the participants in my study, followed by a discussion about the dimensions and theoretical lenses used to analyze the research data. Finally, I will provide analysis of the data.

Before proceeding, I would like to point out that the word “participants” is what I choose to address the young people in my study, but sometimes I use “kids” as well. In the interview process, I noticed that when I talked to the participants as if they were my peers they appeared to be more expressive and talked more intellectually. However, when I addressed them as kids they were less talkative. The use of the term “participant” is to acknowledge the parallel relationship I prefer between the participants and myself.
The reason I use kids in lieu of "children" is that the word "kids" was used by the participants themselves when they addressed their peers. A similar observation was discussed in Barrie Thorne’s (1993) *Gender Play: Girls and Boys in School*; she further points out that "children" was more of a put-down (term) than "kids" (p. 416).

In this Chapter, I include many quotations from my research participants. In them the participants may exhibit limited perspectives. The perspectives of the participants are not the principle focus of this study and will not be discussed. To preserve the original expression of my research participants, in most quotes, the participants' words were not edited and are quoted as they were spoken or written. However, some participants used too many expletives such as "like" or "you know", that could be at times distracting and make the understanding of their words difficult. In those cases, some of the expletives are edited out to allow for a better comprehension of meaning. The participant's written articles about Chinese dragons were spell checked and corrected but the grammar and syntax were not modified.

**The Chinese Dragons Program**

When the Chinese Dragons program began, the participant, who played the role of a news reporter, was welcomed by the chief executive editor of *Perspectives* (a fictional virtual newspaper) in a digital video (see Figure 24). At the end of the welcome message, the editor asked the participant to proceed to the Check-in Center (see Figure 25). The participant typed his or her name to check into the news agency. In the next frame, the cultural editor, in a digital video, explained the assignment to the participant, that is, to write an article about Chinese Dragons and to emphasize that the participant needed to
decide upon the title and content of his or her article (see Figure 18). At the end of his message, the cultural editor urged the participant to go to the research center (see Figure 19) where materials have been prepared for the article writing assignment. In the research center, there were three slides of artworks, and the participant did their research by exploring these three artworks. I selected these three artworks to manifest the different symbolic meanings of Chinese dragons. The participant could choose and drag any one of them to a panel in the upper right corner to see an enlarged version of the slide and read a small information blurb about the artwork in a panel below the enlarged slide. The three slides, from top to bottom, were a silk banner, dragon robe, and bronze mirror. Below is the information about each slide that was displayed after the participant dragged the slide to the upper-right panel (see Figure 19).

**Painted silk banner from Mawangdui tomb No. 1**

- **DATE**: Shortly after 168 BC; early Western Han (206 BC - 8 AD)
- **MATERIAL**: Silk
- **FUNCTION**: To comfort the soul of the dead.

**Dragon Robe**

- **DATE**: Qing Dynasty (1644 - 1911)
- **MATERIAL**: Silk
- **FUNCTION**: The most common formal garment worn by the emperor, princes, and mandarins as emblems of their office.

**Bronze Mirror**

- **DATE**: Tang Dynasty (618 - 907)
MATERIAL
Bronze

FUNCTION
Mirror, an auspicious gift with five rings of auspicious symbols.

After the participant made his or her slide selection and clicked on the “start” button the cultural editor appeared again and explained the exploration procedure and the program interface (see Figure 26). The editor pointed out that there was a different task for each artwork exploration and he indicated the use of the notepad for the participants to take notes (see Figure 27) during their interaction. The following are the task descriptions for the three artworks in the program as they were displayed on the interface screen.

Silk Banner
Find this Han silk banner, examine it by clicking on the nine blinking dots. The banner is inside of the Mawangdui Tomb. To find it first enter the Tomb...

Dragon Robe
Find this dragon robe, examine it and locate four symbols on it. The emperor inside of the Forbidden City has the robe. To find it first find him.

Bronze Mirror
Find out how many dragons are on this bronze mirror. You can find them by examining the five rings on the back side of the mirror.

After reading the task description, the participant clicked on the “go” button to proceed to explore the artwork. Traveling back in time by watching a galloping Chinese chariot, the participant experienced the “time lapse” to arrive at the historical period of the chosen artwork. Meanwhile the participant also saw a visualization of a Western timeline and chronology of Chinese dynasties (see Figure 28). If the participant chose the silk banner, after arriving in the Han dynasty, the dynasty when the artwork was
produced, a wooden figure emerged from the background as a host to welcome the participant. By clicking on the host, the participant formally started the artwork exploration.

In the case of the silk banner, the participant first learned brief information about the Han dynasty and its territory. The participant then entered a tomb and searched for the silk banner. After finding it, the participant examined the banner, which depicts three distinctive realms (see Figure 29) (a) heaven, (b) the land of living, and (c) the underworld. I placed nine blinking dots on the banner as pointers to the important details on the banner. The participant had to click on all of the nine dots to complete the exploration of the banner. The program kept track of how many dots the participant had clicked. If all nine dots were clicked the cultural editor would appear once more to congratulate the participant for completing the exploration of the artwork, and give the participant a prompt on writing the article about Chinese dragons (see Figure 30). The participant clicked on the article button to activate the article pad and started writing his or her article (see Figure 20). When the pad was closed, the participant was brought back to the research center (see Figure 19) to start another artwork exploration. Most participants explored one artwork in each session. When each participant returned for the second or third session, the participant could skip the welcome message and go directly to the check-in center. After choosing his or her name from the return users list, the participant was brought directly to the research center to choose another artwork slide to start their subsequent explorations.
The Participants

The fourteen participants in this study included five girls and nine boys. They included one third grader, one fifth grader, eight sixth graders, one seventh grader, two eighth graders, and one ninth grader. The national and ethnic makeup of the study participants was comprised of two African-Americans, six Asian-Americans, three Caucasian-Americans and three international kids. To protect the identities of the participants, all names, including the participants and the parents, in this study are pseudonyms. The following three Figures (31, 32, and 33) can better illustrate the demographic information of the participants.

Figure 31. Gender Distribution

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1 The three international participants spoke English as a second language.
Figure 32. Grade Level Distribution

Figure 33. Ethnic and Nationality Distribution
In what follows, I provide a brief summary of each participant’s profile, which includes descriptions of the participants’ academic performance. The words “performed very well academically” mean that the participant received mainly As. “Academic performance was high” or “high academic achievement” means the participant’s grades averaged between A and B. “Academic performance was good” means that the participant’s grades averaged between B and C.

Anna, a nine-year-old third grader, was an Asian American and her favorite subjects were math and science. Both of her parents were born in an East Asian country. Her father had a Ph.D. and worked for a technology company; her mother did housekeeping. Anna performed very well academically. According to her father, she was an advanced third grader and her reading comprehension was at fifth grade level. Anna was also very athletic and played in a community soccer team. Her brother, Clark, also participated in this study.

Johnny, an eleven-year-old fifth grader, was an African American and his favorite subjects were science and art. His mother, a Caucasian American, was the mother of four children; his father, an African American, worked in a legal profession. His academic performance was good. Johnny also played in a community soccer team. His brother, Denny, participated in this study as well.

Jenny, an eleven-year-old sixth grader, was an Asian American and her favorite subject was soccer. Her father, a Caucasian American, worked for the U.S. Postal Service and her mother, from a South Asian country, did housekeeping. Her academic performance was good. Jenny also played in a community soccer team. Her cousin, Amanda, participated in this study as well.
Clark, a twelve-year-old sixth grader, was an Asian American and his favorite subjects were math and science. Both his parents were born in an East Asian country. His father had a Ph.D. and worked for a technology company; his mother did housekeeping. Clark performed very well academically. According to his friend Steve, who also participated in this study, Clark was a very good soccer player. His sister, Anna, participated in this study as well.

Steve, a twelve-year-old sixth grader, was a Caucasian American and his favorite subject was math. He told me that he would like to be a writer when he grows up. Both of his parents were scientists and taught at a large midwestern university. Steve had high academic achievement and also played in a community soccer team. His friend, Clark, participated in this study as well.

Billy, a twelve-year-old sixth grader, was an international student and his favorite subject was social studies. Both his parents were from a Middle Eastern country. His mother was studying in a graduate program at a large midwestern university; his father was a writer. Billy performed very well academically. Both his twin brother, Matt, and his sister, Nina, also participated in this study.

Matt, a twelve-year-old sixth grader, was an international student and his favorite subject was social studies. Both his parents were from a Middle Eastern country. His mother was studying in a graduate program at a large midwestern university; his father was a writer. Matt had high academic achievement. Both his twin brother, Billy, and his sister, Nina, also participated in this study.

Nina, an eleven-year-old sixth grader, was an international student and her favorite subject was art. Both her parents were from a Middle Eastern country. Her
mother was studying in a graduate program at a large midwestern university; her father was a writer. Nina had high academic performance. Both her twin brothers, Billy and Matt, also participated in this study.

Aaron, a twelve-year-old sixth grader, was a Caucasian American and his favorite subjects were math and science. Both his parents worked for a social science institute. Aaron performed very well academically. His sister, Missy, also participated in this study.

Mark, a twelve-year-old sixth grader, was an Asian American and his favorite subjects were math and science. Both of his parents came from an East Asian country. His mother owned and ran a restaurant. Mark had high academic achievement and played piano. He loved to do things on a computer. He designed his own Web site and was planning to form a computer company with his friends.

Bruce, a twelve-year-old seventh grader, was an Asian American and his favorite subjects were math, science, and language arts. His father came from an East Asian country and had a Ph.D. He owned and ran an engineering company. His mother was a Caucasian American. Bruce had high academic achievement and was very athletic—ran track and was good at gongfu. He also played trumpet.

Denny, a fourteen-year-old eighth grader, was an African American and his favorite subject was science. His mother, a Caucasian American, was the mother of four children; his father, an African American, worked in a legal profession. His academic performance was good. Denny also played in a community soccer team. His bother, Johnny, participated in this study as well.
Amanda, a fourteen-year-old eighth grader, was an Asian American and her favorite subject was language arts. She was Jenny’s cousin and lived with Jenny’s family because her uncle was her guardian. Amanda performed very well academically and ran track at her school. Her cousin, Jenny, participated in this study as well.

Missy, a fourteen-year-old ninth grader, was a Caucasian-American and her favorite subjects were history and English. Both her parents worked for a social science institute. Missy performed very well academically and actively participated in girl scouts. Her brother, Aaron, participated in this study as well.

English was the first language to all of the eleven American participants. The three international participants were generally proficient in speaking and writing English, but their proficiency varied. All of the fourteen participants lived in the suburbs of a large midwestern city and all had a computer at home. Most participants attended public schools except Clark and Steve.

Data Analysis

The research data was gathered from interviews, observations, and computer interactions, and mainly falls into two categories (a) the interactive experience pertaining to the design and application of the research instrument—the Chinese Dragons program, (b) the participants’ knowledge construction affected by the program interaction. There was not a clear dichotomy between the two categories instead there was a co-relationship between them. The data of the first category was mainly found in the interview and observation data, which can be further divided into sub-categories that include the participants’
• Opinions on aspects of the Chinese Dragons program such as the timeline, narration, note taking, text, and navigation.

• Overall experience.

This sub-category was further divided into three sub-sub-categories. They were:

- Rating the exploration of the three artworks.
- Application of the Chinese Dragons program.
- Good points and suggestions for improvement.

• Computer mediation.

The sub-categories, again, are not neatly distinct categories, but overlap. They are established here for the discussion of the data analysis. On the other hand, the data of the second category, i.e. knowledge construction, mainly found in the two written documents (i.e. versions of notes and articles), can be further divided into sub-categories which include

• Selection and transformation of information: What information in the Chinese Dragons program interested the participants.

• Sources of information and knowledge in knowledge construction: What information and knowledge were incorporated in each participant’s article writing.

• Cognitive equilibration and organizational structure: Balance between assimilation and accommodation shown in the participant’s articles (changes in the title and content) and the structure used in organizing their articles.

• Types of knowledge transfer: Which were demonstrated in the participants’ writing.
Knowledge construction is a complex phenomenon with multiple dimensions that concern the learning action, process, and or the result of the learning. To understand how it was affected by the multimedia interaction, this study uses different lenses (i.e. the above four sub-categories) to intersect and dissect the data to reveal a more comprehensive picture of the participants’ knowledge construction.

In addition, data pertaining to the participants’ dispositions toward the research participation and prior computer experience, in part, enlighten the understanding of their interactive experience and the result of their program interaction. The following data analysis starts with the discussion of the participant’s dispositions and prior computer experience and then progresses to the participant’s interactive experience and knowledge construction.

**Dispositions**

When recruiting participants I showed the Chinese Dragons program to the parents or legal guardians of potential participants to avoid any surprises. The participants did not see the program until they came to their first session. Nine participants knew about the research from their parent(s). I explained the research to the other five participants when I visited their home or school. The participants’ feelings about the research participation varied. I asked the participant: “What do you feel about participating in this project”? Steve, Clark, Denny, and Jenny said, they felt “pretty cool”, “good”, “excited”, “fun and important” (Steve-Int1a; Clark-Int1a; Jenny-Int1a;
Nina-Int2); Amanda said, it is “interesting” to participate in an “education software project” (Amanda-Int1a); Anna, Johnny, and Bruce felt curious and did not know what to expect from this (Anna-Int1; Bruce-Int1a); Mark was not sure what he felt and told me “I feel nothing” (Mark-Int1a).

Some of the positive feelings toward the research participation should be credited to the research medium—a computer—as well as the “honorable role” of participating in a research project as perceived by the participants. During the third session interview, Matt said, “I like it. I enjoyed the experiment. It’s very much not only education but not very tense or . . . strict. You know what that means. It’s interesting and also on the computer and also because my participation is actually tell you about what to make it better. Those make it much more interesting to do” (Matt-Int3).

**Prior Computer Experience**

Since this study involved the use of a multimedia computer program, the participants’ prior experience and disposition toward computers might inform this study about their interaction experience with the Chinese Dragons program and their knowledge construction affected by the program. All fourteen participants had prior computer using experience and their families had computers at home. The type of computers that most participants had experience with was IBM compatible PCs with the Microsoft Windows operating system; some participants such as Clark, Aaron, and Mark also had experience using Apple computers. Most participants used computers everyday; Anna and Bruce used computers about one hour per week.

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2 “Int” stands for interview. In most cases, each participant was interviewed four times. Twice in the first (Continued on the next page)
They used computers at school, home, and the library. At school, most participants used computers to type (papers, reports, or projects) and do research on the Web. Some participants had opportunities to use educational software such as typing tutors, math programs, or encyclopedias. The opportunities of using educational software among the participants varied. Nina told me, she got to use a typing tutoring program, but “only once a month” (Nina-Int1a). On the other hand, Steve’s school had a lot of educational programs and he used an encyclopedia program for a “bunch” of science projects (Steve-Int1a). Most participants had more opportunities to use computers at home than at school. Jenny expressed that they were not allowed to use computers frequently at school; she said, “They (Teachers) don’t let you. We can only go on the computer if we look up like a research on a project, which we don’t do very much” (Jenny-Int1a).

As to using computers in a school or public library, except for a few participants, most of them had used library computers either to do research on the Web or to look up a book or journal. Home was the place where most participants had frequent and various computer-using experiences. Besides typing homework and doing research on the Web, they used computers at home to send e-mails, use educational software, play games, do drawing, and PowerPoint animation.

All participants, except Bruce and Missy, exhibited positive attitudes toward the use of computers. The common reasons why they liked to use computers included fun or playing games, making things easier such as writing, and providing access to a lot of
information. Aaron said, typing is “a lot neater than handwriting stuff” (Aaron-Int1a). Amanda said, “It’s fun and easier than looking at a book” (Amanda –Int1a). Jenny said, “Because it’s fun and you can look up a lots of things” (Jenny –Int1a). Nina said, “It’s kind of fun to do with programs, which you can do all kinds of things, normally, in hand you can’t do” (Nina-Int1a). Further, besides recognizing computers as good tools, Clark saw the impact of computers in our lives. He stated “I think we are probably going to have to use it everyday of our lives because like palm pilots right now we have organizers” (Clark-Int1a). In contrast, Bruce had mixed feelings about computers; he liked to use computers for games but was not interested in sitting down at computers for a long period of time. In the first interview, Bruce said, “Yeah, I like to use a computer but I don’t let it take over a lot of my time because I like to be active most of the time. I don’t really find it interesting to sit down that much” (Bruce-Int1a). In the third interview, he, again, stated “I don’t really like computers that much. Unless, you know it’s a game or something” (Bruce-Int2). Missy expressed her frustration over using computers. She said, “I don’t like computers. I find them very frustrating. They don’t ever do what you want them to” (Missy-Int1a).

When asked about their first computer experience, the participants recalled that they had their first computer experience between age four to seven. Jenny and Missy remembered that when they were four they used a computer to paint (Jenny-Int2; Missy-Int1a). Nina guessed that between the ages of four and six, she was looking at things on a computer and pressing the keyboard and mouse (Nina-Int2). Amanda, Steve, Denny, Johnny, Aaron, and Anna remembered playing a game at their first computer encounter.
Interactive Experience Affected by the Program

This study investigates how the participants' interactive experience was affected by the research instrument. Interactive experience is an internal process of a learner and can be in part observed in the outward behaviors or words of the learner. Although observation was used to collect the participant's non-verbal expressions during the program interaction, the interview method was the main means for capturing the participants' interactive experience in their own words. For example, interview questions such as "what do you feel about taking notes in the program?" were to understand the participants experience with a specific design aspect of the program. Other interview questions, such as "what do you feel about the Chinese Dragons program?" were to solicit the participant's overall experience about the program whereas interview questions like "do you prefer learning from your teacher or learning by interacting with a multimedia program?" were intended to unveil the participants' views on computer mediation. The participants' interactive experience is discussed in the following order: various design aspects, overall experience of the program, and computer mediation.

Various Design Aspects of the Chinese Dragons Program

The various design aspects to be discussed include timeline, narration, note taking, text, and navigation. For purposes of discussion, I will focus on one aspect at a time. However, the interactive experience of the participants with the program was built upon the interconnections of all the design aspects.

**Timeline.** Time is an important concept when teaching history. However, time itself is abstract and requires the ability of abstraction to comprehend it. Scholars suggest that teaching time to younger students should be done through experiencing time in a
concrete way, such as growing a plant and making visual notes on the plant's growth. I
applied this advice by designing a timeline for the Chinese Dragons program. There
were two designs in the program. One is the "chariot timeline" that is both spatial and
temporal based (see Figure 28). In the chariot timeline, the participant not only visually
noted the passing of time by observing changes in the Western timeline and
corresponding Chinese dynastic chronology but also experienced the lapse of time as the
chariot traveled back to the destined dynasty when the artwork was created. The other
timeline was a typical static linear timeline found in many history textbooks (see Figure
34). In addition to these two timelines, the third indicator of time in the program was the
numerical dates given in the text such as 1644-1911 for the Qing Dynasty.

After completing their program interaction, when asked to put the three artworks
in chronological order, most participants were able to put them in the right order. I asked
further, "what indicators in the program help you to put them in this order?" The chariot
timeline appeared to be the primary indicator used by the participants to put them in the
right order. For example, Jenny and Bruce put the three artworks in the right order (silk
banner, bronze mirror, and then dragon robe). Jenny said, "When it (the horse) was
running, that horse. Up there, the strip and it shows you how far that went back in time"
(Jenny-Int3). In addition to the chariot timeline, the typical visual timeline also helped
Bruce on this task. Bruce stated, "when first started out I saw the horse like move back a
really long time and then the second time it didn't take so long and the third time it took a
really short time and then also on the robe part it showed the chronological order of it. I
saw the timeline (the typical visual timeline)" (Bruce-Int3). On the contrary, those who
primarily relied on the dates to perform the task, e.g. "I tried to remember the dates."
Steve-Int3), made an error in the order between the robe and the mirror. Interestingly, everyone asked to perform the task made no mistake on which of the three artworks was the oldest one—the silk banner. I used multiple modalities to represent time, i.e. spatial, temporal, and textual modes—to suit different learning preferences. My study demonstrated that any one of the three modes had its own fans.

**Narration.** The program had voices that narrated the text to the participant. Most participants shared a similar view about the program’s narration function. They preferred the narration but would not mind reading the text themselves or would like to read along or read the text over after the narration. For example, Jenny said, “I like the narration but I also like to read it over” (Jenny-Int1b). Why did the participants prefer narration? The reasons given by the participants were the following: reading the text to them helped with their comprehension, showed them how to pronounce Chinese words, and gave their eyes a break from the screen. Amanda said, “If they (the narrators) read it and you read it with them then it’s helpful” (Amanda-Int1b). Mark explained, “pronunciation can be different from spelling. Like Q-I-N-G supposed to be Qing dynasty can be pronounced kwing” (Mark-Int2). Clark said, “computers have- because it’s really light like really sometimes hurts my eyes” (Clark-Int1a). Clark and Aaron both expressed that the narration gave their eyes a chance to move away from the screen. I observed, during the interaction, at times participants looked somewhere else instead of the screen. I asked Aaron, “Why did you look around instead of reading the text”? Aaron replied, “The narrator was reading to me so I can take my eyes away from the computer” (Aaron-Int1a).
However, two participants of this study, Missy (9th grade) and Bruce (7th grade), were indifferent about the narration and preferred to read the text themselves. Bruce said “I usually learn better if I read it or I listen to it but I don’t really like to listen to it as much as like to read it” (Bruce-Int1b). Bruce added, “Sometimes I like to read it and sometimes I just want to listen to it... When I want to read it usually when it’s about research or something like that. But when I want to listen is when a teacher is trying to physically teach me something” (Bruce-Int1b). Bruce’s last statement may sound a bit obscure but he did demonstrate a different attitude toward narration than most of the study participants. Furthermore, Missy demonstrated even stronger opposition to narration than Bruce. She said, “Sometimes, the narration get a little bit annoying” (Missy-Int3). This may be due to the fact that Bruce (seventh grade) and Missy (ninth grade) were older or more advanced, and could read faster. The narration might have had the opposite effect on them—slowing them down.

**Note Taking.** Most participants regarded the notepad in the program as a helpful function for writing the article about Chinese dragons. It was helpful to the participants in different ways. To Amanda and Jenny, the notepad helped them to store information, Amanda said, “I take what you think is going to put in the article”; the notepad was helpful to Amanda because “I can’t remember it all” (Amanda-Int1b). Jenny said, “Taking notes is really a big help when you are writing the article. It’s a good idea... You can go back to your notes and look at them when you do the article” (Jenny-Int1b). Bruce was used to taking a lot of notes at school and shared with me how he took notes. He said, “I usually read a section of the whole thing and then I started typing of what I could remember. Then I looked back for reference and then I typed again”
To Clark, taking notes was “very helpful”, “a nice way of studying . . . because when [he] takes notes [he] sort of remembers” (Clark-Intlb). In addition, notes helped Clark develop ideas for writing the article. He said, “it’s just that I need to get an idea. I take like take notes but then when I go to the article I forgot that I didn’t take notes that much and I went back and . . . I came to the article. But once I get a lot of notes I can like storm up an idea and write about it” (Clark-Intlb).

Text. During the participants’ program interaction, they asked me about words that were new to them, such as “auspicious”, “trigram”, “commoner”, and “emphasize”. I grew concerned about the vocabulary used in the program which might be difficult for some participants. To Anna (3rd grader) and Johnny (5th grader), this program was challenging and had more new words to them than other participants. Most participants expressed that they knew most of the words and the few new words did not affect their comprehension of the text. However, when participants were asked whether I should build a glossary function into the program, most participants, except Clark, Bruce and Missy, believed that the glossary was a good idea and would be very helpful.

Navigation. During the program interaction, I observed how participants navigated in the program; in addition, the interaction history recorded the participants’ exploration sequence. Both sources of data helped me understand the participants’ navigation in the program. Navigation design plays an important role in the learners’ experience with an interactive multimedia program. Learning to navigate in a program is similar to learning a sign system. First, the learner needs to figure out what each sign means; after the participant learns the system, the meaning or instruction represented by the sign becomes transparent to the participant. One key issue of navigation is the
learning curve of the navigation system. If the navigation system is complex it will take participants longer to learn and can well interfere with the interactive experience.

Typically, in each session of this study, participants explored an artwork and wrote a version of their article about Chinese Dragons. I observed that in Session I, most participants took a longer time on the artwork exploration and spent less time on writing the article because they were learning the navigation system. After that initial learning experience, in the second and the third sessions, navigating through the program seemed to become second nature to them and they could navigate through the program much faster. The participants spent more time in writing their articles in the second and third sessions. Hsiao-Ping Chen, my fellow graduate student, came to observe Aaron and Missy’s last session with me. She wondered how they knew what to click and where to go in the program. Hsiao-Ping asked Missy, “How did you know where to click?” “Well, you kind of get use to it. Once you figure out you know generally how to go foreword and then kind of get the hang of it” (Missy-Int3), Missy replied. From both Hsiao-Ping and my observations, the learning curve of the program navigation was small and the navigation became transparent to the participants in their last sessions.

**Overall Experience**

**Rating the Exploration of the Three Artworks.** After exploring the three artworks, participants were asked to rate the exploration of the three artworks, i.e. the banner, robe, and mirror, and to explain the criteria that they used on which to base their rating. The two tables followed provide the results of eleven participants’ rating and a tally of the voting results. The silk banner received seven first favorite votes, the dragon
robe received three first favorite votes, and the bronze mirror received the least number of first favorite votes—one vote.

<table>
<thead>
<tr>
<th>Name</th>
<th>First Favorite</th>
<th>Second Favorite</th>
<th>Third Favorite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Johnny</td>
<td>Banner</td>
<td>Robe</td>
<td>Mirror</td>
</tr>
<tr>
<td>Jenny</td>
<td>Banner</td>
<td>Mirror</td>
<td>Robe</td>
</tr>
<tr>
<td>Clark</td>
<td>Robe</td>
<td>Banner</td>
<td>Mirror</td>
</tr>
<tr>
<td>Steve</td>
<td>Robe</td>
<td>Mirror</td>
<td>Banner</td>
</tr>
<tr>
<td>Billy</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Matt</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Nina</td>
<td>Banner</td>
<td>Robe</td>
<td>Mirror</td>
</tr>
<tr>
<td>Aaron</td>
<td>Mirror</td>
<td>Robe</td>
<td>Banner</td>
</tr>
<tr>
<td>Mark</td>
<td>Banner</td>
<td>Mirror</td>
<td>Robe</td>
</tr>
<tr>
<td>Bruce</td>
<td>Banner</td>
<td>Robe</td>
<td>Mirror</td>
</tr>
<tr>
<td>Denny</td>
<td>Robe</td>
<td>Mirror</td>
<td>Banner</td>
</tr>
<tr>
<td>Amanda</td>
<td>Banner</td>
<td>Robe</td>
<td>Mirror</td>
</tr>
<tr>
<td>Missy</td>
<td>Banner</td>
<td>Robe</td>
<td>Mirror</td>
</tr>
</tbody>
</table>

Table 2: Rating the Exploration of the Three Artworks

<table>
<thead>
<tr>
<th>Artwork</th>
<th>First Favorite</th>
<th>Second Favorite</th>
<th>Third Favorite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Banner</td>
<td>7</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Robe</td>
<td>3</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Mirror</td>
<td>1</td>
<td>4</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 3: Tally of the Ratings

The participants varied in the criteria that they used to rate the exploration of the three artworks. Most of the participants’ rating criteria had to do with the information about the three artworks. Steve and Amanda’s rating was based on the “amount of

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information" (Amanda-Int3) that was useful for writing their articles about Chinese dragons. Missy and Bruce rated the three artworks based on how interesting the information was to her or him. Missy said, "you know the robe or the banner had the most interesting information. When I learn about history I like to learn about individual people... Like with the banner, it was talking about lady Dai, but um and with the mirror, it really didn’t talk about people at all. I mean, you know it was good information anyway, it’s just that’s just kind of my own personal taste-“ (Missy-Int3). Bruce said, “it was a little bit more interesting with the robe and the banner than the mirror” (Bruce-Int3). Aaron was the only participant who gave a first favorite vote to the bronze mirror. His rating was based on how the information was presented; Aaron said, “... I like it just plain out better than the story... so I don’t have to pick it out of the story” (Aaron-Int3). Clark’s rating was based on the degree of difficulty that the information presented. The mirror was his least favorite because it was the most difficult.

Besides information, participants also rated the three artworks based on other factors. Jenny, Nina, and Johnny rated the three artworks based on how fun it was to explore each of the three artworks. Jenny said, “The reason I like the banner the most is because more exciting and a lot more to it. A lot more interesting things to do. Like you do these stuff and you had to find it in the boxes (caskets) like which box was in. That was fun too. There is more history behind it” (Jenny-Int3). Johnny said, “... the robe and the banner I think are more interesting... because you have to find where they are and it’s harder” (Johnny-Int3). Denny and Mark used more than one criterion for rating the exploration of the three artworks. Denny like the robe the most because “how it looked” and he liked the mirror second because of the information about “the twelve
animal cycle" (Denny-Int3). Mark rated the banner as his favorite because it provided a lot of information about the dragon and rated the robe as his least favorite because the information was not too appealing to him and he was not comfortable about examining the robe of the emperor. He said, "if [the emperor was] wearing the robe at that time I don't think I would be too comforting to be looking at the robe off of him. Taking it off of him and examining it. Seeing where everything is by stitch. That's not too- yah" (Mark-Int3).

**The Application of the Chinese Dragons Program**

*Suitable Level.* Participants were asked to give their opinions on the suitable level of the Chinese Dragons program. Because of the level of difficulty of the text, most of the participants' answers to this question fell in the middle school to lower high school range (see Table 4). Nina (third grader) expressed that this program was challenging to her and would be too difficult for third graders. Bruce, Mark, and Steve believed that this program could also be suitable for upper elementary school students. With the addition of a glossary function, Steve believed that upper elementary school students would be able to use this program and would also be able to understand "the big words" (Steve-Int3).
<table>
<thead>
<tr>
<th>Name</th>
<th>Grade Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna (3rd grade)</td>
<td>too hard for 3rd graders</td>
</tr>
<tr>
<td>Johnny (5th grade)</td>
<td>6th or 7th graders</td>
</tr>
<tr>
<td>Jenny (6th grade)</td>
<td>6th up to 8th</td>
</tr>
<tr>
<td>Clark (6th grade)</td>
<td>7th and up</td>
</tr>
<tr>
<td>Steve (6th grade)</td>
<td>5th to 9th</td>
</tr>
<tr>
<td>Billy (6th grade)</td>
<td>good for all 6th graders</td>
</tr>
<tr>
<td>Matt (6th grade)</td>
<td>good for all 6th graders</td>
</tr>
<tr>
<td>Nina (6th grade)</td>
<td>good for all 6th graders</td>
</tr>
<tr>
<td>Aaron (6th grade)</td>
<td>6th to 9th or 10th graders</td>
</tr>
<tr>
<td>Mark (6th grade)</td>
<td>4th grade and up to anywhere in high school</td>
</tr>
<tr>
<td>Bruce (7th grade)</td>
<td>4th to 9th</td>
</tr>
<tr>
<td>Denny (8th grade)</td>
<td>middle school</td>
</tr>
<tr>
<td>Amanda (8th grade)</td>
<td>7th to 8th</td>
</tr>
<tr>
<td>Missy (9th grade)</td>
<td>more for 6th, 7th, instead of 8th, 9th</td>
</tr>
</tbody>
</table>

Table 4: Suitable Grade Level

Suitable Subjects. Participants also gave their opinions on the suitable subjects for use of the Chinese Dragons program. Most students thought that this program had the potential to be used in social studies and language arts classes, but had less potential for art and science classes. For example, Clark said, “it provides writing mechanics for, um, for the writing of many articles because like you have a set of information and then based on that information you can put it on many articles, on like a certain article and a certain topic” (Clark-Int3). Steve believed that the program could be used for social studies because “it’s about the past” (Steve-Int3). However, Amanda had reservation about using the Chinese Dragons program for social studies because “(in school) history only teaches like American history” (Amanda-Int3). Missy suggested that if the program were to be used in a language arts class the program would “have to make [the] information less spelled out. You’d have to like make it so that people would have to go back and
When asked how the program could be used for art classes, most participants replied that it could be used for drawing classes. Clark said, "It also can be used (for art classes) because it has like the different graphics and based on those graphics you can like draw and draw many like copies of those articles, the um, paintings and pictures" (Clark-Int3). On the other hand, when asked about the use of the Chinese Dragons program for teaching about art, most participants either blatantly disagreed or reluctantly agreed. I asked Jenny, "How about the use of this program to learn about art". Jenny replied, "I don’t think so" (Jenny-Int3). Missy said, "I think it could be, my art classes have never gone that deep. They’ve always just kind a said here paint a picture. You know maybe they’ll go into something on the artist but like my humanities class right now. When we study a culture they’ll show us artwork and tell us about what it means and things” (Missy-Int3). In contrast, Mark’s response to this question was an exception; he said, “It could teach how in historian time how they actually, what they actually thought of art... In art everyone talks about how they did art in history and this shows how the Chinese did art” (Mark-Int3). As to the use of program for science classes, Jenny was the only participant who mentioned its potential use in science classes. Her reason was “because some of things in science have to do with like some of the things in the past. Like the person that made water” (Jenny-Int3).

**Good Points and Suggestions for Improvement.** In the final interview, participants were asked to talk about the good points of the Chinese Dragons program and give suggestions to improve the program. The good points revealed their positive
interactive experience affected by the program and the suggestions indicated which aspects of the program might have hindered their interactive learning experience or could be improved to enhance their interactive learning experience. In the following, I first give a summary of the good points and suggestions given by each participant and then make a cross-participant-analysis of the good points and suggestions.

<table>
<thead>
<tr>
<th>Anna (third grade)</th>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna liked the explorative process of the program. She said, “you first have to find out where things are and then you have to type up notes and then you have to write your article about the Chinese dragons” (Ana-Int1).</td>
<td>Anna did not give any suggestions to improve the program. She said, “No, I didn’t see any (that I don’t like) yet” (Ana-Int1).</td>
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<table>
<thead>
<tr>
<th>Johnny (fifth grade)</th>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Johnny liked the stories in the silk banner, the people (especially the sun shooting hero, Houyi) in the stories. He could vividly recall the sun legend, “there was like nine suns and then they all went up and the sky at once and it made the earth really hot so then Houyi was like a really good archer and then he shot them down” (Johnny-Int3). He also liked the tasks of “finding stuff” in each artwork exploration.</td>
<td>Johnny would like me to add a review function to the program “so that [the user] can go back and review” (Johnny-Int3).</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Jenny (sixth grade)</th>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jenny liked the program for three reasons (a) learning new things, (b) finding stuff in the history, and (c) the narration in the program. She said, “The reason I like it is because it’s good that you are learning something new. The second reason I like</td>
<td>Although Jenny liked the narration she did not like the voice to read to her all the time. She suggested that I should have the narration on some pages and play music in the background. And play nice music for those pages without narration.</td>
<td></td>
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</tbody>
</table>
it is because you go back in history and find it. The third reason I like it is because the voices -- they can read it for you and you can just listen” (Jenny-Int3).

In addition, Jenny suggested me to add “a little more color” to the program. She thought the use of black and white graphics was “boring” (Jenny-Int3).

<table>
<thead>
<tr>
<th>Good Points</th>
<th>Suggestions</th>
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<tbody>
<tr>
<td>Clark (sixth grade)</td>
<td></td>
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<tr>
<td>Good Points</td>
<td>Suggestions</td>
</tr>
<tr>
<td>Clark liked the program because of its information about Chinese culture and its graphics/pictures. He said, “I liked it because it had a lot of information about the culture of Chinese. It gave me a really good understanding of many different artifacts from the people of that time. And it was pretty neat about the graphics. They are pretty cool because you had like a timeline and went back in time and then the pictures like the screen-the Chinese dragon screen with the nine number, the auspicious number nine and the vest (dragon robe)” (Clark-Int3).</td>
<td>Clark expressed that, in the exploration of the bronze mirror, he was sort of confused when reading the text about the three astronomical charts before manipulating the charts. He suggested to put the text and charts on the same screen so the text and charts help illuminate each other. Clark also suggested that I should make “copy”, “paste”, and “tab” functions available for the notepad and article pad so the user could format the text, copy text from his/her notes and paste to his/her article, and move text around more freely. Clark’s third suggestion was to add an article button so that users can click on it and write the article anytime they want.</td>
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</table>

Steve noticed in the narration of four xiang there was a few seconds that “the music got a little messed up with the voice” and suggested me to fix the problem. He also liked the idea of having a pause function for the narration (suggested by Aaron).

<table>
<thead>
<tr>
<th>Good Points</th>
<th>Suggestions</th>
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<tbody>
<tr>
<td>Steve (sixth grade)</td>
<td></td>
</tr>
<tr>
<td>Steve liked the narration, the “next” and “back” arrows for program navigation, and the notepad function— “It’s a little bit easier than writing it down on paper” (Steve-Int3).</td>
<td>Steve noticed in the narration of four xiang there was a few seconds that “the music got a little messed up with the voice” and suggested me to fix the problem. He also liked the idea of having a pause function for the narration (suggested by Aaron).</td>
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</table>

<table>
<thead>
<tr>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Billy (sixth grade)</td>
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<tr>
<td>Billy liked this program because “it was a good way to learn”— “a good way to research” (Billy-Int3). He explained what he meant by that “First, we have to go to find the Robe. In order to find the</td>
<td>Billy suggested me to give a context to the mirror, i.e. the background, the time, and the place, and also put more information about the symbols on the robe. I placed the dragon robe and the</td>
</tr>
</tbody>
</table>
Robe, it’s not the only mission searching one about the ancient city and dynasty stuff. In the mirror, you looked at every details and learned besides just to count the dragons but going through (every ring) and reading about it. You learned lot about 28 su and eight trigrams and that’s actually interesting so you learn a lot from it and it’s fun. So it’s a good way to research. How you get into the Tomb. You get into things. That’s fun. Really” (Billy-Int3). In Billy’s definition, “research” means learning in the process of exploration.

In contrast, I did not built a context for the bronze mirror instead I put more emphasis on the mirror itself. Each ring on the backside of the bronze mirror was provided with information and could be enlarged and examined. On the other hand, the robe itself was not provided with detailed information.

Matt (sixth grade)

<table>
<thead>
<tr>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matt liked the program because the pictures of the program gave him a good understanding of the Chinese culture and history. Matt explained, the pictures gave him “a feeling of what they have. Do you know not just big description about stuff and I don’t truly know what it means. You know. With all these [pictures] you can really see” (Matt-Int3).</td>
<td>Matt, one of the three pilot testers, ran into some program bugs in the early process of the data collection. Because of this “painful experience of getting stuck”, one of his suggestion was “no bugs please” (Matt-Int3). In addition, Matt also suggested to give the user the control over the forbidden city tour so that during the tour the user could pause to take notes.</td>
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</table>

Matt liked the program also because the program had the right amount of information and was suitable for his age.

Nina (sixth grade)

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<thead>
<tr>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nina liked the program because she felt that she “really learned a lot and it’s fun doing it” (Nina-Int2). Further, Nina liked the program because the program was interactive and the pictures in the program gave her a sense of going to other places. She said, in the program, “you need to search to go to other places not just sitting in a room” (Nina-Int2).</td>
<td>Nina suggested me to add more sound effects such as an arrow shooting sound after the archer Houyi launched his arrows and add more mini-tasks or questions to challenge the user to search for answers. For the article writing, she suggested that the user should be allowed to pick what pictures to include in the article along with the text.</td>
</tr>
</tbody>
</table>

Nina suggested that the user should be allowed to pick what pictures to include in the article along with the text.
### Aaron (sixth grade)

<table>
<thead>
<tr>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaron liked the explorative aspect of the program; he said, it's &quot;just fun to discover—the facts, everything&quot; (Aaron-Int3). He thought this program was educational and would help him in school. In addition, unlike other complex programs, this program &quot;doesn't take long to learn&quot; (Aaron-Int3).</td>
<td>Aaron suggested to add two new functions. One is the &quot;pause&quot; function so the user could pause the narration while taking notes and resume the narration when the user wanted to. The other function suggested by Aaron was that before the article pad popped up, a prompt should appear and ask the user whether to proceed to writing the article or to go back and look at some more information about the artwork.</td>
</tr>
</tbody>
</table>

### Mark (sixth grade)

<table>
<thead>
<tr>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marked liked the program because it was on computers. He said, &quot;I will look at or consider [anything on a computer]&quot; (Mark-Int3). He liked the &quot;speaking&quot; aspect of the program which includes the narration and the virtual editors speaking in the digital videos. He stated, &quot;the narration makes it easier&quot; and &quot;the video is giving you a quest so you actually have to do something...&quot; (Mark-Int3). In addition, Mark also liked the playback function of the program; what Mark meant by that was the user's ability to go forward and backward in the program and replay the digital videos. He believed that because of its interactivity this program helped learning and is better than a book.</td>
<td>Mark noticed a caption error and suggested me to fix it. In addition, to make the program more enjoyable to kids, Mark made suggestions about the look and the sequence of the program. He stated &quot;I mean you can make it something [what] kids can enjoy. So it's not professional; it's fun. Well, some kids things are colorful and [I am] not asking you to make it colorful but- don't make it look like so... so professional looking which means it's so perfect where everything is in sequence of what professionals do. You'll have to interview other kids for that&quot; (Mark-Int3). Mark also suggested to look into computer memory issues because he noticed that the computer seemed slow when typing the article.</td>
</tr>
</tbody>
</table>

### Bruce (seventh grade)

<table>
<thead>
<tr>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruce liked the program because he liked the information on the robe and story on the banner, as well as the nice pictures and music.</td>
<td>Bruce made three suggestions. One is to replace the article with an easier task such as writing a report. He explained the difference between writing an article and a report—&quot;well an article you- really...&quot;</td>
</tr>
</tbody>
</table>
talk, you are really writing to the people but essay you just write down the information you don’t need to make like it very interesting you just write it down” (Bruce-Int3). Bruce’s second suggestion was to find a better topic than Chinese dragons. When asked what would be a better topic, he replied, “well me personally I don’t really like that. What my interest would be is some if you wanted to do something historical like if you wanted scientific I would do astronomy maybe or historical maybe how America got its freedom or something like that but you probably couldn’t put that because um- a lot of people know about that already. I don’t know. I thought the Chinese dragon was a little bit boring” (Bruce-Int3). Bruce’s third suggestion was to make the program more interactive—“every once in a while you would have a game or something like that” (Bruce-Int3).

<table>
<thead>
<tr>
<th>Amanda (eighth grade)</th>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amanda liked the information in the program. She said. “there is a lot of interesting information but you can look up yourself if you are interested in it” (Amanda-Int3). She also liked the narration and the virtual newspaper editors whom spoke to her.</td>
<td>Amanda suggested me to put “more information on dragons” (Amanda-Int3).</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Denny (eighth grade)</th>
<th>Good Points</th>
<th>Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denny liked to find the emperor (in the dragon robe exploration) and liked the part (in the banner) that told stories. He also liked pictures in the program.</td>
<td>Denny suggested me to add a replay button so he can replay the narration if he wants to hear it again.</td>
<td></td>
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<tr>
<td>Good Points</td>
<td>Suggestions</td>
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<tr>
<td>Missy like “the way the information was presented”—“How it was paired with the picture and . . . it kind of flowed it wasn’t like, this is this fact, this is this fact . . .” (Missy-Int3). Missy also liked the pictures in the program because “It kind of sets the mood for the whole thing and gets you in the right state of mind. And it’s a lot more interesting than just looking at text” (Missy-Int3). In addition, Missy liked the contextual information about the artworks. Using the mirror as an example, She explained, “it helps you to kind of understand the cultures so that you can understand what they appreciated and how they thought and how that would affect their view of the mirror” (Missy-Int3).</td>
<td>Missy personally did not like the article writing task but she was not sure what would be a good replacement to “get your point across” (Missy-Int3). In addition, Missy would like to have the option of turning off the narration; she preferred reading the text herself. Also, Missy suggested to put more information about the front side of the mirror in the bronze mirror exploration.</td>
<td></td>
</tr>
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</table>

Analysis of the Good Points. The table below (Table 5) is the cross-participant-analysis of the good points. To compose this table, I first list all the good points mentioned by the participants and I categorize these good points into three categories that emerged from the data (a) medium, (b) multimedia strengths, and (c) program design. Under multimedia strengths and program design, there are additional sub-categories. Some good points such as “user control” fall into more than one category, i.e. “multimedia strengths” and “program design” so they appear in both categories. The name(s) in the parentheses are the name(s) of the participants who mentioned the good point in the interview.

<table>
<thead>
<tr>
<th>Cross Analysis of the Good Points</th>
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<tbody>
<tr>
<td>(a) Medium: Delivery medium is the factor for liking the program.</td>
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<td>* Computer (Mark)</td>
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</table>

Table 5: Cross Analysis of the Good Points (continue)
(Table 5 continued)

(b) Multimedia strengths: Enjoyable explorative, discovery experience was offered through interactivities, situated contexts (immersed environment), non-linearity, user control, connections, and multisensory delivery.

- Interactive learning (Mark)
- Finding stuff (Anna, Johnny, Jenny, Denny)
- Discovery aspects of the program (Aaron, Mark)
- Learning in the process of exploration (Billy)
- Need to search to go to other places (Nina)
- Context and quest: Virtual newspaper agent talking to the user in the video—setting a context for the quest (Amanda, Mark)
- Situated context: Pictures give you a feeling of the culture or set the mood (Matt, Missy)
- User control: Going forward and backward as the user wants (Mark, Steve)
- Multisensory learning experience
  - Narration (Jenny, Amanda, Mark, Steve)
  - Music (Bruce)
  - Virtual newspaper agent talking to the user in the video (Amanda, Mark)
  - Pictures/Graphics: Accent the text, give a feeling of the culture, and set the mood for the interactive experience (Nina, Denny, Clark, Matt, Bruce, Missy, Jenny)

(c) Program design: Design factors contribute to the enjoyable interactive experience.

- Fun (Billy, Aaron, Nina, Jenny, Mark)
- Educational
  - Learning something new (Jenny)
  - Educational and help him in school (Aaron)
  - Learning a lot and fun (Nina)
- Content
  - Stories (Johnny, Denny, Bruce)
  - People in the story or information about people (Johnny, Missy)
  - Interesting information (Amanda, Bruce)
  - Information about Chinese Culture (Clark)
  - Background information about the dynasty of the artwork, not just information about the artwork (Missy)
  - Right amount of information and right level for sixth graders (Matt)
  - The way the information was presented and the information flowed from one to another (Missy)
- Notepad (Steve, Clark)
- Doesn’t take long to learn: Navigation transparency (Aaron)
- User control: Going forward and backward as the user wants (Mark, Steve)
The first category of good points is *medium*. The Chinese Dragons program because of its medium, i.e. a computer, attracted computer lovers such as Mark even before his first contact with the program. The second category of good points is *multimedia strengths* which was offered through interactivities, situated contexts (immersed environment), non-linearity, user control, connections, and multisensory delivery. The third category of good points is *program design*. In this section, I will not elaborate on the discussion of the first category, *medium*, since the issues about computer mediation will be discussed in the next section, i.e. *Computer Mediation*.

**Multimedia Strengths.** Many of the good points about the Chinese Dragons program mentioned by the participants can be characterized as multimedia strengths—what multimedia can best offer. Please see the previous table (Table 5) for a summary of these points under the category of multimedia and see some of the participants’ quotes about these from the summary of the good points and suggestions of each participant. The Chinese Dragons program through its multimedia features provided the participants a situated context to engage in active and meaningful learning.

**Situated Learning.** Learning is connected with its setting. The multiple-forms of media and interactivities in the Chinese Dragons program created a virtual setting, which was conducive to active learning and participation. I observed that after each participant got on the computer they developed an intimate and personal relationship with the program as if what they were doing was a real task. They mentioned that the persons on the computers “talk to us” (Amanda-Int3), or they could “go to places” (Jenny-Int1b), “go back in history” (Jenny-Int3), “get into the tomb”, and “get into things” (Billy-Int-3) in the program. Matt said, the design and pictures made him “really feel the culture” and
gave him “feelings into it” (Matt-Int3). Missy said, “Pictures kind of sets the mood for the whole thing and gets you in the right state of mind” (Missy-Int3).

*Active and Meaningful Learning.* The Chinese Dragons program provided a setting for active and “meaningful learning” (Novak, 1998). “Active learning is guaranteed to expand the brain” (Marlowe & Page, 1998). People learn more when they are actively engaged in learning. Meaningful learning requires “non-arbitrary, non-verbatim, substantive incorporation of new knowledge into cognitive structure” and “deliberate effort to link new knowledge with higher-order, more inclusive concepts in cognitive structure” (Novak, 1998, p. 20). The overarching assignment, writing an article, kept the participants on their toes throughout the program interaction. They needed to mindfully search for information and to decide independently what to include in their article writing. As Amada said, “You have to research a lot because of the article. You have to know what you are looking for—stuff on dragons” (Amanda-Int1b). Similarly, Nina said, “(In this program,) you need to search to go to other places not just sitting in a room” (Nina-Int2). Billy said, It’s a good way to learn because usually in school, you either just learned boring (things) or you just need to remember some facts for tests . . . (Interacting with the Chinese Dragons program) is a good way to research.” He explained:

First, we have to go to find the Robe. In order to find the Robe, it’s not the only mission searching about the ancient city and dynasty stuff. In the mirror, you looked at very details and learned besides just to count the dragons but going through (every ring) and reading about it. You learned lots about 28 su and eight trigrams and that’s actually interesting so you learn a lot from it and it’s fun (Billy-Int3).
Program Design. Many good points mentioned by the participants are due to the program design. Please see Table 5 for a summary of these points under the category of program design and see some of the participants’ quotes about these from the summary of the good points and suggestions of each participant. Participants liked the program because it is fun and educational. The fun factor kept most participants interested in their exploration of the three artworks and came back for subsequent sessions. The program was also liked because it is educational. Jenny said, “it’s good that you are learning something new” (Jenny-Int3). Aaron said, “it’ll help me in school” (Aaron-Int3). Nina said, “you really learned a lot” (Nina-Int2). Fun and educational were two integral elements of this program and dependent on each other.

The content of the program was also mentioned as a positive point by participants. Johnny, Denny, and Bruce liked the stories. Johnny and Missy liked the people in the stories or information about people in the program. Amanda and Bruce liked interesting information in the program. Clark appreciated the information about Chinese Culture—“It gave [him] a really good understanding of many different artifacts from the people of that time” (Clark-Int3) whereas Missy praised this program for providing contextual information about the dynasty in which the artwork was created and not just specific information about the artwork. Further, the right amount of information and the way the information was presented contributed to the participants’ enjoyable experience with the program. In addition, the navigation—transparent to the participants, user control, and notepad function were appreciated by the participants.

Analysis of the Suggestions. I asked participants for suggestions to enhance the program. The table below (Table 6) produces a cross-participant-analysis of their
suggestions. To compose this table, I first listed all the suggestions mentioned by the participants and categorized these suggestions into two categories that emerged from the data: (a) multimedia features and (b) program design. Under each category, there are sub-categories. Some suggestions such as “build a context for the mirror” fall into more than one category, i.e. “multimedia features” and “program design” so they appear in both categories. The name(s) in the parentheses are the name(s) of the participants who mentioned the suggestions in the interview.

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**Cross Analysis of the Suggestions**

(a) Multimedia features: Multimedia features of the program that need added features or be revised to make a more enjoyable interactive experience

- Multisensory elements
  - More colors (Jenny)
  - Enjoyable look for kids (Mark)
  - More sound effects (Nina)
  - Narration
    - Narration should not be on all of the pages (Jenny)
    - Add a narration replay button (Denny)
    - Add a narration pause function (Aaron, Steve)
    - Have a narration off option (Missy)
    - Fix the narration/music bug in the mirror (a few seconds of scratchy sound) (Steve)
  - Text
    - More information about the front side of the mirror (Missy)
    - More information on dragons (Amanda)
    - More information about the symbols on the robe (Billy)

- Interactivities, situated context, and user control
  - More mini-tasks and questions to keep users searching for answers (Nina)
  - More interactivities: more games (Bruce)
  - Enjoyable sequence for kids (Mark)
  - Allow the user to pause during the Forbidden City tour (Matt)
  - Build a context for the mirror (Billy)

Table 6: Cross Analysis of the Suggestions (continue)
(Table 6 continued)

(b) Program design: Aspects of the program design that need to add new functions or be revised to make a more enjoyable interactive experience.

- Let the user choose pictures to include in the article (Nina)
- Add action prompts: i.e. Are you ready to write the article or do you want to go back to look at more information (Aaron)
- Copy, paste, and tab functions for the notepad and the article pad (Clark)
- Add an article button so the user can access it at any time (Clark)
- Replace the article writing task with a report or other tasks (Bruce, Missy)
- Add a review function (Johnny)
- Put the text and the three astronomical charts on the same screen (Clark)
- Allow the user to pause during the city tour (Matt)
- Better topic (Bruce)
- Information/context
  - More information about the front side of the mirror (Missy)
  - More information on dragons (Amanda)
  - More information for the symbols on the robe (Billy)
- Technical
  - Bug free (Matt, Mark)
  - Memory management (Mark)

To avoid repetition, please see the table (Table 6) above for a summary of these suggestions and read the participants’ quotes about suggestions from the summary of the good points and suggestions of each participant. The suggestions include fixing small technical programs, adding sound effects, giving the user more control over narration, designing a more kid-like (less professional) looking interface, adding a glossary function, adding copy, paste, and tab functions for the notepad and article pad and so on. Among these suggestions, I consider the suggestions about narration, a glossary function, building a context for the mirror, and the copy and paste functions for the article pad and notepad are most significant for improving the interactive learning experience of the
program. I plan to use these suggestions to make changes in the next version of the program. Certainly, the small bugs will be fixed in the new version.

Narration was considered a helpful function for reading comprehension by most participants but I also received many suggestions about it. To suit the needs of most users but not to interfere with the users who like to read themselves, in the new version, I will give the user the option of turning it off, pausing it, and replaying the narration. I will also add a glossary function to the new version of the program so the user can look up definitions and pronunciation of difficult words such as “auspicious” and Chinese words such as “Changan.” Among all three artwork explorations, the mirror received the least number of favorite votes, I conclude that the reason has to do with the lack of a situated context for this object. Participants like to explore, to discover, to search, or to find stuff. Although participants such as Aaron, Billy, and Clark were interested in the information on the mirror itself, providing a context for it would make the exploration more meaningful and more interesting to them. Billy felt the mirror was “just given to him” and took him no effort to find it at all and suggested, “if it’s possible to add a little like finding . . . the place [of] the mirror” (Bill-Int3).

The suggestion by Clark to add “copy and paste” functions to the notepad and article pad is one that would potentially impact the participants’ article writing process. Piaget suggested, that in the cognitive equilibration process, learners respond to contradictions in three ways:

(1) They might ignore the contradictions and preserve with their initial scheme or idea; (2) they might waver, holding both theories simultaneously and dealing with the contradiction by making each theory hold for separate, specific cases; or (3) they might construct a new, more
encompassing notion that explains and resolves the prior contradiction. (Fosnot, 1996, p. 16)

From comparing versions of their articles, I found participants tended to stay with the structure they established in the first version of their article about the Chinese dragon or held to different parallel structures instead of breaking away from the constraint of the structures to reconstruct a new structure for writing their article (see discussion in *Cognitive Equilibration and Organizational Structure*, page 153 and Table 11 & 12). Certainly, the participants' cognitive ability contributed to this. However, the fact that people have a tendency to resist change cannot be ignored. And, if the changes require a lot of work it adds more weight to the resistance. Since the "copy and paste" functions were not available to the participants they were less inclined to move words, sentences, and paragraphs around when they encountered cognitive contradictions. In other words, cognitive activity is mediated by the tools given; this leads us to Vygotsky's mediation theory—tools, artifacts do not merely facilitate but also fundamentally shape our experience.

**Computer Mediation**

In this study, I designed and produced the research instrument. To illustrate the multiple dimensions of Chinese dragons, I chose artworks with Chinese dragon motif that represented different symbolic meanings of Chinese dragons such as the messenger between the heaven and earth, imperial, and astronomical associations. I studied literature about Chinese dragons and made decisions on what to include and what to omit. The research instrument—the Chinese Dragons multimedia CD-ROM, like any other mediums, was value laden and represented the researcher's perspective.
After the first program interaction, most of the participants showed a positive attitude toward the program interaction. Participants such as Matt, Bill, Nina, Jenny, Clark, and Steve showed enthusiasm about learning through the multimedia interaction. Inspired by the participants' enthusiasm about the program, I ventured into computer mediation issues. I asked them two questions: (a) If you have a choice between learning Chinese history and culture through interacting with a multimedia program like this or learning the knowledge of Chinese history and culture from your teachers which way would you prefer? and (b) You learned information from your teachers and you also got information from computers. If these two sources of information conflict which source will you trust? And why? As the producer of the program, knowing the effort put into the production of the program and knowing what was behind the product (e.g. ideology, perspectives), on one hand, I was pleased with what I heard; however, on the other hand, I was alarmed by what I heard as well.

The answers to the first computer mediation question (interactive programs vs. teachers, see above) that I asked can be divided into three types: (a) prefer learning from interactive programs, (b) prefer learning from teachers, and (c) like to have both channels of learning. What follows are quotations representing each type of answer from the interviews.

*Prefer Learning from Interactive Programs.* The majority of the research participants (ten out of fourteen) expressed that they preferred learning Chinese history and culture through interacting with a program rather than from teachers. The explanations given by the participants varied. Jenny said, “because (when) my teacher tells me it she talked for long time so it gets boring. When I did it by myself on a
computer, the interactive thing, it's kind of fun" (Jenny-Int1b). I counteracted her answer and asked, "Don't you have different types of teachers some teachers will, say for an example, when you learn about that, maybe you can do a play . . . " (Jenny-Int1b). Jenny replied, "It's just that I don't like to hear about. I like to go more to the Internet and search it because I find computers are more fun than teachers. I like reading or acting it up. Sort of fun" (Jenny-Int1b). I further asked Jenny, "however, you can not ask computers questions but you can ask teachers questions". Jenny disagreed, she believed that you can ask questions on computers too. She said, "you go to a certain place and you ask it, the questions, and it will answer your questions. Because I found a place you can ask the question . . . " (Jenny-Int1). She also believed that many reference CD-ROMs provided answers too. On the other hand, teachers are not always available, "sometimes, teachers are always busy answering other kids' questions" (Jenny-Int2).

Clark preferred the interactive CD-ROM because he liked to see pictures and in CD-ROM he could go back to see them whenever he wanted. Clark said, "I prefer the CD-ROM because you can like see the pictures. I'm really like I can't really concentrate on like I see a teacher they hold up like books and pictures it's like you can always go back and look at the information. It's just like the teacher sometimes like keep the information from you" (Clark-Int1b).

Steve liked the "choices" provided by an interactive program. He said, "Well, you don't get bored as easily I don't think, but it's more interesting. Because you move around and you click on the choices. And that's the main reason I think" (Steve-Int1b). Nina compared teachers and interactive programs. The reason why she less preferred learning from a teacher was "because [her] teacher talked too much" (Nina-Int1b). She
added, "Sometime the teacher explains too much. Talks too much. She keeps on doing
the same thing. The same thing" (Nina-Intlb). In the contrary, Nina believed that the
typical kind of learning on computers was characterized as "researching", i.e. the learner
plays an active role and had to search for information.

_Prefer Learning from Teachers._ Two participants, Bruce and Amanda,

preferred learning Chinese history and culture from their teachers. The reasons why they
preferred teachers over interactive multimedia programs were different. Amanda was a
grade conscious student and wanted to learn what would be on the tests. She believed
that teachers knew what would be on the test, could tell her what to take notes on, and
could go through the content much faster. The following is my interview conversation
with Amanda on this subject.

Guey-Meei: Let me ask you a question... To learn Chinese culture and
history, (if) you have a choice of having a teacher teach you about Chinese
culture and history or you have a choice of doing that on a CD-ROM
which one will you prefer?
Amanda: Teacher. Because you have to listen to her. When you listen
you all have the same information and that's on the test.
Guey-Meei: So you prefer teachers to teach you the information. So you
don't like to do it on the CD-ROM.
Amanda: Well, because the teacher knows what's on the test and she's
probably going to teach you what-
Guey-Meei: Oh, I see. So you are concerned about the test. So you are
concerned that the topics covered by the CD-ROM and the teacher are
different.
Amanda: Yeah.
Guey-Meei: What if they are all the same? If have a choice of a teacher or
a CD-ROM.
Amanda: The teacher, because it seems like it will go faster and she can
tell what to take notes on.
Guey-Meei: I see. So the CD-ROM you have to figure out yourself where
to take notes.
Amanda: Mm-mm (affirmatively).
Guey-Meei: Interesting (Amanda-Intlb).
Bruce gave a different reason as to why he preferred teachers over an interactive multimedia medium. Bruce first said, “Well- I’m more of an audible learner. . . It sticks in my head if I hear it”. He later revised his answer, “O, well I mean I’m kind of an all around kind of learner. It sticks in my head if I hear it, if I see it, or if I do it” (Bruce-Int1b). I felt unclear about Bruce’s answer and asked, but “in the CD-ROM you can hear it, you can see it” (Bruce-Int1b). Bruce agreed, in the CD-ROM, he saw and heard but he did not think he could actually “do” things. He said, “Not really. You can’t really do anything on it. . . Except for clicking the mouse and typing something. But, mm- basically yeah you see it and you hear it” (Bruce-Int1b).

Like to Have both Channels of Learning. Matt and Billy liked to have both channels of learning and thought that it was not easy to compare learning from teachers with learning through interactive programs because there were different types of teachers and computer programs. Matt stated “I prefer both. Every place is like that. It’s about who is your teacher. How is that (the interactive program) designed? It depends on everything (many things) because the computer CD can be every way (many ways) and a teacher can almost teach every way (many ways). You can do an act. You can just read from a book. You do so many different things” (Matt-Int2). Billy gave a similar account and he pointed out the pros and cons of these two learning channels. He stated, “First, it (you) can’t really compare (them) because teachers’ teach[ing] can mean whole (many) different levels. Usually, if you have a teacher you usually have more time that . . . you can learn about an area instead - But this way (through interactive programs) is a more fun way and those- I learned a lot. Those things I learned a lot of compare to the time. Usually, if you are in situation you are doing with a teacher you are usually learning more
anyway. But you probably are spending usually a lot more time. That’s usually (the case) but usually it would be a lot more boring though. But teachers could make interesting things and they could blow it” (Billy-Int3).

Similar to the first question about computer mediation, the answers to the second computer mediation question (information from teachers vs. information from computers, see page 120) can also be divided into three types: (a) trust information on computers, (b) trust information from teachers, and (c) it depends—compare both sources and exercise judgement. What follows are quotations of each type of answer from the interviews.

**Trust Information on Computers.** The youngest participant of this study—Anna (third grade) trusted information on the computer over information from teachers. The following is the interview conversation I had with Anna on this question.

Guey-Meei: Do you trust all the information that are put on the computer? Do you believe these information?
Anna: Yeah
Guey-Meei: Yes, why do you believe them? Anyone can put the information on the computer?
Anna: um- because it sounded real.
Guey-Meei: If I ask you, if your teacher tells you something about dragons then you look at things on the computer and it tells you different things and which one would you believe? Or you would believe both?
Anna: um I would believe the computer.
Guey-Meei: You would believe the computer not the teacher? Why?
Anna: Because the things on the computer are updated.
Guey-Meei: Updated, and your teacher might sometimes say thing wrong? Or their knowledge might be old? Is that what you mean?
Anna: Um- the teacher might have been teaching for a long time.
Guey-Meei: Yes, so they might know a lot.
Anna: They might not look it up on the internet, before they say it (Anna-Int1).

Similarly, Jenny (sixth grade) thought information on computers was more credible than information from teachers. She said, “I will trust what computers tell me
because the computer has right answers and the person that wrote all the stuff to put on a computer probably looks up a lot before they wrote anything done”. “You don’t think the teachers did that?”, I asked. Jenny replied, “Hum, not all teachers but some teachers” (Jenny-Int3).

Mark stated that he would not trust either source unless he had a third source of information. However, he said, “now if I had to answer. I would trust the program more because it wouldn’t, they’d publish a program, they’re not going to put any wrong information. Most of the time you’re not going to find a program that says three times two is twelve” (Mark-Int3).

Trust Information from Teachers. When two sources of information (i.e. teachers’ and computers’) conflict, Amada (eighth grader) trusted teachers’ “because she gives the information that she thinks is right and is probably going to be on the test” (Amanda-Int3). Amanda’s judgment about credible information source was subject to her concerns about grades and tests.

It Depends. When encountered with a conflict between the two information sources in question, Steve and Bruce would first judge the credibility of the information source other than the teachers’ or rely on the help of a third information source, and then make a judgment on which information to believe. Bruce said, he would bring in the CD-ROM, multimedia, or a book to the teacher and ask his teacher about it. He said, “I probably ask the teacher what do you think about this? This is what this says and you are saying a different thing.” I further asked Bruce,” what if your teacher told you I’m right the source [what] you brought in is wrong. What would you think?” Bruce replied, “I’d get a second opinion and if they say the same thing then I would probably just believe my
teacher" (Bruce-Int3). In Steve’s opinion, information on the Internet is not as credible as a CD-ROM title published by a reputed company. He said, "I don’t trust that much on the internet. I didn’t really know who is saying it. But CDs I think are pretty accurate so I guess I’d trust a CD or any kind of program like that, that’s known company a little bit more than a teacher" (Steve-Int3).

Hall (1996) points out that the critical view of technology is largely being overlooked when teachers integrate technology into curriculum. The computer mediation discussion above also alarms us about the importance of teaching students to take a critical view of computer technology. When I asked my participants if they would have a choice between learning from a teacher and learning by interacting with a computer program, the participants had different answers. Two participants chose teachers. Two participants liked to have both. However, the majority of participants (ten out fourteen) chose interacting with computer programs over teachers. When I asked them if there were conflicts between the information from your teachers and information you acquired from computer sources, which one would you trust? More participants believed that information acquired on the computer could be trusted more than information from teachers because information acquired from computers was “researched” but teachers’ may be spontaneous. The conversations with my participants allowed me to witness how computer technology impacts on today’s young minds. Computer media are not just tools; they shape our experience (McLuhan, 1967).

**Knowledge Construction**

Knowledge is socially, historically, and culturally constructed. In the same vein, the meaning of Chinese dragons depends on the interaction between an individual with
his or her society and Chinese dragons. There is no ultimate truth about Chinese dragons. For example, people living in the south and north of China perceive dragons differently because of the different environmental factors in the two regions. In the north, the climate is characterized by chronic dry weather. Insufficient rainfall often resulted in long droughts, interspersed with periods of heavy rainfall that brought massive flooding, which was intensified by the highly erodable loess soil of the region. These floods made changes in the course of the Yellow River and became a constant threat. Thus, the Dragon King, the god who was believed to regulate rain, became prominent in the minds of the northerners. On the other hand, in the southern part of China because the hot and humid environment was conducive to the spread of disease and pestilence, the dragon assumed the role of a god who could protect people and drive away the disease causing spirits, which made the people's lives miserable. One popular ritual expression of this belief was the annual dragon boat festival where the causes of disease were symbolically put out to sea. Therefore, the temples for the Dragon King were located mostly in the north and the dragon boat festival was a popular custom that originated in the south.

The meanings of Chinese dragons have many layers and multiple dimensions. In the Chinese Dragons program, to avoid the fault of over-generalization, Chinese dragons were presented in different cases and artworks, to represent the different symbolic meanings of the dragon in each context, such as in the case of the silk banner—the tomb of a noble lady from the Han Dynasty. The program did not pack neat facts about Chinese dragons to transmit to the participants. Instead, the program gave participants opportunities to select and transform information to develop their own representation of Chinese dragons. I understand that each participant brought their own prior knowledge to
the learning experience of the program. This played an important role in the participants' knowledge construction and meaning making process. When newly learned knowledge from the program interacts with prior knowledge and previously learned knowledge from the program, contradictions may result. The sources of the contradictions could be in organizational structures, scope of a definition, or contradictory information. The learner’s response to contradictions may take the shape in any of the three forms that Piaget has suggested—ignore the contradictions, hold contradictory theories simultaneously, and construct a new and more encompassing notion (see page 118-119).

Since knowledge construction is a complex phenomenon, it cannot be measured by a single criterion. This study looks at the participant’s knowledge construction with four sets of lenses including (a) selection and transformation of knowledge, (b) sources of information and knowledge in knowledge construction, (c) cognitive equilibration and organizational structure, and (d) types of knowledge transfer. Before talking about the lenses used to look at the participants’ knowledge construction and analyzing the participants’ knowledge construction through these lenses, I would like to discuss the participants’ knowledge about Chinese dragons before and after the program interaction. Evidently, the Chinese Dragons program had an impact on the participants’ knowledge about Chinese dragons.

Prior knowledge of Chinese dragons. Before interacting with the program, when asked about what they know about Chinese dragons, participants answered that question with unsureness and showed a limited knowledge about Chinese dragons. For example, Anna knew that the Chinese dragon was in the twelve animal cycle but she was not sure whether Chinese dragons were “good” or “bad”. Johnny and Denny both saw a
dragon dance at a festival and believed that Chinese dragons were a "good" ancient animal. Missy’s answer was similar to Denny and Johnny’s. In addition, Missy was the only participant who mentioned that the Chinese dragon connotes good luck. The understanding of the Chinese dragon of some participants such as Mark, Aaron, Jenny, and Bruce demonstrated a mixed understanding of Chinese dragons and western notions of dragons. Mark said, Chinese dragons are "a myth and represent most Chinese stuff [such as] people, war, anger, and invincibility" (Mark-Int1a). Aaron said, “they (Chinese dragons) are like different--some evil and some are-. They all mean different things . . . like anger and some are like happiness . . .” (Aaron-Int1a). Jenny said, “Well, I know that they (Chinese dragons) used to live like all over the world so . . . Other people are born on the year of dragon” (Jenny-Int1a). Bruce said, “a lot of tapestries or pots or whatever umm- artifacts from the Chinese history have had the symbol of a dragon on it. Well umm- I’m not quite sure what it means but I think it symbolizes mm freedom, umm- war and- -that’s about all I know” (Bruce-Int1a).

When asked of the question—What do you know about Chinese dragons, I observed Asian American participants were relatively more verbal about what they knew and their answers tended to show evidences of a mixed understanding of Chinese and Western dragons. On the other hand, non-Asian American participants were reluctant to answer this question because they felt that they didn’t know much about the subject. However, the research data did not show that Asian American participants had more prior knowledge about Chinese dragons than other participants.
In Chinese history and culture, although some Chinese dragons were associated with bad deeds, the symbolism associated with Chinese dragons was predominantly good in nature. Participants’ answers showed little differentiation between Chinese and western notions of dragons prior to the program interaction. The symbolism of Chinese dragons such as war, anger, and invincibility mentioned by participants are more typical characteristics of Western dragons, which are seen in movies or described in fictional stories. For example, Clark mentioned that he saw dragons in a movie called “Dragon Boy”, who had “... weapons and [he] would like kill some dragons, like underwater dragons. He like, because they were like bothering him. He was just like making waves. He didn’t know what he was doing, but then like made a tidal wave and then the dragon got scared and they like setup a guard or something like that, and then the guard like attacked them and then he just killed them or like sent them back down” (Clark-Int1a).

After the three sessions of program interactions, participants talked more fluently about Chinese dragons and could compare and differentiate the differences between Western and Chinese dragons as if they had become dragon experts. Although there were variations among the participants’ understanding of Chinese dragons and comparisons of Chinese and Western dragons, overall the participants demonstrated a better understanding and comparison after the program interaction was completed. In the following, I give an example of the participants’ understanding of Chinese dragons after the program interactions and also an example of the comparison between Chinese and Western dragons. Clark talked about his understanding of Chinese dragons after the program interaction. He said,
Chinese dragons like, benevolent for rain. They were like a transportation to the heavens for gods, goddesses, and immortals. They were on many artifacts including robes. And like nine was an auspicious number so they put nine along with dragons on the screen so there were nine dragons on the screen. And then they were put on many constellations, like constellations, artifacts, robes, and other things to like provide good stuff for Chinese people. They put like for their burial they had like artifacts put in with the person in the coffin and then like one of those artifacts was the banner which had dragons and other animals on it to represent many things. And that’s about all (Clark-Int3).

After the program interaction, when asked to compare Chinese and Western dragons, Jenny said,

What I discover about these dragons is a whole lot of dragons for thousands of years have been living all over the world. And not all are bad. The Western dragons seem to have a problem with a lot of humans. Try to attack them. Human feared them because they have sharp, vicious teeth and claws and how big they are. And most people think maybe these dragons are spiritual creatures sent to guide us and help us and some these dragons are to be put on clothing, banners, on lots of decoration and things because some people think that dragons are sign of royalty and guidance and good. And we still have some problem with the people that really don’t like dragons because back to the old ages as people would say dragons are trying to steal the princesses and knight around the world would come to kill the dragon. And not all dragons are big. Not all dragons are fire breathing. They don’t all have teeth. And from what I have seen dragons are not as mean, as vicious, and [as] cool as they seem (Jenny-Int3).

In the quotations above, Clark summarized what he learned from the program and Jenny brought in prior knowledge from Western folklore to make the comparison.

Lenses for Looking at Participants’ Knowledge Construction

Selection and Transformation of Knowledge. One of the lenses used in this study to look at the participants’ knowledge construction is “selection and transformation of knowledge”. This study is interested in knowing what information in the CD-ROM
interested the participants and whether the information was used and transformed in their knowledge construction. Comparison between each participant’s notes and article is the main source of data to look at the participants’ selection and transformation of knowledge.

Sources of Information and Knowledge. “Sources of information and knowledge”, incorporated in the participants’ articles about Chinese dragons, is another lens to look at participant’s knowledge construction. Versions of each participant’s article is the main source of data for this analysis. In their articles, I conclude that there are four sources of information and knowledge: (a) Chinese dragons; (b) artworks; (c) cultural and historical context; and (d) prior knowledge—personal knowledge, including contemporary and Western notions of dragons. Figure 35 illustrates these four sources of information and knowledge in four circles. “Chinese dragons”, being the source of information closest to the topic of the participant’s assignment in the program—writing an article about Chinese dragons, is located in the innermost circle. Depending on their “apparent relevance” from the assignment, the sources of information about “artworks”, and about “cultural and historical context”, are placed in the second and third circle from the center; whereas “prior knowledge”, which is brought into the knowledge construction by each participant, is placed in the fourth and outermost circle. The three inner circles of information sources, i.e. “Chinese dragons”, “artworks”, and “cultural and historical context” are found in the Chinese Dragons program and the outermost circle of knowledge source, i.e. “prior knowledge”, can not be found in the program.
Cognitive Equilibration and Organizational Structure. Cognitive equilibration and organizational structure is another lens used to look at participants’ knowledge construction. As discussed in the Chapter 2, cognitive equilibration is “a dynamic process of self-regulated behavior balancing two intrinsic polar behaviors, assimilation and accommodation” (Fosnot, 1996, p. 13). Assimilation is “the cognitive process by which the person integrates new perceptual matter or stimulus events into existing
schemata or patterns of behavior” (Wadsworth, as cited in Efland, in press, p. 36) or in short, “the organization of experience with one’s own logical structures or understandings” (Fosnot, 1996, p. 13). On the other hand, accommodation is “comprised of reflective, integrative behavior that serves to change one’s own self and explicate the object in order for us to function with cognitive equilibrium in relation to it” (Fosnot, 1996, p. 13) or in other words, “the creation of new schemata or the modification of old schemata” (Wadsworth in Efland, in press, p. 37). In the process of equilibration, it is the contradictions which cause learners to search for accommodations. According to Piaget, when learners encounter contradictions, their ways of accommodation may fall into one of the three types: choose to ignore the contradiction, hold both theories, or create a new theory to explain the contradiction (see page 118-119).

This study is interested in looking for evidences of cognitive equilibration in the participants’ knowledge construction process and the participants’ responses to contradictions in the balancing process. Versions of each participant’s article are the main source of data used to look at the participant’s cognitive equilibration and organizational structure.

The information presented in the Chinese Dragons program is case based. The information about Chinese dragons is presented in the context of artworks and artworks are in turn presented in the context of the Chinese historical dynasties in which they were created. On the other hand, the participants’ virtual assignment in the program was to write an article about Chinese dragons. Therefore, there was a contradiction between the required organizational scheme of the assignment (i.e. Chinese dragons) and the organizational scheme of the information presented in the program (i.e. artworks).
Therefore, to look for the participants' responses to this contradiction I analyze each participant's article. On the other end, to look for evidences of cognitive equilibration in the participants' knowledge construction process, I compare versions of the article and pay special attention to changes made to the title (which reflect the personal interpretation of the content) and whether participants ever went back to their previous versions of the article to make additions, alterations and or reorganization.

Types of Knowledge Transfer. “Types of knowledge transfer” is another lens to look at the participants’ knowledge construction. There are two levels of knowledge transfer—“low road” and “high road” (Efland, 1995; Fogarty, Perkins & Barel, 1992). The evidence of “low road” knowledge transfer is typically demonstrated in recall of facts. On the other hand, the “high road” knowledge transfer is evidenced in whether the learner is able to apply his or her learned principles for understanding and interpretation to other cases.

Fogarty suggests a model to evaluate level of transfer; there are six levels in his model (from simple to complex transfer), i.e. overlook, duplicates, replicates, integrates, maps and innovates (Fogarty as cited in Fogarty, Perkins & Barell, 1992). The following are descriptions of the six levels of transfer:

- **OVERLOOKS** Misses appropriate opportunities; overlooks; persists in former ways
- **DUPPLICATES** Performs the drill exactly as practices; duplicates with no change; copies
- **REPLICATES** Tailors, but applies in similar situations; replicates
- **INTEGRATES** Integrates; subtly combines with other ideas and situations; uses with raised consciousness
- **MAPS** Carries strategy to other content and into life situations; associates and maps
- **INNOVATES** Innovates; takes ideas beyond the initial conception; risks; diverges (p. 102)
To use the dichotomy of the "high road" and "low road" transfer to code the participants' knowledge transfer is not sufficient. However, Fogarty's six levels model is not completely applicable to code the knowledge transfer exhibited in each participant's article about Chinese dragons. I refer to these two systems to devise a four-type system to code the participants' knowledge transfer: (a) duplication, (b) paraphrasing, (c) integration, and (d) generalization, synthesis, and application of information. The duplication and paraphrasing are indications of low road transfer; on the other hand, the integration, generalization, synthesis, and application of information are evidence of high road transfer. Versions of each participant's articles about Chinese dragons is the primary data source used for looking at evidences of knowledge transfer by the participants.

**Summary of Each Participant's Knowledge Construction**

What follows is a summary of each participant's knowledge construction as viewed through the four lenses discussed above (a) selection and transformation of knowledge, (b) sources of information and knowledge, (c) cognitive equilibration and organizational structures, and (d) types of knowledge transfer.

### Anna (third grade)

| Selection and Transformation of Knowledge (shown in the notes) | • Dragon Robe: The Nine Dragon Screen, The Hall of Supreme Harmony, The Hall of Middle Harmony, Dragon Robe, Some Words of Advice (8,886 rooms)  
• Bronze Mirror: Bronze Mirror of the Tang Dynasty (five rings, dragon picture on the 1st and 2nd ring), Poem Inscription (auspicious gift).  
Transformation knowledge: N/A (Anna used the notepad to write her article). |
| Sources of Information and Knowledge | In Anna's article, the sources of information included mainly focused on "Chinese dragons" and "artworks", and some on "context" information. |
| Cognitive | At first she used the notepad to take notes and then |
eventually used it to write her article. Anna did not title her article possibly because she used the notepad for writing the article and the notepad does not have a title field.

When writing her article, Anna seemed to try to answer the question about what Chinese dragons are rather than writing an article about Chinese dragons. Assimilation was observed. She put pieces of information that she thought related to Chinese dragons together. She appended new pieces of information at the end of her existing “article” except for the last piece of new information. She placed it at the very beginning of her “article”.

The contradiction between “artwork” and “dragon” was ignored. In her article, Anna mainly organized Chinese dragon information according to artworks.

Johnny (5th grade)

Selection and Transformation of Knowledge (shown in the notes)

- Silk Banner: Han Dynasty (Confucianism)
- Dragon Robe: The Hall of Supreme Harmony (decorated with dragon symbols), Dragon Robe (dragons are good luck).
- Bronze Mirror: Twelve Animals of the Animal Cycle (chronological purposes to denote the twelve year cycle)

The contextual information on Confucianism was not used in the article writing.

Sources of Information and Knowledge

In Johnny’s article, the sources of information included “Chinese dragons” and “artworks”.

Cognitive Equilibration and Organizational Structures

Johnny titled his article “Chinese Dragons”.

Similar to Anna, in Johnny’s article, he seemed to answer the question—what Chinese dragons are—rather than writing an article about Chinese dragons. Johnny compiled pieces of information that he thought related to Chinese dragons. Assimilation was observed. In general, he appended new pieces of information after his existing “article” except for the last three pieces of new information. After I prompted him to explain “what does each of the two dragons on the mirror mean” and “what are the symbols on the silk banner”. Johnny inserted two sentences—“The first one is blue dragon east. The second one is used for chronological purposes to denote the twelve year cycle.” after the sentence “On the Bronze Mirror there are two dragons” (Johnny-Article). And Johnny inserted another sentence “There are two dragons on the top and two dragons on the bottom” after the sentence “A silk banner was placed on Dai with many symbols on it” (Johnny-Article).
The contradiction between “artwork” and “dragon” was ignored. In his article, Johnny described the three artworks, with some Chinese dragon information, in the order he explored, i.e. the mirror, the banner, and then the dragon robe.

<table>
<thead>
<tr>
<th>Types of Knowledge Transfer</th>
<th>* Duplicate information from the program.</th>
</tr>
</thead>
</table>

**Jenny (6th grade)**

| Selection and Transformation of Knowledge (shown in the notes) | Silk Banner: Site of the Mawangdui Tomb No. 1, Three Dimensional View of the Mawangdui Tomb, Two Dimensional View of the Mawangdui Tomb No. 1, Painted Silk Banner (3 realms), Two Intertwined Dragons (heavenly creatures, connecting the three realms, all immortal beings ride on the back of the dragons), Chang E and the Moon, and Ten Suns and Houyi  
Dragon Robe: (Because the Power Macintosh crashed Jenny lost notes about the dragon robe.)  
Bronze Mirror: Bronze Mirror of the Tang Dynasty (five rings), Twelve Animals of the Animal Cycle (twelve animals, chronological purposes to denote the twelve year cycle), Eight Trigrams 1, and Ecliptic and Astronomy  
The contextual information on Han thought about after life (in Site of the Mawangdui Tomb No. 1), the Mawangdui Tomb (in Three Dimensional View of the Mawangdui Tomb), and the two intertwined dragons were omitted in the article writing. |

<table>
<thead>
<tr>
<th>Sources of Information and Knowledge</th>
<th>In Jenny’s article, the sources of knowledge include “Chinese dragons”, “artworks”, and her “personal knowledge” (of Western dragons).</th>
</tr>
</thead>
</table>

| Cognitive Equilibration and Organizational Structures | Jenny titled her article “Silk Banner” after the first artwork exploration. She did not change the title after that.  
In Jenny’s article, she devoted most of her effort to describe what were on the three artworks rather than finding the different meanings associated with Chinese dragons. Assimilation was observed. In writing her article, Jenny added the new information that she learned from the program to the end of her existing article and did not make changes to the part she had written previously.  
The contradiction between “artwork” and “dragon” was ignored. In her article, Jenny described the three artworks in the order she explored, i.e. the banner, the robe, and then the mirror. At the end, she brought in her view of Chinese dragons to conclude the article. |
|---------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|

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| Types of Knowledge Transfer | • Duplicate and paraphrase information from the program.  
• Generalization of information.  
Quotes:  
“During my expedition I have realized that dragons are spiritual  
creatures, not all are mean and that they are respected by lots  
of people in the past. They were used for decorations and not  
very many were feared by them. Each dragon represents  
something, or a story, so don’t fear dragons but love, and  
respect them, good-bye” (Jenny-Article). |

| Clark (6th grade) | Selection and Transformation of Knowledge (shown in the notes) | • Silk Banner: Han Dynasty (Confucius idea), Two Views of the Mawangdui Tomb No. 1, Central Compartment, Three Nested Painted Caskets, Painted Silk Banner, Heavenly Realm (legends), Two Intertwined Dragons  
• Dragon Robe: Qing Dynasty, Some Words of Advice, Around the City, Taihe Gate, The Hall of Supreme Harmony, The Nine Dragon Screen, Dragon Robe, The Dragon Robe & the Twelve Symbols of Authority.  
Notes to himself: “Write about how it differs to American dragons” (Clark-Article).  
The contextual information on Han Dynasty (Confucius idea), Tang Dynasty, Qing Dynasty, Some Words of Advice, Around the City, and Taihe Gate were omitted in the article writing. |

| Sources of Information and Knowledge | In Clark’s article, the sources of knowledge include all of the four sources, i.e. “Chinese dragons”, “artworks”, “context”, and “personal knowledge”.  
Examples of personal knowledge: “For example, 1987 is the rabbit”, “Like, the Egyptians, she had some possessions including a painted silk banner which depicts the journey of Lady Dai’s soul” (Clark-Article). |

| Cognitive Equilibration and Organizational Structures | Clark titled his article “Chinese Dragon Robe” after his first artwork exploration. In the second session, he changed the title to “Chinese Dragon and Chinese History”. During the third session, first, he changed the title to “Chinese Dragons” and later he changed the title back to “Chinese Dragon and Chinese History” (Clark-Article).  
Some evidences of accommodation were observed. In the first session, Clark set the initial structure for his article—began |
Clark started with a general statement about Chinese dragons and then used dragons on artworks to illustrate different meanings of the Chinese dragon. In the second and third sessions, he basically followed this initial structure but made augmentation—he expanded the beginning statement and went back to his writing to add words and phrases to make his article more coherent and transition better from one idea to another idea. In the third session, Clark added a conclusion (a comparison of cultures represented by Chinese and Western dragons) to his article.

Clark saw the contradiction between the “dragon” and the “artwork” and made both to be the organizational structure of his article.

| Types of Knowledge Transfer | • Paraphrase information from the program.  
|                            | • Integrate information from different artworks.  
|                            | • Generalization and application of information. |

Quotes:
“Many of the dragons give a lot of history about Chinese culture so we can thoroughly understand. But American dragons are way different, they are usually considered as living creatures that breathe fire and destroy cities or towns. With American dragons, there are barely any culture information for Americans. So I believe that Chinese dragons are way better than American dragons because they include the history of Chinese culture!” (Clark-Article).

**Steve (6th grade)**

| Selection and Transformation of Knowledge (shown in the notes) | • Silk Banner: Han Dynasty (date), Chang E and the Moon (Chang E), Two Intertwined Dragons  
|                                                               | • Dragon Robe: Qing Dynasty (date), Dragon Robe  
|                                                               | • Bronze Mirror: Tang Dynasty (date), A Use of a Tang Mirror, Four Symbolic Animals of the Celestial Palaces, Chinese Astronomical Systems (Dragon Xiang was in the summer), Twelve Animals of the Animal Cycle. |

The contextual information on Chang E (in Chang E and the Moon) was included in the first version of Steve’s article but was omitted in the final version of his article.

| Sources of Information and Knowledge | In Steve’s article, the sources of information include “Chinese dragons”, “artworks”, and “context” information. |

| Cognitive Equilibration and Organizational Structures | Steve titled his article “Chinese Dragons” after his first artwork exploration and in the second session, he kept this title. In the third session, Steve changed the title of his article to “Chinese Dragons of the Han, Qing, and Tang Dynasties” (Steve-Article). |
Evidences of accommodation were observed. In the first session, Steve wrote about the Chinese dragons on the silk banner. When he came for the second session, he appended the description of the Chinese dragons on the dragon robe after the silk banner's. In addition, after he explored the two artworks and observed some commonalities between the dragons on the robe and the banner. Steve elevated this statement—"The Han people thought that dragons were heavenly, powerful creatures."—originally pertained to the Han silk banner, to a general statement about Chinese dragons. In the third session, after I suggested Steve to break one long paragraph into paragraphs. Steve took the suggestion and made the structure that he developed in the second session more distinct, i.e. general statement followed by the description of dragons in the three artworks, and also he added a concluding paragraph at the end of his article.

Steve saw the contradiction between the "dragon" and the "artwork" and made both to be the organizational structure of his article.

**Types of Knowledge Transfer**

- Paraphrase information from the program.
- Integrate information from different artworks.
- Generalization of information.

Quotes:
"As you can see from this article Chinese dragons were on considered to be quite powerful. You may also have noticed that dragons appeared with the number twelve twice: twelve symbols of authority and twelve Zodiacs. Dragons were clearly one of the main concerns of the ancient Chinese" (Steve-Article).

**Billy (6th grade)**

**Selection and Transformation of Knowledge**

- Dragon Robe: Qing Dynasty (date), The Forbidden City (1420 to 1925), Some Words of Advice (8,886 rooms)
- Bronze Mirror: Twenty-eight Su (represents the 28 days that takes the moon to circle the earth.)
- Silk Banner: Two Views of the Mawangdui Tomb No. 1 (date—168 B.C.)

The information in Billy's notes was all used in his article.

**Sources of Information and Knowledge**

In Billy's article, the sources of information include mainly on "Chinese dragons" and "artworks", and some on "context" information.

**Cognitive Equilibration and Organizational**

Billy titled his article "The Bronze Mirror of the Tang Dynasty discovered!" after his first artwork exploration and in the second session, he changed this title to "Dragons in the Chinese history". In the third session, Billy revised the title a little to
### Billy (8th grade)

**Structures**

“Dragons in the Chinese history and culture” (Billy-Article).

Evidences of accommodation were observed. In the first session, Billy wrote about the Chinese dragons on the bronze mirror. When he came for the second session, he added a general statement about Chinese dragons at the beginning and appended the information of the Chinese dragons found on the dragon robe after the silk banner’s. In the third session, Billy appended the information about the Chinese dragons found on the silk banner after the dragon robe’s and he added a concluding paragraph at the end.

Billy saw the contradiction between the “dragon” and the “artwork” and made both to be the organizational structure of his article.

**Types of Knowledge Transfer**

- Paraphrase information from the program.
- Some evidence of generalization of information.

Quotes:

“This artifact shows that dragons played an important role in Chinese astronomy and date keeping methods.” “... dragons were even involved in Chinese policy.” “That shows how dragons were important in religion” (Billy-Article).

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### Matt (6th grade)

**Selection and Transformation of Knowledge (shown in the notes)**

- Dragon Robe: (notepad was not available at that time)
- Silk Banner: did not use notepad
- Bronze Mirror: Tang Dynasty, Bronze Mirror of the Tang Dynasty, twenty-eight Su, Four Symbolic Animals of the Celestial Palaces, Eight Trigrams, Twelve Animals of the Animal Cycle (names of 12 animals)

The information in Matt’s notes was all used in his article.

**Sources of Information and Knowledge**

In Matt’s article, the sources of information included “Chinese dragons” and “artworks”, and some on “context” information.

**Cognitive Equilibration and Organizational Structure**

Matt titled his article “The China’s Rob” in the first session. In the second session, he changed his title to “China’s” and in the third session, he changed the title to “China’s Dragons” (Matt-Article).

Assimilation was observed. In each subsequent session, Matt appended a new paragraph about Chinese dragons on the artwork he explored in the session and did not go back to the paragraph(s) he previously wrote to make alteration or rearrangement.

The contradiction between “artwork” and “dragon” was ignored. In his final article, Matt wrote three paragraphs about the three artworks he explored, i.e. the robe, the banner, and then the mirror.
### Nina (6th grade)

<table>
<thead>
<tr>
<th>Types of Knowledge Transfer</th>
<th>Nina (6th grade)</th>
</tr>
</thead>
</table>
| Selection and Transformation of Knowledge (shown in the notes) | - Silk Banner: Two Intertwined Dragons  
- Dragon Robe: Dragon Robe  
Notes to herself: “what does dragon [refer] to in the west”.  
The information in Nina’s notes was all used in her article. |
| Sources of Information and Knowledge | In Nina’s article, the sources of information include “Chinese dragons” and “artworks”, and “personal” knowledge.  
Examples of personal knowledge: “In the USA you might think dragons are scary but in China they are auspicious because they were heavenly creatures and could bring blessing from heaven” (Nina-Article). |
| Cognitive Equilibration and Organizational Structure | Nina titled her article “Dragon Ball” in the first session and did not change it in the subsequent session (Nina-Article).  
Assimilation was observed. In the first session, Nina started her article with a statement comparing Chinese and Western dragons and wrote about the Chinese dragons on the silk banner and then added information about the Chinese dragons on the dragon robe after those on the silk banner. When she came for the second session, Nina appended information about dragons found on the mirror and a conclusion after the article she had previously written in the first session.  
The contradiction, she thought that the Tang dragons were scary, was ignored. Nina saw the contradiction between the “dragon” and the “artwork” and made both to be the organizational structure of her article. |
| Types of Knowledge Transfer | - Paraphrase information from the program.  
- Generalization of information.  
Quotes: “Chinese dragons were kind like more the god’s - They are kind of like their mate. Like a pet would follow you everywhere and helps you. They were heavenly creatures” (Nina-Int2). “But in Chinese history including today the dragon is like a god. From being gods pets they became gods themselves” (Nina-Article). |

### Aaron (6th grade)

<table>
<thead>
<tr>
<th>Selection and Transformation</th>
<th>Aaron (6th grade)</th>
</tr>
</thead>
</table>
| Silk Banner: Two Intertwined Dragons  
Bronze Mirror: Tang Dynasty, Bronze Mirror of the Tang |
Dynasty, Four Symbolic Animals of the Celestial Palaces, Ecliptic and Astronomy, Chinese Astronomical Systems (Dragon Xiang was in the summer), Twelve Animals of the Animal Cycle, twenty-eight Su, Poem Inscription
- Dragon Robe: Dragon Robe

The information on Tang Dynasty, Ecliptic and Astronomy were omitted in the article writing.

In Aaron's article, the sources of information include mainly on "Chinese dragons" and "artworks", and few on "context" information.

In the first session, Aaron titled his article "Dragons in the Han Dynasty". In the second session, Aaron changed the title to "Dragons in Ancient China" and did not change the title until the fourth session. In the fourth session, Aaron changed his article title to "What Dragons Meant in Ancient China" (Aaron-Article).

Assimilation was observed. Similar to most participants, in each subsequent session, Aaron appended the newly learned Chinese dragon information to where he left off in the previous session. It was clear to Aaron in the last session that his article was about different meanings of Chinese dragons from different dynasties which is evidenced in his final title "What Dragons Meant in Ancient China" (Aaron-Article). He ended his article with the commonality among all three artworks.

To respond to the contradiction between artworks and Chinese dragons, Aaron was able to create a structure that gave dragons prominence over the artworks; on the other hand, in the paragraph about Chinese dragons on the Bronze mirror (2nd paragraph), Aaron was holding both the artworks and Chinese dragons simultaneously and they seemed to have held equal weight and separate places.

- Paraphrase information from the program.
- Some evidence of integration of information from two artworks.
- Some evidence of generalization of information.

Quotes:
"Dragons in all three of these dynasties were based on the universe. By universe, I mean space, earth, heaven, and the underworld" (Aaron-Article).

Mark (6th grade)

- Silk Banner: Han Dynasty (date), Two Intertwined Dragons
- Dragon Robe: Dragon Robe, The Dragon Robe & the Twelve Symbols of Authority (justice, discernment of good or evil).
- Bronze Mirror: Chinese Astronomical Systems (dragon was
<table>
<thead>
<tr>
<th>Notes</th>
<th>on east side—summer view of sky</th>
<th>All of Mark’s notes were transformed to construct his writing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sources of Information and Knowledge</td>
<td>In Mark’s article, the sources of knowledge include all of the four sources, i.e. “Chinese dragons”, “artworks”, “context”, and “personal knowledge”. Example of personal knowledge: “Americans see dragons a different way compared to the Chinese dragons also. Americans see them as evil creatures, killer, and the physical image is also different” (Mark-Article).</td>
<td></td>
</tr>
<tr>
<td>Cognitive Equilibration and Organizational Structures</td>
<td>Mark titled his article “The Chinese Dragon” in the first session and kept that title for the second session. In the third session, he changed the title to “How Dragons Were Used by the Chinese” (Mark-Article). Assimilation was observed. Similar to most participants, in each subsequent session, Mark appended the newly learned information to where he left off in the previous session. It appeared that Mark had determined in the first session that his article was to be organized around the meanings of dragons not on the three different artworks. Mark created a structure for accommodating the Chinese dragon information from the three different artworks. He gave the dragon a prominent place and the artwork and context knowledge were used to illustrate meanings of dragons. In his final article, Mark began with a general statement about Chinese dragons and the body of his article flowed from one idea of Chinese dragons to another and ended with a conclusion.</td>
<td></td>
</tr>
<tr>
<td>Types of Knowledge Transfer</td>
<td>• Paraphrase information from the program. • Integrate information from different artworks. • Generalization of information and making connection. Quotes: “When people died the Chinese took the bodies into a tomb and painted a story on a strip of silk. They would involve the dragon in this part because the saw the dragon as a transport from the earth to the heavens” (Mark-Article). “The dragon wasn't only used in China. Some other countries may have used it way before the Chinese did. For how it got started, the main focus is the Chinese when we think of dragons. The idea of dragons was a good myth, but the Chinese also have many serious things about it” (Mark-Article).</td>
<td></td>
</tr>
</tbody>
</table>
**Selection and Transformation of Knowledge (shown in the notes)**

- Silk Banner: Two Views of the Mawangdui Tomb No. 1, Painted Silk Banner, Heavenly Realm, Wind God, Lady Dai Receiving Food, Jade Disk, Offerings to the Dead (Lady Dai), Two Intertwined Dragons
- Bronze Mirror: Chinese Astronomical Systems (dragon—summer)
- Dragon Robe: The Nine Dragon Screen, Inside the Hall of Supreme Harmony, Dragon Robe

The information in Bruce's notes was all used in his article.

<table>
<thead>
<tr>
<th>Sources of Information and Knowledge</th>
<th>In Bruce’s article, the sources of information include mainly on “Chinese dragons” and “artworks”, and some on “context” information.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Equilibration and Organizational Structures</td>
<td>In the first session, Bruce titled his article “to get to the heavenly realm, the dragons had to” and did not change it afterwards (Bruce-Article). Similar to most participants, in each subsequent session, Bruce appended the newly learned information to where he left off in the previous session. It seemed that Bruce had determined in the first session that his article was to be organized around the different symbolism of Chinese dragons. This was illustrated in his beginning statement question: “Do you know what the Chinese dragons symbolize?” (Bruce-Article). Evidence of accommodation was observed in the second version of Bruce’s article. In the first session, after he explored the silk banner Bruce concluded the role of Chinese dragons was like the angel in the Western cultural lore. At the end of the first version of Bruce’s article he wrote, “The Chinese culture is very dependant on the dragon. It symbolizes what we think of as angels (—bring the soul of the dead to heaven)” (Bruce-Article). In the second session, after he explored the bronze mirror piece, Bruce learned different symbolisms of Chinese dragons. He realized the contradiction and deleted the part about the analogy between Chinese dragons and angels. Bruce recognized the complexity of Chinese dragons. In his final article, Bruce ended his article with the following statement: “So do we know the true meaning of the Chinese Dragons? Do they mean wisdom, courage, truth, or purity? We know so much of the meaning but we may never know the full extent” (Bruce-Article).</td>
</tr>
</tbody>
</table>

| Types of Knowledge Transfer | • Paraphrase information from the program. • Some evidence of generalization of information. Quote: “The Chinese culture is very dependant on the dragon. It symbolizes what we think of as angels. We know what the dragon symbolizes but we are just beginning to understand” |

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“So do we know the true meaning of the Chinese Dragons? Do they mean wisdom, courage, truth, or purity? We know so much of the meaning but we may never know the full extent” (Bruce-Article).

<table>
<thead>
<tr>
<th>Denny (8th grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection and Transformation of Knowledge (shown in the notes)</td>
</tr>
<tr>
<td>* Dragon Robe: Inside the Hall of Supreme Harmony, Dragon Robe</td>
</tr>
<tr>
<td>* Silk Banner: Painted Silk Banner, Two Intertwined Dragons</td>
</tr>
<tr>
<td>The information in Denny’s notes was all used in his article.</td>
</tr>
<tr>
<td>Sources of Information and Knowledge</td>
</tr>
<tr>
<td>In Denny’s article, the sources of information include mainly on “Chinese dragons” and “artworks”, and some on “context” information.</td>
</tr>
<tr>
<td>Cognitive Equilibration and Organizational Structures</td>
</tr>
<tr>
<td>Denny did not title his article in the first session. In the end of the second session, I prompted Denny to do that, he then gave his article a title—“Chinese Banners and Dragon Robes” (Denny-Article) and did not change the title after that.</td>
</tr>
<tr>
<td>Assimilation was observed. In each subsequent session, Denny appended a new paragraph about Chinese dragons on the artwork he explored in the session and did not go back to the paragraph(s) he previously wrote to make alteration or rearrangement.</td>
</tr>
<tr>
<td>The contradiction between “artwork” and “dragon” was ignored. In his final article, Denny wrote three paragraphs about the three artworks, with the Chinese dragons information, he explored.</td>
</tr>
<tr>
<td>Types of Knowledge Transfer</td>
</tr>
<tr>
<td>* Duplicate and paraphrase information from the program.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Amanda (8th grade)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection and Transformation of Knowledge (shown in the notes)</td>
</tr>
<tr>
<td>* Silk Banner: Han Dynasty, Site of the Mawangdui Tomb No. 1, Two Dimensional View of the Mawangdui Tomb No. 1 (5 compartments), Three Nested Painted Caskets</td>
</tr>
<tr>
<td>* Dragon Robe: Qing Dynasty, The Forbidden City, The Nine Dragon Screen, The Hall of Supreme Harmony, Dragon Robe</td>
</tr>
<tr>
<td>The information on Site of the Mawangdui Tomb No. 1, Qing...</td>
</tr>
</tbody>
</table>
Sources of Information and Knowledge

- In Amanda’s article, the sources of information include “Chinese dragons” and “artworks”, and “context” information.

Cognitive Equilibration and Organizational Structures

- In the first session, Amanda titled her article “Chinese Dragons” and did not change it afterwards (Amanda-Article).
- Assimilation was observed. In each subsequent session, Amanda appended a new paragraph about Chinese dragons on the artwork she explored after her previous version of the article and did not go back to the paragraph(s) she previously wrote to make alteration or rearrangement. She ended her article with a closing statement about the importance of dragons to Chinese people. She said, “So from the early eras of Chinese culture to the more futuristic times of the Chinese dates, the dragon has been one of the most important symbolic and spirited animals” (Amanda-Article).
- The organization of a paragraph was set in the first session—A general statement about Chinese dragons in a dynasty followed by specific examples or descriptions of Chinese dragons in an artwork.
- Amanda saw the contradiction between the “dragon” and the “artwork” and made “Chinese dragons” to be the organizational structure of her article.

Types of Knowledge Transfer

- Duplicate and paraphrase information from the program.
- Some generalization of information.
- Quotation:
  “The dragon could connect the three realms, which is somewhat shown on the banner. Gods, goddesses, and immortal souls are shown to be riding on the backs of dragons to go to heaven. Surely the dragon was a creature of great worth and power” (Amanda-Article).

Missy (9th grade)

Selection and Transformation of Knowledge (shown in the notes)

- Silk Banner: Jade Disk, Wind God, Two Intertwined Dragons, Site of the Mawangdui Tomb No. 1 (life after death), Painted Silk Banner (silk—expensive, dragons on silk banner), Han Dynasty (spirits, immortality, morality, loyalty, ritual behavior, agricultural society, appointed officials based on merit)
- Bronze Mirror: some names of 28 su in the Graphics of the twenty-eight Su

- Missy’s notes on names of 28 su was not used in her writing.

Sources of Knowledge

- In Missy’s article, the sources of knowledge include all of...
| Information and Knowledge | the four sources, i.e. "Chinese dragons", "artworks", "context", and "personal knowledge".  
Example of personal knowledge: "The dragons were also thought to bring rain, which in an ancient society like this, would have meant fertility, food, and therefore life" (Missy-Article). |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive Equilibration and Organizational Structures</td>
<td>In the first session, Missy titled her article &quot;The Importance of the Chinese Dragon during the Han Dynasty&quot; (Missy-Article). In the second session, Missy changed her title to &quot;The Chinese Dragon&quot; and did not change it afterwards (Missy-Article). Missy did not simply append newly acquired information at the end of her previous version of the article. She placed them where she saw it appropriate. She added sentences to integrate ideas and flowed from one idea to another. Missy was the only participant who showed strong evidences of cognitive equilibration in the process of her writing—balancing between assimilation and accommodation. When she encountered contradictions she created a new structure to accommodate the contradiction. For example, in the fourth paragraph of the second version of her article (see Appendix I), to integrate the silk banner and the dragon robe, she added a sentence—&quot;The dragon was appreciated enough to be placed on robes and banners of silk.&quot;—before the paragraph written in the first version—&quot;Even though paper was available and silk was as expensive as gold. The Hans believed in immortality, so their burials would be extremely important to them because it determines the rest of their eternity&quot;. In addition, Missy added another sentence in the end of the paragraph—&quot;This is just as the emperor during the Qing dynasty claimed divine right and was therefore worshipped, and highly regarded.&quot; (Missy-Article)—to connect the ideas from both the banner and the robe. In her final article, Missy started with a general statement about Chinese dragon and then discussed the different meanings of Chinese dragons found on the three artworks and ended with a concluding paragraph. The differences between Missy’s article and those of other participants with a similar structure was that she broke the constraint of artworks and made connections between the different ideas of Chinese dragons embedded in the three artworks (see the discussion above). In addition, she bought her interpretation of the information into the description of the Chinese dragons. For example, Missy wrote, &quot;This symbolism of masculinity attributes to the dragons sign as being powerful and liked. In this society, the women were regarded much lower than men. Since the dragon symbolizes masculinity in this society, it was thought to have much power, like men&quot; (Missy-Article).</td>
</tr>
</tbody>
</table>
Missy saw the contradiction between the “dragon” and the “artwork” and made “Chinese dragons” to be the organizational structure of her article.

Types of Knowledge Transfer

- Many evidences of integration of information.
- Many evidences of synthesis and generalization of information.

Quotes:
“Today however, though the dragon is thought of highly, though there is very little symbolism in it in today’s American society. Since the year 2000 is being advertised to such an extent, and it is the year of the dragon in the Chinese zodiac, the dragon received a sort of revival, or maybe an introduction into the part of American society without Chinese heritage or beliefs” (Missy-Article).

Cross-Participant-Analysis of Knowledge Construction

In the following I make a cross analysis of the participants’ knowledge construction through the four lenses (a) selection and transformation of knowledge, (b) sources of information and knowledge, (c) cognitive equilibration and organizational structures, and (d) types of knowledge transfer.

Selection and Transformation of Knowledge. This study is interested in finding what information in the program interested the participants during their explorations and whether the information they jotted down in their notes was used or transformed in the course of their knowledge construction—writing the article about Chinese dragons. The source of data for this analysis was the participants’ notes (see Appendix J). The following table (Table 7) is the result of this analysis. What this table demonstrates is that most of the participants were interested in all sources of information in the program, i.e. information about “Chinese dragons”, “artworks” that depict dragons, and the “context” of the artworks. Three participants, Nina, Denny, and Billy, were the exceptions. Nina only took notes on Chinese dragons; Denny took notes on Chinese
dragons and artworks; whereas Billy took notes on artworks and the context but not anything specifically on Chinese dragons. In addition to taking notes on the information in the program, Nina and Clark also wrote down self-reminder notes—comparing Chinese and Western dragons.

<table>
<thead>
<tr>
<th>Sources of Information</th>
<th>Dragons</th>
<th>Dragons &amp; Artworks</th>
<th>Artworks &amp; Context</th>
<th>Dragon, Artworks, &amp; Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Names</td>
<td>Nina</td>
<td>Denny</td>
<td>Billy</td>
<td>Johnny, Jenny, Clark, Steve, Matt, Aaron, Mark, Bruce, Amanda, Missy</td>
</tr>
</tbody>
</table>

Table 7: Sources of Information in Participants' Notes

As to amount of notes that participants took, five participants took a large amount of notes (more than 21 lines); two participants took a medium amount of notes (between 11 to 20 lines); six participants took a small amount of notes (less than 11 lines). Please see the following table for more details. The number in parenthesis is the total number of lines of notes taken by each participant.
<table>
<thead>
<tr>
<th>Large</th>
<th>Medium</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bruce (23)</td>
<td>Matt (13)</td>
<td>Nina (5)</td>
</tr>
<tr>
<td>Jenny (24)</td>
<td>Steve (17)</td>
<td>Johnny (5)</td>
</tr>
<tr>
<td>Aaron (37)</td>
<td></td>
<td>Mark (7)</td>
</tr>
<tr>
<td>Amanda (40)</td>
<td></td>
<td>Denny (8)</td>
</tr>
<tr>
<td>Clark (70)</td>
<td></td>
<td>Billy (8)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Missy (9)</td>
</tr>
</tbody>
</table>

Table 8: Amount of Notes

When writing their articles, six participants used or transformed all the pieces of information in their notes into their articles and seven participants did not use all the information in their notes. Please see the table that follows for names of the participants and the summary of each individual’s knowledge construction, which shows the details of the notes not used in their writing. Among the three sources of information, the “context” information was the type of information omitted most by participants in their article writing.

<table>
<thead>
<tr>
<th>Use of Notes in the Article</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partially Used</td>
</tr>
<tr>
<td>Names</td>
</tr>
<tr>
<td>Johnny</td>
</tr>
<tr>
<td>Jenny</td>
</tr>
<tr>
<td>Clark</td>
</tr>
<tr>
<td>Steve</td>
</tr>
<tr>
<td>Aaron</td>
</tr>
<tr>
<td>Amanda</td>
</tr>
<tr>
<td>Missy</td>
</tr>
</tbody>
</table>

Table 9: Use of Notes in the Article
**Sources of Information and Knowledge Used in the Article.** This study examined what sources of information and knowledge were actually used in the knowledge construction of the participants’ article writing. As discussed before, the four sources of information and knowledge included in the participants’ articles include (a) Chinese dragons, (b) artworks, (c) context, and (d) prior knowledge. The first three sources of information could be found in the program and the forth source of knowledge was the prior knowledge that the participant brought to the program interaction. Table 10 shows sources of information and knowledge used in the participants’ articles. Most of the participants’ articles (eight out of fourteen) incorporated all three sources of information found in the program. One participant, Johnny only used information about Chinese dragons and artworks in his article. In two participants’ articles, Jenny and Nina’s, I found the use of information about Chinese dragons and artworks and their personal knowledge. In three participants’ articles, Clark, Mark and Missy’s, I found the use of all four sources of information and knowledge. For the examples of prior knowledge used in their articles please see the summary of each individual’s knowledge construction discussed before this section (i.e. before the cross-analysis of participants’ knowledge construction).
Cognitive Equilibration and Organizational Structure. This study also looks for participants’ responses to the contradiction in organizational structure as well as their cognitive equilibration evidenced in the participants’ article writing. As discussed before, the information presented in the Chinese Dragons program is case based—information of Chinese dragons presented in the context of artworks and artworks presented in the context of Chinese historical dynasties. On the other hand, the participants’ virtual assignment in the program was to write an article about Chinese dragons. Therefore, there was a contradiction between the required organizational scheme of the assignment and the organization scheme of the information presented in the program.

In the participant’s article, there are three organizational patterns exhibited. One of the patterns is that the participants were subject to the informational organization of the Chinese Dragons program and used artworks as their organizational scheme. In another pattern, participants tried to combat the organizational structure of the program.
but could not completely overcome it, thus both artwork and dragon were used as the organizational schemes of their articles. In the third pattern, participants were able to create a structure that allowed the dragon to be the organizational scheme of their articles. These three patterns observed in this study were parallel to Piaget’s observation of an individual when encountering a contradiction between two theories. For example, Piaget suggested, that in the cognitive equilibration process, an individual would either choose to ignore the contradictions, hold contradictory theories simultaneously, and construct a new, more encompassing notion (see page 118-119). The following table (Table 11) shows that there were five participants in this study that ignored the contradiction and used artworks as the organizational scheme of their articles. Four participants used both artworks and dragons as their organizational scheme. Five participants were able to overcome the contradiction and used dragons as the organizational scheme of their articles, which was required of the virtual assignment.
When examining versions of the participants’ articles, I observed some evidences of the participants’ cognitive equilibration. The evidences were observed in the change of their article title, as well as, in the versions of their articles—in which participants went back to their previous versions and made changes, additions, and or reorganization. As shown in the table that follows (Table 12) there were seven participants who changed their article title to better reflect the content of their article and there were five participants who made changes, additions, and or reorganization to their previous version(s) of the article. Among these five participants, Clark, Steve, Billy, and Bruce made some additions or changes to their articles whereas Missy not only added and changed but also reorganized the text in her article.

### Table 11: Response to the Contradiction in Organizational Structure

<table>
<thead>
<tr>
<th></th>
<th>Artwork</th>
<th>Parallel</th>
<th>Dragon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnny</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jenny</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clark</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Steve</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Billy</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Matt</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nina</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Aaron</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mark</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bruce</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Denny</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Amanda</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Missy</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
In a way, I was surprised to know why most participants just appended text to the previous version of their articles. Certainly the cognitive growth of the participants was accountable for this. However, there were other contributing factors as well. Kos and Maslowski (1998) stated that “lack of automaticity with lower-order skills, such as spelling and handwriting, may hinder the development of some children’s higher-order skills such as the generation and organization of ideas” (p. 5). I speculate the “not adequate typing skill” might have contributed to the appending phenomenon observed in the process of the participants’ article writing. Some participants had not developed good typing skills and typing might have consumed most of their energy and became an obstacle to overcome before they were able to concentrate on their ideas (e.g. Johnny and Matt). Perhaps assisting these participants in typing may remedy the difficulty of typing and help them get their ideas onto the computer. For example, in the second session, Matt lost his article due to a program bug and was not willing to re-type the article he typed previously because he types slowly. Persuaded by his mom, Matt dictated and I typed his article for him. Another contributing factor I suspect is that the copy and paste functions were not available for the notepad and the article pad. As mentioned before, people have a tendency of resisting changes. And, if the changes require a lot of work it adds more likelihood to the resistance. To reorganize the article meant to retype the text that they would like to move around. To most participants that meant a lot of work. This connects to Vygotsky’ notion of how tools, artifacts shape our experience. In this case, how the function of the program might shape the participants’ knowledge construction.
Table 12: Evidences of Cognitive Equilibration

<table>
<thead>
<tr>
<th></th>
<th>Shown in Changes of the Title</th>
<th>Accommodations Shown in Versions of Participants' Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Johnny</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Jenny</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Clark</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Steve</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Billy</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Matt</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Nina</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Aaron</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mark</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Bruce</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Denny</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Amanda</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Missy</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Types of Knowledge Transfer. For understanding the participants' knowledge construction, this study also looks at the types of knowledge transfer in the participants' articles. There were four types of knowledge transfer exhibited in the participant's articles. They were: (a) duplication, (b) paraphrasing, (c) integration, and (d) generalization, synthesis, or application of information. The table that follows shows the type(s) of transfer demonstrated in each participant's article. Duplication and paraphrasing were types of low road transfer whereas integration, generalization, synthesis, or application were types of high road transfer. Johnny, Anna, Matt, and Denny showed only low road transfer in their articles. The rest of the participants all showed some forms of high road and low road transfer in their articles. For examples of quotes from the participants who demonstrated "generalization, synthesis, or application"
knowledge transfer, please see the summary of knowledge construction of each participant.

<table>
<thead>
<tr>
<th>Name</th>
<th>Duplication</th>
<th>Paraphrasing</th>
<th>Integration</th>
<th>Generalization, Synthesis, or Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anna</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnny</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jenny</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Clark</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Steve</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Billy</td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Matt</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nina</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Aaron</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mark</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Bruce</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Denny</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amanda</td>
<td>X</td>
<td>X</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Missy</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Table 13: Type of Knowledge Transfer

Conclusion

In this chapter, I analyzed how the participants' interactive experience was affected by the different aspects of the research instrument and how the participant's knowledge construction resulted from the Chinese Dragons program interaction. For implications, plan of future study, and conclusion of this study please see the discussion in the Chapter 5.
CHAPTER 5
WHAT DO WE LEARN?
WHAT DOES THIS TELL US?
WHERE ARE WE GOING FROM HERE?

The main story told by the data is that computers, like any other previous technology, not only facilitates the students' learning experience but also fundamentally reshapes and transforms that experience. The strengths of multimedia computing—interactivities, situated contexts (immersed environment), non-linearity, user control, connections, and multisensory delivery—are capable of creating a new and different learning experience embraced by young learners. Speaking from first hand experience, as an instructional designer and researcher, I learned how a constructivist, situated, and case based multimedia learning program like the Chinese Dragons program in this study could empower learners to build up an understanding of complex knowledge through the exploration of multiple cases and the multimedia features central to this experience.

I also observed how the presented organizational structure of information and the tools provided by the multimedia learning program could have a strong hold on the learner's knowledge construction, which more advanced learners could use to create cognitive structures of their own. In addition, I witnessed how this multimedia program
played a part in shaping the young participants' views about computers, computer
mediated knowledge and learning. From my conversations with the participants on the
computer mediation issues and the impact of technology mediation suggested by
Vygotsky, McLuhan (1967) and Preziosi (1989), I believe, we, as teachers, parents, or
instructional designers, must be aware that we are—what we use, what we learn, and how
we learn. I do not think resisting the use of computers is the way to combat the impact of
the computer-mediated experience. Instead, we need to teach our students critical
computer literacy—to be conscious about what we are using, learning, and receiving from
“computers”.

In this chapter, I will first share my experience of creating the multimedia
learning program of this study—the Chinese Dragons CD-ROM. I will discuss
guidelines that I have concluded from this study that may be helpful to other educational
software designers or researchers interested in designing an interactive learning program.
Following this, I offer some of my thoughts inspired from this study, my plan for the next
version of the Chinese Dragons CD-ROM—what to expect in the new version--, and my
plan for future research.

Sharing My Experience

In this study, I designed and produced the Chinese Dragons CD-ROM program,
implemented its use, and analyzed the effects of the program. There are many things that
I have learned from this process. I would like to share some principles embodied in the
Chinese Dragons program that contributed to the participants’ enjoyable interactive
learning experience. These guidelines are (a) connecting with young users—fun and
active learning, (b) case based representation for building up complex understanding, (c) user control and consideration, (d) multi-sensory delivery to create situated learning contexts (immersed setting), and (e) computers being the medium.

Connecting with Young Users. In this study, most participants’ first experience with computers (started between age four to seven) was playing a game, which is quite different from the generations before them. The study participants started their computer experience with playing on computers and learning to work on computers later. By contrast, I started my computer experience with working on computers and learned to play on computers much later. My first experience with computers was learning how to write programs using the basic programming language when I was eighteen years old. That experience was not much fun as compared with the experience of my participants’ generation.

When playing a game the player is usually having some fun and is actively engaged in interaction. The young users of this generation perceive computers as an active, interactive, and fun medium. In order to connect with young users, an interactive learning program needs to match their perception of computers. The Chinese dragons program met that expectation and was perceived by participants as fun, interactive, and active learning. As described by one participant, they did not just sit there and be passive; they had to search, find, and explore. Participants considered searching, finding, and exploring fun. Gregory states that for “learning to occur, students must construct their own meaningful and personal knowledge bases . . .” (Gregory, 1995, p. 8). This program gave participants opportunities to learn through constructing their understanding.
and knowledge. In addition, participants were fond of the stories and mythology acquired through interaction with the program.

*Case Based Representation for Building up Complex Understanding.*

Concurring with Efland (1995), the Chinese Dragons program intends to “preserve the innate complexity of the material being learned, while at the same time, recognizing the learner can not capture all the complexity at once. The learner does not have to deal with the totality in one learning episode, rather, with multiple traversals, a complex understanding is achievable” (p. 146). In the program, participants dealt with one case representation of Chinese dragons at a time. Exploring multiple cases of Chinese dragons helped participants to build up a complex understanding of knowledge learned (Chinese culture and history through Chinese dragons). In their writings and interview responses, participants demonstrated such a complex knowledge build-up.

*User Control and Consideration.* When designing an interactive learning program it is important to give the user as much control as possible such as options to stop, pause, and advance to the next “page”. Often a user will “complain” if they cannot do what they want to do in a program. Certainly, the addition of more controls means an increase in the amount of time and effort involved. Similarly, user consideration is very important in designing a program. In the Chinese dragons program, I had to consider the amount and the type of information to include; whether they had the right difficulty level and whether they would interest the target users of the program.

*Multi-sensory Delivery to Create Situated Learning Contexts.* Situated learning theory emphasizes that learning is inseparable from its setting and learning is context dependent. One of multimedia’s strengths is its multi-sensory delivery, which helps to
create a situated and immersed context for learning. Graphics (including animation),
narration, music, and video, the multimedia elements of the Chinese Dragons program,
were mentioned as favorite points of the program. These multimedia elements set the
context for the exploration as many participants such as Missy, Matt, and Clark stated.

*Computer being the Medium.* Motivation and learning are closely related.
Students who are motivated usually demonstrate better learning results and higher
performance (Bandura, Corno and Mandinach in Relan, 1992). Schunk defines
motivation as "the process whereby people set goals and engage in cognitive activities
(e.g., monitor goal progress) and behaviors (e.g., expend efforts) to attain their goals"
(Schunk in Sultan and Jones, 1995, p. 96). Motivation has two types: extrinsic and
intrinsic. According to Schunk, "[i]ntrinsically motivated learners exert effort simply for
the inherent pleasure of the learning task itself... On the other hand, extrinsically
motivated learners view the learning task as a means to obtain a reward or to avoid
punishment." (Schunk in Sultan and Jones, 1995, p. 96).

Reported by many educators, computer assisted instruction (CAI), representing
modern technological media, brings about positive motivational results and optimal
attitudes toward learning (Brown, Boschung, Kulik, Bangert and Williams in Relan,
1992; Yang as cited in Sultan and Jones, 1996). For example, "CAI improved attitudes
toward course work and the computer ..." (Kulik, Bangert and Williams in Relan, 1992,
p. 3). "[CAI] yield[s] significantly higher global self-esteem ratings ..." (Boschung in
Relan, 1992, p. 4).

Schunk believes that motivation cannot be "directly observed" but can be
"inferred from people's statements, choice of action, effort expenditure, and task
persistence” (Sultan and Jones, 1995, p. 96). Lee and Boiling (1996) suggest some indicators of the extrinsic motivation, e.g. engaging in deep processing, focused attention, persistence, extended effort etc. Relan also suggests the following as signs of intrinsic motivation, “task persistence, perceived control, level of task engagement, cognitive effort expended, attitude toward learning, cognitive monitoring, expectancies of success, self-efficacy and self-worth” (Relan, 1992). In this study I observed many motivation indicators in most of the participants such as persistency, voluntary choice, and extended work. Computers being the media of the interactive program should get some of the credit.

**Some Thoughts**

Here are some additional thoughts inspired by this study that I would like to share with my readers. My interview conversation with participants about computer mediation issues has an important message. Teaching a critical view about computers should be part of teaching computer literacy. Some participants stated that the reason why they liked learning on computers rather than learning from a teacher was because interacting with a program was more fun and a teacher sometimes talked too much and was boring. Moreover, some participants believed what they learned on computers was more credible than what they learned from their teachers.

Stating the above does not mean that I side with these participants. I do not believe that computers could or should replace teachers. I believe that there are things that computers cannot do that teachers can do better. We are sensible, tangible, emotional, and intellectual beings while computers are not. However, I believe the
computer is a valuable educational tool and it can be very helpful to teaching and learning. We have students with different learning styles, preferences who learn at different paces. The use of multimedia computing can accommodate these differences. In addition, computers provide young learners with motivation for learning—a medium associated with fun, interactivity, and active engagement (discussed above).

I believe that it is important to understand this tool not only in its technical and application aspects but also for its mediated impact. To resist the use of computers is not the best strategy to counteract the impact of computers. The participants' words send us an alarming message—we need to teach students to have a critical view about the computer-mediated experience and knowledge.

Although teaching practice is not a focus of this study some of the participants words about their teachers' teaching have led me to think about my own teaching. How did I teach my students? Did I understand what they are interested in learning? Did I care more about my own teaching agenda and less about whether they are learning? These participants' words function like a checklist for use when I plan my teaching and when I am teaching.

A Further Consideration—the Privacy Issue. Because of increased computer use, the physical characteristics of a learner's literacy work are disappearing. In the first Chapter, I stated that one of the significances of this study is providing snapshots of a learner's knowledge construction process. I designed a way to track the users' program interaction. I informed most of my participants about the tracking function but did not explore this issue with them any further. I wonder what was the user's perception of this tracking function? Would the user feel as comfortable with computers if they knew that
the computer was recording their activity? One advantage of using an interactive
program on computers is that computers are "patient" with users—without nuisance
computers will re-display the same information or read the text multiple times to the
users if they so request. However, if they knew that the computer is tracking their
interactivity, would they be less likely to repeat the request and be afraid of "making
mistakes" because the computer is watching them?

_Deconstruct the Stereotype of Chinese Dragons._ This study on the Chinese
Dragons program did not intend to advocate any particular belief in Chinese dragons but
was intended to deconstruct the stereotype of Chinese dragons to present how Chinese
dragons were understood in Chinese history and culture. I believe that understanding
differences promotes understanding of each other and ignorance of differences creates
misunderstanding and separate people. At the end of the final interview, Nina and Missy
came to a similar conclusion. Nina expressed that sometimes differences became the
cause of wars. Nina said:

Animals are treated differently in cultures. Like the dragon, in China,
dragons are heavenly and great companions to the gods. In China,
dragons are powerful, heavenly, fearless, and great companions. But in
the Western part of the world, dragons are mean and scary (usually fight
the gods) they terrorize people, destroy villages, and kill. They are scary,
ugly, and sometimes, they are half of something else. China has
celebrated the dragons. Around the world people have different ideas,
sometimes it causes wars. China has given dragons honor by putting them
on clothes, silk and more. While in the West they showed how bad
dragons are by putting paintings, like this [point to the Dragon book].
Sometimes one of these things starts the world fearsome wars.
I asked, explain the last sentence to me.
She said, Sometimes different people think different things and start a war.

Similarly, Missy expressed that learning about others help to open
people’s eyes, she said,
I think it's (learning Chinese dragons is) interesting because as long it's not telling this is what you have to believe this is the only thing that's right and I think it's a good thing just to kind of open your eyes to other beliefs.

What to Expect in Chinese Dragons V. 1.5

There are aspects of the design of the Chinese Dragons program (V. 1.0) that need improvement and functions that need to be added to better the students' learning experience with the program. The function that needs further improvement is narration. I will add a glossary function and build a context for the bronze mirror in the new version of the program, and am debating about whether to add a “copy and paste” function for note pad and article pad. Further, the analyses of the participants’ articles indicates that about two-third of the participants’ knowledge construction affected by the interaction with the program lacks “integration transfer” (see discussion about types of knowledge transfer in Chapter 4) and incorporation of dynastic contextual information. To facilitate “integration transfer” and incorporation of dynastic contextual information in their knowledge construction, I am considering improving the design of the program—to create a network of connections.

Narration. The new narration function will enable students to pause, turn off and replay the narration.

Glossary Function. The new version of the Chinese Dragons program will have a glossary function to provide definitions and pronunciation of difficult words such as “auspicious” and Chinese words such as “Mawangdui.”

Context for the Bronze Mirror. I will do further research on the bronze mirror so that I can build a context for the mirror that is similar to the one in the banner or the
dragon robe. This context will help students make for a more meaningful understanding of the mirror and add a fun factor to the exploration of the mirror.

**Copy and Paste Function.** I am debating about whether to add the "copy and paste" function to the notepad and article pad. On one hand, this function will enable students to move text around with much ease. On the other hand, the function may make "copy and paste" too convenient and may make students less inclined to paraphrase the information found in the program. Versions of the students' articles show that most participants appended text to their previous article text rather than rewriting the earlier text to include the new information. I speculate that this may be due to that people tend to resist changes. Participants did not want to retype the text that they wanted to move—it was too much work. However, I am afraid that the "copy and paste" function may result in increased compilation of information found in the program, rather than higher order "integration transfer". Currently, I am inclined to add the "copy and paste" function to the program but further research needs to study the pros and cons of adding such a function.

**Network Connections.** Among all four types of knowledge transfer, integration transfer was the least observed in the participants' knowledge construction. To facilitate this type of transfer, I plan to create network connections among the three cases of artworks with Chinese dragon motifs.

**Plan of Future Research**

This research has taught me a lot about multimedia design and learning and I have also learned that there is much more to learn about understanding the dynamics between...
them. I am interested in different perspectives and ways that will grant me a more comprehensive picture about multimedia and learning. This research clues me in on the possible next steps to take in that quest. The following are some of them.

**Different student population—from different economic classes.** I would like to understand how students from families of a lower socio-economic class would respond to the program and how the differences in program interaction and the knowledge construction are affected by the program interaction. In this study, all of my research participants were from middle economic class families. This population sets a limitation on the transferability of this study. To include responses from students of different economic classes will give readers a clearer picture to assess the transferability of this program to other situations.

**Getting teacher's input on this program.** It is important to get the input from the perspectives of teachers, especially, if this program is to be used in a classroom setting. I plan to recruit teachers who are interested in trying out this program in their classrooms. I am interested in knowing their views on the design of the program, their ways of integrating this program into their curriculum and classroom activities, and how they see the benefits and downsides of the use of this program. I would like to research whether the use of prompts will help to facilitate accommodations and resulting cognitive growth, i.e. teachers serve as interpreters of the program and provide prompts and feedback to students when they interact with the program.

**Use of the Chinese Dragons program in a lab or Classroom Setting.** To efficiently reap the benefits of this program it will have to be used in a lab or classroom setting in school or a learning center where a larger population of students
could use it in a group setting. This research serves an important foundation for achieving that end. In this research, with fourteen research participants, I was able to observe and interview students individually and had in-depth interview conversations with each of them. However, in a group setting, I will not be able to talk to students individually. Based on the interview answers obtained in this research, I can devise a research questionnaire to obtain students’ views on this program after their interaction. In a lab or classroom setting, I will be able to efficiently collect a large quantity of student data in a couple sessions and will more likely have access to a student population with a more natural distribution curve in learning ability and socio-economic backgrounds.

*Based on this model to develop a program of other topic.* This program, based on a constructivist, situated, and case base approach, had success in building up students’ understanding of complex knowledge. I will seek partners who are content experts on other subjects to develop a program using other subjects based on this model and research its effects on understanding of other knowledge domains.

*Study of the effects of narration.* Narration was mentioned by four participants (Jenny, Amanda, Mark, and Steve) as the favorite point of the Chinese dragon program; on the other hand, it also attracted suggestions from five participants (Jenny, Denny, Aaron, Steve, and Missy). Participants had different preference about narration and had split opinions on it. It made me curious about its actual effect on the learner’s comprehension of the text and I would like to research it myself. How does narration help reading comprehension? To what degree, does it helps? What types or age group of learners prefer narration? What type or age groups of learner prefer to read text
themselves? What is the difference between reading comprehension with narration and without narration? What annoys those students who like to read the text themselves? Is it because the speed of narration can not keep breast with their reading speed or for other reasons?

**Conclusion**

As an educator and researcher with technical and artistic background, I am set to undertake a quest for exploring issues related to multimedia and learning. This research represents the commencement of that quest. I have learned much from this research and my research participants. I learned that the students' verbalization of their ideas or views is part of their thinking process (it's also true for adults). Sometimes, the students' suggestions were self-contradictory and cannot be taken as they are. It takes time and patience to learn what they really intended to mean or tried to express. Kids are a valuable source for inspiration and are the purpose for designing better education programs. I suggest that teachers and educational designers should work more closely with students in various age groups to develop teaching plans and educational programs, which are better and more enjoyable for learning. This study gives an account of learning experience and knowledge construction affected by multimedia interaction, which may serve as an inspiration for other research and program designs.


The Getty Center for Education. Lesson Plans & Curriculum Ideas, in the ArtsEdNet web site (http://www.artsednet.getty.edu)


176


CD-ROM Titles:


References for the Chinese Dragons CD-ROM Content Research

Publication in English:


179


**Publications in Chinese**


180
Figure 1. A Representation of a Semi-lattice (Esland, 1995, p. 148).
Figure 2. Northwest Airline United States/Canada/Mexico Service
Figure 3. Hub Network
These men did not come to America to find freedom or to discover new worlds or to get rich. These ancient hunters came here in search of game.

Figure 5. Early American History through Art
Figure 6. Africa Trail
Figure 7. Oregon Trail
Figure 8. Castle Explorer
Figure 9. My First Amazing History Explorer
Figure 10. Where in Time Is Carmen Sandiego?
Figure 11. Five Different Hypermedia Pathways (Keifer-Boyd, 1996, p. 29).
Figure 12. Chinese Dragons, Prototype 1
Figure 13. Chinese Dragons, Prototype 2
Figure 14. Chinese Dragons, Prototype 3
Figure 15. Chinese Dragons, Prototype 4, Main Interface
Figure 16. Chinese Dragons, Prototype 4, Two Slide Comparison
Figure 17. Chinese Dragons, Prototype 4, Chinese Dragons Challenge
The topic of this Month's cultural column is

Figure 18. Chinese Dragons 1.0, Reporter Assignment
Figure 19. Chinese Dragons 1.0, Research Center
Figure 20. Chinese Dragons 1.0, Article Pad
Figure 21. An Example of the Visualization of the Content Organization
Figure 22. The Travel Route of the China Trip
Figure 23. Images Used in the Scenario Question
Dear Guest Reporter,

Perspectives® is the most reliable news source for the American readers since 1911. We bring instant and accurate news and rich cultural stories to our readers. We are proud of our experience, excellence and tradition. You are assigned to our cultural division. Please proceed to check in.

Gusey-Meesl Yang  
Executive Editor

Figure 24. Chinese Dragons 1.0, Welcome from the Executive Editor
Figure 25. Chinese Dragons 1.0, Check-In Center
Find this Han silk banner, examine it by clicking on the nine blinking dots. The banner is inside of the Mawangdui Tomb. To find it first enter the Tomb...

Figure 26. Chinese Dragons 1.0, Explanation of Task and Interface
Figure 27. Chinese Dragons 1.0, Notepad
Figure 28. Chinese Dragons 1.0, Chariot Timeline
Figure 29. Chinese Dragons 1.0, Painted Silk Banner
Figure 30. Chinese Dragons 1.0, Video Prompt
Figure 34. Chinese Dragons 1.0, Conventional Timeline
APPENDIX A

AN EXAMPLE OF THE PARTICIPANT'S INTERACTION HISTORY
NAME: Clark
DATE: Saturday, April 22, 2000

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APPENDIX B

AN EXAMPLE OF THE DESCRIPTION OF A CD-ROM TITLE, PUBLISHED REVIEWS, AND THE THREE CHILDREN’S REVIEWS
## Description/Reviews

The Silk Road is a trade route that links China and the West together, starting from Xian, China and ending in Karachi, Pakistan. The people, religions, history, customs, languages, and explorers on the Silk Road are examined. Features include: slide shows, games (journey and life simulation, and virtual University of Dunhuang), video, narration, and music.

**Strength/Praise:**

- “Using slide shows, interactive games, video, narration, and music, the Silk Road CD-ROM succeeds at the daunting task of presenting this grand historical collage”.  
  
  (FamilyPC/March, 1997)

**Awards received:**

- 1995 - Graphex 95 - Society of Graphic Designers of Canada (Vancouver): Merrit Award
- 1996 - International Digital Media Awards (Toronto): Gold Medal (best consumer/enrichment, best use of photography), People's Choice Award.

(DNA Multimedia, Inc. Web Site)

## Reviews by Children

- It took a while to get familiar with the interface/navigation.
- The long, complex and passive video presentation was not liked because it presented too much information at a time. It was not possible to grasp and retain all information.
- The “University test” was too difficult and intimidated the user. As a result, the user did not feel too much fun with this CD-ROM.

(tested by a 9th and 5th graders)
APPENDIX C

AN EXAMPLE OF THE TEXT IN THE CHINESE DRAGONS PROGRAM
Silk Banner
Han Dynasty p.1

Liu Bang, the founder of the Han, rose from the lowly rank of a peasant to overthrow
the Qin dynasty. The Han dynasty was an agricultural society, and instituted a Confucian
bureaucratic system, which appointed officials based on their merit.

Han Dynasty p.2

The philosophy of Confucianism, which emphasizes morality, loyalty, and ritual
behavior, was promoted by the state.

Han Dynasty p.3

The invention of paper in the Han Dynasty aided the circulation of Confucian texts.
However, non-Confucian ideas, such as the belief in spirits, immortality, were popular
among the common people as well. The Han Dynasty is divided into two distinctive
periods: the Western and Eastern Han.

Han Territory

During the Han Dynasty, the territorial boundaries of China expanded greatly.
Looking for military allies and trade opportunities, the Han empire expanded westward
along the silk road and northward into the Korean peninsula. Further, the Han court also
sent armies to assist in the political expansion of the empire south beyond the Yangzi
River.

This silk banner, which was found in a tomb in the southern portion of the Han
empire, reveals some of the important beliefs about the afterlife during the Han Dynasty.

Site of the Mawangdui Tomb No. 1

Han people believed in life after death - after a person died, the person’s soul was
divided into two parts. One part would ascend and, possibly, enter Heaven and, the other
part would remain around the grave to consume the offerings placed in the grave. Han
people built elaborate tombs and furnished them with offerings to show their good will
toward the deceased person, but also to prevent angry ghosts from acting against them.

This is the site of Han Mangwangdui Tomb No. 1. It’s a huge tomb.

Two Views of the Mawangdui Tomb No. 1

The person buried in this tomb is Lady Dai, the wife of a prime minister of a small
southern kingdom -located in modern Changsha. Lady Dai died around 168 BC, which
was more than two thousand years ago. When the tomb was discovered in 1972, people
found the well preserved body of Lady Dai and a great number of funeral goods buried
with her. Most significant among them, was a painted silk banner which depicts the
journey of Lady Dai’s soul. The two views of the Mawangdu tomb on the right can help
you understand the tomb and find the banner.
Two Dimensional View of the Mawangdui Tomb No. 1

This view better illustrates the five compartments of the huge "wooden box" placed at the bottom of the Mawangdui tomb. The center compartment contained the body of Lady Dai which was placed in the innermost of three nested coffins. The four side compartments contained various grave goods for use by the soul of the deceased person in the afterlife.

Northern Compartment

The north compartment was modeled after the "retiring hall" in a traditional Chinese house during the Han period and contained a number of personal household items, such as eating and drinking utensils, bedroom articles, and furniture. Clothed figurines, which represented Lady Dai's attendants, dancers, and musicians, were placed in the eastern part of the compartment.

Western Compartment

This compartment contained clothes, and documents written on bamboo strips. Among the documents is a burial inventory, which lists all the contents of the tomb.

Central Compartment

This compartment housed three, nested, painted, caskets. The painted silk banner was placed on the top of the innermost casket, which contained the body of Lady Dai wrapped in several layers of silk.

Eastern Compartment

Wooden servant figurines, household articles, and food were placed in this compartment.

Southern Compartment

Wooden servant figurines, household articles, and food were placed in this compartment.

Three Dimensional View of the Mawangdui Tomb

This view helps illustrate the burial structure of the tomb. The tomb is 52-feet deep. At the bottom of the tomb an immmense wooden box was placed on bamboo mats. The wooden box was first covered by a layer of charcoal and then by a layer of white clay to prevent moisture from getting into the box and destroying its contents. The interior of the box was divided into five compartments, which held the body of Lady Dai and grave goods for her use in the afterlife.

Three Nested Painted Caskets

The outermost of the three nested caskets was painted solid black. The second one was also black, but has painted depictions of human, semi-human, and animal figures among swirling clouds. The innermost of the three nested caskets has painted images of
heavenly mountains, animals— including deer, cranes, dragons—and other figures against a red background.

You have almost found the painted silk banner! The banner was placed over the innermost coffin. But, which one on the right is the innermost coffin? Don't be fooled by the photo.

**Painted Silk Banner**

This 6 3/4-foot- long T-shaped banner was made of silk, a material which was considered as valuable as gold during the Han period because of the expense of its manufacture. Silk was a much sought after commodity. Merchants transported Chinese silk to the west along the silk road. Chinese silk reached as far as the Roman Empire.

The images on this banner depict the journey of Lady Dai's soul ascending to Heaven in three distinct sections. The top part of the banner represents the heavenly realm; the middle part depicts the land of living and the bottom part represents the underworld.

**Heavenly Realm**

The top section of the banner depicts the realm of heaven where mythical creatures -- the sun crow, moon toad, celestial dragons and beasts -- reside.

The right half of this section depicts imagery related to a famous Chinese legend about the sun. Opposite, imagery on the left half represents a Chinese story about the moon. In the middle, the seated figure with an intertwined snake tail is believed to be the goddess -- **Nuwa**.

**Nuwa**

This female figure with a snake body is believed to be the legendary goddess **Nuwa**. In Chinese mythology **Nuwa and Fuxi, her male counterpart, are considered to be the common ancestors of mankind, which Nuwa created from a lump of clay.**

The creature with a bat like head and the beak, wings, and body of a bird is believed to be the Chinese wind god. Accompanied by two intertwined dragons, the wind god is shown leading the soul of Lady **Dai** to Heaven.

**Ten Suns and Houyi**

In Chinese mythology, there once were ten suns, and within each sun, there lived a crow. The ten suns took turns, one at a time, to rise in the sky to shine light on the earth while the other suns were resting in a *fu* (mulberry) tree.

One day all of the ten suns decided to go to the sky together. The heat from the ten suns in the sky caused a big disaster on the earth.

To rescue the people, the Heavenly Emperor sent a skillful archer, **Houyi**, to the earth. To continue the story, please bring the arrow on the ground to **Houyi**.

With his heavenly bow and arrows, **Houyi** shot down nine of the suns leaving only one to remain in the sky.

As a result, the earth returned to its normal temperature and order.
Chang E and the Moon

The lady on the dragon's wing is believed to be the legendary lady Chang E who is an important figure in Chinese mythology about the moon.

Chang E is the wife of the legendary hero Houyi, who was sent down from Heaven to rescue the people. After Houyi shot down nine of the ten suns in the sky, the Heavenly Emperor was very angry and would not allow Houyi and Chang E to return to Heaven because the suns, which Houyi shot down, were the Heavenly Emperor's sons.

Finally, Houyi obtained a pill of immortality from the Queen Mother of the West so that he could return with his wife to their heavenly home.

However, before they departed, Chang E stole the pill from her husband and took it herself. Soon after she took the pill, she flew upward to the moon and turned into a toad.

The Land of the Living (Earth)

The middle section of the painted silk banner depicts the realm of the living. People are shown making offerings to the deceased person, Lady Dai and her attendants are depicted receiving food from her servants. The wind god and two intertwined dragons, passing through a bi are shown as if preparing to bring Lady Dai upward to heaven.

Wind God

The creature with a bat-like head and the beak, wings, and body of a bird is believed to be the Chinese wind god. Accompanied by two intertwined dragons, the wind god is shown leading the soul of Lady Dai to Heaven.

Lady Dai Receiving Food

The tallest standing figure, who bent with old age leans on a walking staff, is believed to be Lady Dai. She is accompanied by three female attendants standing behind her.

Two Intertwined Dragons

Han people believed that dragons were auspicious because they were heavenly creatures and could bring blessings from Heaven. Further, dragons could connect the three realms of Heaven, earth, and mankind. Gods, goddess, and immortals rode on the backs of dragons to ascend to Heaven.

In this banner, the two intertwined dragons with their tails extending into the underworld bring Lady Dai upward to join other heavenly residents by passing through a bi, jade disk (symbol of heaven).

Jade Disk

Ancient Chinese believed that earth was square and Heaven was round. The Bi, a round jade disk, created before the Han dynasty (206 BC - 220 AD), was used to represent Heaven in important state ceremonies.
Offerings to the Dead (Lady Dai)

With a set of bronze ritual vessels, male figures, possibly mourners, are shown making offerings to the soul of Lady Dai.

Underworld

The bottom part of the painted silk banner depicts the underworld. An earth spirit who stands on two intertwined serpentine creatures, holds in his two hands a plague, which symbolizes the earth.
APPENDIX D

THE FIFTEEN DATES OF DATA COLLECTION
<table>
<thead>
<tr>
<th>Dates</th>
<th>3-26-2000 Sunday</th>
<th>4-8-2000 Saturday</th>
<th>4-9-2000 Sunday</th>
<th>4-21-2000 Friday (Easter)</th>
<th>4-22-2000 Saturday</th>
</tr>
</thead>
<tbody>
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<td>Aaron</td>
<td>Jenny</td>
<td>Clark</td>
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<td></td>
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<td>Steve</td>
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<td>Nina</td>
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<td>Bruce</td>
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<td>Nina</td>
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<td>4-27-2000 Thursday (Spring break)</td>
<td>4-29-2000 Saturday</td>
<td>4-30-2000 Sunday</td>
<td>5-5-2000 Friday (after school)</td>
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<td>5-21-2000 Sunday</td>
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* The names in the same font came together on that date.

Table 14: The Fifteen Dates of Data Collection
APPENDIX E

THE SCHEDULING OF THE RESEARCH PARTICIPANTS
<table>
<thead>
<tr>
<th></th>
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<td>Friday</td>
<td>Saturday</td>
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</table>

Table 15: The Scheduling of the Research Participants
Participant Info:
Name: ____________________________________________
Grade: ___________ Age: ______ Gender: ______
Ethnic Backgrounds: ______________ Geographical Setting: ____________
School: ___________________________ Favorite Subjects: ______________________
Are you interested in the research results? ____ Yes ____ No
Address: ____________________________________________________________________

Session1: Before the program interaction interview guide:
• What do you feel about coming here to participate in a research project?

• Tell me what you know about Chinese dragons?
• Where have you seen Chinese dragons?

• Have you used computers before? ____ Yes ____ No
• What kind of computers do you use?

• Where do you use computers and what do you use computers for? What programs have you used?
  • Home
  • School
  • Library
  • Other

• When was the first time you used a computer? How old were you? What did you do on the computer?

• Do you like to use computers? Why? Why not?

• Did any projects at school involve the use of computers? Please tell me about them.

• Do your teachers use computers in classroom? How?

• Performance: __________________________
Session 1: After the program interaction interview guide:

- What do you feel about the program?

- Which part of the program do you like? Why?

- Which part of the program you don’t like? Why?

- Timeline?

- Narration?

- Notes?

- Writing the article?

- Are there a lot of words that you don’t understand? Auspicious? Emphasize?

- Choice between learning form a teacher and using an interactive program to learn?
APPENDIX G

SECOND SESSION INTERVIEW GUIDE
Session 2: Interview Guide

Name: ____________________________________________ Date: _________

Notes to the participant before the program interaction

After Interaction interview:
Did you notice any new features?

Today, you did __________________________
Can you tell me your experience with <this piece>?

Can you compare <today’s piece> and <last time’s piece>?

How is your article going?

A gift choice between two books.

Questions emerged from observation:
APPENDIX H
THIRD SESSION INTERVIEW GUIDE
Session 3: Interview Guide

Name: ________________________________ Date: __________________

Notes to the Participant before interaction
Complete the article today.
The finished article will be printed out with color pictures

Final interview:
Please rate the three pieces of artwork exploration in the program. Why?

Of the three artifacts, which one is the oldest piece? The second oldest? And the third oldest? What indicator did you see in the program that helped you to put the three artworks in this order?

Please tell me at least three things that you like in the program.

Please tell me at least three things that you would like me to improve so I can make this program better.

Glossary function? Review mode? Necessary?

Suitable level?

The use of this program in a classroom situation? Which subject? SS, RR and art?

Computer knowledge vs. teacher knowledge. Which do you trust if there is a conflict? Why?
Tell me what you know about Chinese dragons.

Scenario question:

Display several pictures of Western and Chinese Dragons.

- You are a famous scholar and are invited to make a presentation about Chinese and Western dragons. Now you are to prepare for the presentation. You need to outline your presentation and use some or all of the visuals provided here to illustrate the points you want to make. Please take a few minutes to outline your presentation and pick the visuals that you would like to use in your presentation. I will then ask you to give a short oral presentation.

Questions emerged from observation:
APPENDIX I

AN EXAMPLE OF THE PARTICIPANT'S ARTICLE

ABOUT CHINESE DRAGONS
The Importance of the Chinese Dragon during the Han Dynasty

The Han dynasty regarded dragons very highly. They saw them as a bridge between the three realms - heaven, the earth, and the underworld. In a silk banner, placed on the inner casket of Lady Dai's tomb during the Han dynasty, Dragons and the wind god are depicted bringing Lady Dai, along with her servants, to heaven, yet their tails are in the underworld, their bodies and heads in the earth section of the banner, but they are heading through a bi - a jade disk used to symbolize heaven.

The Hans thought highly enough of The dragon to use it on a silk banner, even when paper is available and silk is as expensive as gold. The Hans believed in immortality, so their burials would be extremely important to them because it determines the rest of their eternity.

On the above mentioned banner, two more dragons are shown lifting two mythological heroes down from heaven to complete their quests on earth.

All in all, this shows that the dragons were a connection between the three realms, and therefore highly regarded in the Han dynasty.

The Chinese Dragon

During the Qing dynasty, the dragon was a symbol of royalty and power. On the robe of the emperor and his mandarins, the dragon was depicted chasing a flaming pearl. This displays wisdom and truth. The dragons were also thought to bring rain, which in an ancient society like this would have meant fertility, food, and therefore life. The dragon also brought good luck and was a symbol of masculinity.

This symbolism of masculinity attributes to the dragons sign as being powerful and liked. In this society, the women were regarded much lower than men. Since the dragon symbolizes masculinity in this society, it was thought to have much power, like men.

The Han dynasty regarded dragons very highly. They saw them as a bridge between the three realms - heaven, the earth, and the underworld. In a silk banner, placed on the inner casket of Lady Dai's tomb during the Han dynasty, Dragons and the wind god are depicted bringing Lady Dai, along with her servants, to heaven, yet their tails are in the underworld, their bodies and heads in the earth section of the banner, but they are heading through a bi - a jade disk used to symbolize heaven.

The dragon was appreciated enough to be placed on robes and banners of silk. Even though paper was available and silk was as expensive as gold. The Hans believed in immortality, so their burials would be extremely important to them because it determines the rest of their eternity. This is just as the emperor during the Qing dynasty claimed divine right and was therefore worshipped, and highly regarded.
On the above mentioned banner, two more dragons are shown lifting two mythological heroes down from heaven to complete their quests on earth.

All in all, this shows that the dragons were a connection between the three realms, and therefore highly regarded. Today, however, though the dragon is thought of highly, there is very little symbolism in it in today's American society.

* Sat, May 13, 2000/3:42 PM
* The Chinese Dragon

Dragons have been a major part of the Chinese culture since before the Han dynasty. Throughout this time they have been a well respected symbol, whether it be of luck, of power, of the supernatural forces, or for scientific purposes.

During the Qing dynasty, the dragon was a symbol of royalty and power. On the robe of the emperor and his mandarins, the dragon was depicted chasing a flaming pearl. This displays wisdom and truth. The dragons were also thought to bring rain, which in an ancient society like this, would have meant fertility, food, and therefore life. The dragon also brought good luck and was a symbol of masculinity.

This symbolism of masculinity attributes to the dragons sign as being powerful and liked. In this society, the women were regarded much lower than men. Since the dragon symbolizes masculinity in this society, it was thought to have much power, like men.

The Han dynasty also regarded dragons very highly. They saw them as a bridge between the three realms - heaven, the earth, and the underworld. In a silk banner, placed on the inner casket of Lady Dai's tomb during the Han dynasty, Dragons and the wind god are depicted bringing Lady Dai, along with her servants, to heaven, yet their tails are in the underworld, their bodies and heads in the earth section of the banner, but they are heading through a bi - a jade disk used to symbolize heaven.

The dragon's connection with other worlds was transferred on to the Tang Dynasty. During this dynasty, Astronomers used the dragon in labeling the sky. It allowed them to keep better track of the motions of the planets, sun and all in all, our planet. The four xiang labeled the parts of the sky visible during the four seasons, and also symbolized the four main directions. The four xiang were the black tortoise (north and autumn), the blue dragon (east and summer), the red bird (south and spring ), and the white tiger (west and winter). This was on honor for these animals, because the stars could be used to do things like predict events and tell when to plant and harvest crops, which, without, the people could not live.

The dragon was appreciated enough to be placed on robes and banners of silk. Even though paper was available and silk was as expensive as gold. The Hans believed in immortality, so their burials would be extremely important to them because it determines the rest of their eternity. This is just as the emperor during the Qing dynasty claimed divine right and was therefore worshipped and very highly regarded.

All in all, this shows that the dragons were a connection between the three realms, and therefore highly regarded. It would lead them safely to their eternal afterlife, it would tell them when it was time to do things during their lives, as well as give them a status symbol, which meant everything to certain people.

Today however, though the dragon is thought of highly, though there is very little symbolism in it in today's American society. Since the year 2000 is being advertised to
such an extent, and it is the year of the dragon in the Chinese zodiac, the dragon received a sort of revival, or maybe an introduction into the part of American society without Chinese heritage or beliefs. So far it has been well received and has become a very popular symbol to see on clothing and decorative items, yet there is very little meaning behind it, other than that it represents the future in some ways, as it has come to stand for the new millennium, along with electric cars, powerful computers that can fit in your hand, and the exploration of Mars.

Maybe it's a good omen for the future, being an ancient symbol of luck. It worked for the Chinese for hundreds of years, and if we are lucky, perhaps it will continue to bring all it's ancient powers to the world from here on out.
APPENDIX J

AN EXAMPLE OF THE PARTICIPANT'S NOTES
Han (206 BC-220) people thought dragons were auspicious. Heavenly people like Chang E rode dragons. Dragons were heavenly things. Dragons could freely move between the realms. Lady Dai also rode the dragons along with other gods and immortals.

The Qing dynasty was from 1644 to 1911. Dragon robes called jifus were worn by civil and military officials. The most important part of the dragon robe was the dragon chasing a flaming pearl. This represented wisdom and truth. Dragons were considered benevolent, bringers of good luck. They also embody the masculine force in nature, and also heavenly authority. There were always nine dragons on a jifu. Nine was an auspicious number which represented ultimate Yang: male force in nature. Every dragon robe had the same design of the universe.

Tang Dynasty 589-618. Tang women used mirrors to prepare hair. The mirrors had four symbolic animals in the centermost part. One of these animals was the dragon in the east of the center part. The symbols were called Xiang (shun). The four Xiang represented the night sky constellations. The four shun each had a season. The Dragon Xiang was in the summer. All the Xiang were in the stars. The stars moved through the year. There were twelve animals, zodiacs, on the second ring of the mirror. One was the dragon. There were also others like the tiger, goat, monkey, dog, etc. I'm the hare. Each animal had a certain year of a twelve year cycle. People born in the year of an animal were believed to have that animals characteristics.