CHAPTER 2 LITERATURE REVIEW

Information Processing

One assumption of human information processing (IP) theory is that it is analogous to computer processing, in that it receives information, stores it in memory, and retrieves it as necessary (Schunk, 1996). The IP theory is referred to as the learning and memory model which has been used to describe learning in informal settings by Koran, Longino, and Shafer (1983) from Gagne (1970, 1973), Keele (1973), and Bransford (1979). The theoretical basis for this research study uses the assumption stated as an assessment tool to investigate learning strategies through electronic media via web pages as an effective informal learning environment. The generic state of the IP system is commonly referred to as the two-store (dual-memory), originally proposed by Atkinson and Shiffrin (1968, 1971). Figure 2-1 represents a modified version of this model emphasizing the attention, learning acquisition and retention facets of this study.

The IP theory views learning as the coding of information in long term memory by creating schema produced by relating new knowledge to existing information in the short term or working memory. Short term memory, or working memory, is the information that you are focusing on at a given moment. A part of the working memory, the sensory memory is a system of receptors holding sensory information very briefly. Long-term memory is where knowledge is permanently stored. Procedural memory is long-term memory for how to do things or processes.

Albert Bandura (1977) established that there were certain steps involved in the memory modeling process: (1) Attention: if you are going to learn anything, you have to be paying attention. Likewise, anything that puts a damper on attention is going to decrease learning, including observational learning, such as distraction from competing stimuli. If the model is colorful and dramatic, for example, we pay more attention. If the model is attractive, or prestigious, or appears to be particularly competent, you will pay more attention. And if the model seems more like yourself, you pay more attention; (2) Retention: the ability to retain and remember what your attention had selected. Typically, we store what we have seen the model doing in the form of mental images or verbal descriptions. When so stored, you can later “bring up” the image or description, so that you can reproduce it with your own behavior; (3) Reproduction: you have to translate the images or descriptions into actual behavior. So you have to have the ability to reproduce the behavior in the first place; and (4) Motivation: intrinsic and/or extrinsic will increase the rate at which you attend, retain and reproduce.

Although the schematic, which represents the IP theory, appears relatively simplistic, there are many parameters which are included in each phase. The factors which are discussed in this literature review are attention (including stimulus, engaging, holding power, and perception); knowledge acquisition or learning which encompasses both short term (rehearsal, repeating) and long term memory (elaboration, note-taking, mnemonics, imagery); and retention (including retrieval, recall, remembering). In addition, a discussion of two learning strategies, free choice (constructivism) and structured (objectivism), will be compared in the informal learning environment of Cyberspace. This research focuses learners in an informal learning environment. An
informal learning environment will be defined and discussed later in this section; however it should be noted that although many of the previous research in this area takes place in museums, zoological parks, aquaria and science centers, the role and analogy of the computer as an informal learning setting will be included in this study.

Attention

Attention is the focus on a stimulus. People’s attentional capabilities are limited; they can only attend to a few stimuli at a given moment. A stimulus is an event that activates behavior. To initiate a learning activity, one must first provide a suitable stimulus to attract the attention and arouse the curiosity of the learner; thus attention is a necessary prerequisite of learning. As Gagne (1973), Keele (1973), and Bransford (1979) point out, the first step in a sequence of learning and memory events is for the learner to attend to a stimulus. LaBerge (1997) proposed that attention to an object requires the simultaneous activity of three brain regions that are interconnected by a triangular circuit. The regions are the cortical site of attentional expression, the thalamic enhancement structure, and the prefrontal area of control. In the same study, it is also proposed that the additional component of attention directed to a representation of the self be included.

Curiosity plays a role at this point by acting as both a response to a stimulus and a factor for influencing further attention. As Koran and Longino (1983) found, the greater the complexity of the object, the higher degree of curiosity it will evoke. They also compared the time spent as a measure of attention to time in the vicinity of the stimulus can be a measure of curiosity. Further, Koran and Koran (1984) demonstrated that curiosity is a response to a novel stimulus, such as manipulatable objects found in informal settings. This stimulus will increase the amount of attention to the object. Koran (1984) also proposed that static stimuli influence attention for only a short period, thus coding is minimized and information storage and retrieval is low. Likewise, holding power, and engagement time, or the time spent actively learning, will also be limited.

An early study by Shettel et al. (1968) describes exhibit effectiveness as being dependent on the initial attracting power, subsequent holding power, and teaching effectiveness of the exhibit. Holding power is defined as the total time spent at an exhibit. Other studies have been performed attempting to attract visitor attention with a variety of methods such as using audio or participatory schemes (Screven, 1974a, 1974b, 1975; DeWard, Jagmin, Maistro, & McNamara, 1974); recessed objects (Dierking, Koran, Lehman, Koran & Munyer, 1984); manipulation of objects (Dierking, 1987; Koran & Koran, 1984; Koran, Koran & Longino, 1986; Koran & Longino, 1983; Koran, Morrison, Lehman, & Koran, 1984); interaction of visitors with exhibits (Birney, 1993; Boisvert & Slez, 1994, 1995; Dierking & Falk, 1994; Their & Linn, 1976); modeling (Koran, Koran, Foster, & Dierking, 1988); and using exhibit interpreters (Bennett, 1989). In addition, the length of attention has been found to be more important than interest in determining learning (Koran, Foster, & Koran, 1989); and providing links to prior knowledge has been shown to focus attention and increase learning (Ellis, 1993; Ham, 1983; Jenson, 1982; Koran, Koran, & Foster, 1989; Koran, Lehman, Shafer, & Koran, 1983; Miles & Tout, 1993; Screven, 1986).

In another study, Serrell (1997) proposed that the amount of time visitors spend and the number of stops they make in exhibits are systematic measures that can be indicators of learning. The time and stops at a museum can be equivalent to the duration and engagement of an Internet web page. In addition, Serrell (1997) points out that unless visitors get some enjoyable, provocative, or personally meaningful feedback from an exhibit, their attention will turn elsewhere; or if their exhibit challenges are not matched to their skills, visitors will not pay attention.

In order to reinforce the importance of attention, Shettel (1996) suggested that time on task (i.e., holding power) has been found to be one of the most useful predictors of educational effectiveness, and it has been used for this purpose in countless studies. Although holding power has been shown to be an important factor in learning, it cannot work effectively by itself. Attention must be focused by the use of colors, shapes or arrows (possibly motion or animation) on relevant features of the exhibit in order to increase the potential for effective learning (Koran & Lehman, 1981). Olson and Bialystok (1983) found that pictures contain amounts of information but attention must be directed to the visual details of the picture to enable decoding of this
information from the picture. The perceptual prominence of an item can be adjusted through the variables of size, position and value thereby influencing the order of processing individual pieces of data. People use the visual and spatial characteristics of graphical layouts to express relationships between object, icons, or other representations of underlying information (Shipman & Marshall, 1995). Attention to instructional materials can also be monitored via the computer. Dern (1997) reminds us that on-line users leave traces that others can find and use for assessment. This fact will be used in this study to assess learner flow and correlate time and attention to post-assessment scores.

Another aspect of attention is perception. Perception, which precedes coding, is the use of all of the senses to acquire information about the stimulus. It is also the mental grasp, awareness and decoding information and thereby depends on objective characteristics and prior experiences. Information in this instance could be anything from visual questions, pictures, or sensory stimuli. It is an active process and one that is an intrinsic part of learned behavior. Relevance in visual processing is all about being able to discriminate relevant features of an object, structure, image and through combining these features, deciphering an idea of the whole. Perception is an active process, not merely a passive response to visual input but the result of hypothesis formation and testing conditioned by our expectations (Bodecker, 1995). Perception is fundamental to interacting with computers as one needs to perceive the information at and through the interface (Preece, 1994). The information has to be presented in such a way as to avoid ambiguity. Good graphics usually means linking perceptual cues to important information, which means both identifying and capturing what are important, and guiding the reader with appropriate cues (Petre, 1995). Technology does not change the way people perceive information; it can, however, enhance that perception through a combined effort. The power of the recent technological surge of computers is that it produces the ability to combine various types of information, thereby surpassing social coding as the only creator of meaning.

Finally, attention is not only critical as a precursor to learning, but in addition it has been found to operate at both encoding and retrieval (Boronat & Logan, 1997). The importance of this factor will be discussed in following sections.

Knowledge Acquisition

Piaget (1974) defined knowledge as an interaction between subject and object; a perpetual construction made by exchanges between thought and its object; a reconstitution of reality by the concepts of the subject, who, progressively and with all kinds of experimental probes, approaches the object without ever attaining it in itself (Brenguier, 1980). In this respect, a concept is a general category of ideas, objects, people, or experiences whose members share certain properties.

Knowledge acquisition is part of learning. Learning is a process through which experience causes permanent change in knowledge or behavior that is not explained by development alone. Shuell (1986) defines learning as an enduring change in behavior, or in the capacity to behave in a given fashion, which results from practice or other forms of experience. Learning involves the acquisition and modification of knowledge, skills, strategies, beliefs, attitudes, and behaviors. Learning also involves cognitive, linguistic, motor and social skills and can take many forms (Schunk, 1996). However, Brooks and Brooks (1993) indicated that knowledge is temporary, developmental, and relies heavily on social and cultural factors. Schunk, 1996 also states three criteria for learning to take place: behavioral change, or change in the capacity for behavior; the enduring change over time; and change due to practice or other forms of experience.

Learning occurs through either behavioral or cognitive theories. Behavioral theories view learning as a change in the rate, frequency, or form, primarily as a function of the environment and contend that learning involves the formation of associations between stimuli and response. Skinner’s (1953) view was that a response to stimuli becomes more likely to occur as a function of the consequences of responding. In contrast, cognitive theories stress the acquisition of knowledge and mental structures and the processing of information and beliefs. A central theme in cognitive theories is the mental processing of information: its acquisition, organization, coding, rehearsal, storage in and retrieval from memory, and forgetting. For the purposes of this study, only cognitive theories will be discussed.
Cognitive theories contend that instructional factors alone do not fully account for students’ learning (Pintrich, Cross, Kozma, & McKeachie, 1986). In other words, how students attend to, rehearse, transform, code, store, and retrieve information is critically important. Other important instructional principles may include active involvement by learners, use of hierarchical analyses, emphasis on the structure and organization of knowledge, and linking new knowledge to learners’ prior cognitive structures (Ertmer & Newby, 1993). Therefore, learning is no longer simply the acquisition of behaviors, but also includes storing knowledge about relations in the world, and acquiring structural representations and mental models (Graeme, 1995). Finally, Zahorik (1995) list five elements that need to be taken into account for knowledge acquisition to be successful. They include activating knowledge, where prior knowledge structures are utilized; acquiring knowledge, where knowledge is acquired in wholes; understanding knowledge, with thorough examination; using knowledge, extending and refining structures; and reflecting on knowledge.

For optimal acquisition, new knowledge should be presented in a form that can be linked to old knowledge. Knowledge can then be assembled in a hierarchical form called schemata. Schemas are basic structures for organizing information and concepts. They are links between discrete chunks of information organized in a categorical form. Therefore, by activating a superordinate body of knowledge, subordinate information can be attached. This learning strategy process is analogous to standard computer functions and even more closely resembles the workings of an Internet WebPages. Homepages or the starting page are presented and displays various links or commands which will take the user to other pages, which contain associative information. In this way, the user or learner can begin with the foundation information and build on it as they progress through the links of information, integrating pieces of information into their useful schema for future use.

Retention

Retention is typically defined as the ability to remember, whereas retrieval is the process of searching for and finding information in long-term memory. Retention requires coding and transforming modeled information for storage in memory, as well as cognitively organizing and rehearsing information. Retention is increased by rehearsing information to be learned, coding in visual and symbolic form, and relating new material to information previously stored in memory. Knowledge retention is typically measured by performance on paper-and-pencil tests (Halpin & Halpin, 1982).

Evidence from Semb and Ellis (1994) indicates that long-term retention for knowledge taught in schools is substantial. They have made several points including retention decreases over time as a function of length of the retention interval; forgetting curves do not decline as rapidly; increasing the level of original learning differentially affects retention performance; both instructional content and assessment tasks affect learning and retention; most instructional strategies that promote higher levels of original learning may result in better retention; and higher ability students learn and remember more than lower ability students, although forgetting is about the same. They also report that the more prior knowledge or experiences that the student has of the specific concept, the more likely they will be able to retrieve the associated information. Very few students enter a classroom with no prior knowledge of the subject matter to be taught. This situation presents a problem for measuring both original learning and retention. While we focus on knowledge taught in school, we recognize that some learning has occurred prior to schooling and may occur during school outside the classroom, informally (Semb & Ellis, 1994). This aspect, although frequently overlooked, is critical in both sustaining formal education and realizing the power of learning which takes place through informal settings at home or in a museum.

Other factors which may influence the amount of retention and the rate are recall strategies such as chunking, where individual bits of data are grouped into meaningful larger units, typically in groups of seven, or special circumstances such as with episodic memory, where long-term memory for information is tied to a particular time and place, especially memory of the events in a person’s life. These become increasingly important as the learner struggles to maintain large amounts of educational information throughout their scholastic growth.
Learning Strategies

Bruner (1966) states that a theory for learning should address four major aspects: (1) predisposition towards learning, (2) structured so that it can be readily grasped by the learner, (3) an effective sequence to present the material, and (4) the nature and pacing of reinforcements. Good methods for structuring knowledge should result in simplifying, generating new propositions, and increasing the manipulation of information. Garner (1990) agrees that strategies enhance learning. However, learners often fail to invoke strategic behaviors due to five reasons, poor cognitive monitoring; primitive routines; meager knowledge base; attributions and classroom goals that do not support strategy use; and minimal transfer. If learners do not notice that they are not learning, they are unlikely to seek a strategic remedy (Glenberg, Wilkinson, & Epstein, 1982). This statement provides substantial support for the need of self-regulated learners.

Self Regulated Learning

One of the greatest difficulties facing designers of constructivist learning environments is the question of evaluating the learning that takes place. Under the constructivist paradigm, the learner determines his or her own learning goals. Given that the designers may not know the goals of the learner, how can they evaluate whether the goals have been met? The simplest answer seems to be to ask the learner. How does the learner know whether they have met their own goals? If the learner is self-regulating, that is, if they are constantly, and consciously, monitoring their comprehension and correcting comprehension failures, they will know if they have met their goals. How then can the designer know whether the learner is self-regulating? This aspect typically requires additional measures. Because it is a complex cognitive event, which involves numerous activities for the learner, researchers have a difficult time measuring a self-regulation learner (Howard-Rose & Winne, 1993). Three scales which have attempted to quantify self-regulated learning (SRL) are the SRL Rating scale (Corno, & Collins 1983); The Learning and Study Strategies Inventory (LASSI) (Westerman, 1995); and The Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich & Garcia, 1993). The results show that the revised MSLQ metacognitive self-regulation scale seems to be a reliable and valid measure of self-regulated learning when given in a web based learning environment.

Self-regulated learning is a dualistic construct with properties of an aptitude (Snow & Lohman, 1984) and an event (Winne, 1997; Winne & Hadwin, 1997). Self-regulated learners are students whose academic learning abilities and self-discipline make learning easier so motivation is maintained. Albert Bandura (1977) studied observational learning (recall the modeling in the Bobo doll study) and self-regulation. Bandura defined self-regulation as the ability to control our own behavior and it is the workhorse of human personality. Bandura suggests three steps: (1) Self-observation, we look at ourselves, our behavior, and keep tabs on it; (2) Judgment, we compare what we see with a standard; (3) Self-response, if we did well in comparison with our standard, we give ourselves rewarding self-responses. If we did poorly, we give ourselves punishing self-responses.

According to Bandura's social cognitive theory, individuals possess a self-system that enables them to exercise a measure of control over their thoughts, feelings, motivation, and actions. This self-system encompasses one's cognitive and affective structures and provides reference mechanisms and a set of subfunctions for perceiving, regulating, and evaluating behavior, which results from the interplay between the system and environmental sources of influence. As such, it serves a self-regulatory function by providing individuals with the capability to influence their own cognitive processes and actions and thus alter their environments. Individuals engage in self-referent thought that mediates between knowledge and action. Through self-reflection, individuals evaluate their own experiences and thought processes. Bandura (1986) argued that self-reflection is the most uniquely human characteristic. Self-reflective judgments include perceptions of self-efficacy, beliefs in one's capability to organize and execute the courses of action required to manage prospective situations. The higher the sense of efficacy, the greater the effort, persistence, and resilience.
Bandura (1986) wrote that, through the process of self-reflection, individuals are able to evaluate their experiences and thought processes. According to this view, what people know, the skills they possess, or what they have previously accomplished are not always good predictors of subsequent attainments because the beliefs they hold about their capabilities powerfully influence the ways in which they will behave. However, self-perceptions of capabilities help determine what individuals do with the knowledge and skills they currently possess. More importantly, self-beliefs are critical determinants of how well knowledge is acquired initially.

In another study, Yang (1993) has found that with respect to self-regulatory learners: 1) high regulatory students tend to learn better under learner control than program control; 2) high self regulatory students are able to monitor, evaluate, or manage their learning effectively during learner controlled instruction with embedded questions; 3) learner control reduces instructional time required to complete the lesson; and 4) high self-regulatory students manage their learning and time efficiently. One procedure for supporting self-regulated learning is to instruct learners to engage in self-explaining, a behavior associated with enhanced learning, that ordinarily follows from spontaneous self-monitoring (Chi et al., 1994). Learning in informal settings is an ideal environment where activities create opportunities for students to practice scientific inquiry, and to do so in a self-directed fashion where learners take responsibility of their own learning (Gunstone, 1991). Successful learners tend to assess their own understandings and monitor their own progress in ways that seem to facilitate learning (Chi & Bassok, 1989). In other words, one must know what they do not know in order to ask the questions that promote learning (Miyake & Norman, 1979). This suggests the importance of prior knowledge before a concept is introduced or attending an informal learning environment in order to determine the quantity and quality of information which the learner has not already incorporated in their personal schema of knowledge.

In addition, Hagen and Weinstein (1995) believe that master and performance goals can dramatically include college students’ self-regulated learning. These independent but complementary types of goals are shaped in important ways by how faculty organize and structure their classrooms for learning. Involvement in self-regulatory learning is tied closely to student efficacy beliefs (Pintrich & DeGroot, 1990). In presenting a model of self-efficacy as a temporally preceding of self-regulated learning (defined as behavioral constellation of monitoring, elaboration, and effort management strategies), Garcia and Pintrich (1991) determined that a participant’s belief in their capabilities was more likely to lead to higher levels of self-regulated learning. They developed the Motivated Strategies for Learning Questionnaire, which indicated that intrinsic motivation and self-efficacy had substantial effects on self-regulated learning. In another study, Garcia and Pintrich (1992) have shown that metacognitive self-regulatory strategies were consistently positively related to critical thinking across domains. The study supports the positive relationship between motivation, deep strategy use, and critical thinking. Pintrich (1995) has found that self-regulated learning is an important component of learning for college students. Students must have greater awareness of their own behavior, motivation, cognition and their positive motivational beliefs, and must practice self-regulated learning strategies. Corno and Mandinach (1983) define self-regulatory learning as an effort to deepen and manipulate the associative network in a particular area and to monitor and improve that deepening process. It refers to the deliberate planning and monitoring of the cognitive and affective processes that are involved in the successful completion of academic tasks. They also suggest that for some learners these metacognitive processes of planning and monitoring may be so well developed that at times they appear to occur automatically. Five components are viewed by Corno and Mandinach (1983) as necessary and sufficient to define self-regulated learning. The five components are organized into two categories: the information acquisition processes that include alertness (receiving and tracking information), and monitoring; and the transformational processes of selectivity, connectivity, and planning. They continue to state that self-regulated learning, which represents the highest form of cognitive engagement, is epitomized by the task appropriate use of information acquisition and transformation skills. Corno (1994) investigated the development of students’ orientations to engage in self-regulatory effort and to value or even enjoy this experience. The conclusion is that self-regulated learning comes about from the continuing interchange between students and the educating elements of their extended environments (such as in informal settings), adults and knowledgeable peers, various enacting curricula, and affording activities. Winne
(1997) suggests that learners experiment, bootstrapping newer forms of self-regulated learning from prior forms and enabling the learner to step back and review or reflect on their acquisition.

Self-conscious reflection is a perspective of self-regulation that involves evaluation and modification of the goal or objective, as well as design of the path or procedures used to get there. Learning requires self-conscious reflection. Functionally, this is the best approach. This type of learning requires evaluating and choosing between two or more viable alternative paths.

Zimmerman (1989) defines self-regulated learning strategies as actions and processes directed at acquiring information or skill that involve agency, purpose, and instrumentality perceptions by learners. Strategies include self evaluation, organizing and transforming, goal-setting and planning, seeking information, keeping records and monitoring, environmental structuring, self consequenceing, rehearsing and memorizing, seeking social assistance, and reviewing records. Subskills required to organize a course of action are themselves governed by broader self-regulatory skills such as knowing how to diagnose task demands or constructing and evaluating alternative strategies. Self-regulated learning is not a mental ability, such as intelligence, or an academic skill, such as reading proficiency; rather, it is the self-directive process through which learners transform their mental abilities into academic skills (Schunk & Zimmerman, 1998). Possessing these self-regulatory skills can permit students to improve their performances across varied academic activities. He has also developed a cyclic model, which represents the behaviors of a self-regulated learner (figure 2-2).

Figure 2-2. Cyclic Model of Self-Regulated Learning (Zimmerman, 1996).

1. Self-evaluation and monitoring occur when students judge their personal effectiveness, often from observations and recordings of prior performances and outcomes.
2. Goal setting and strategic planning occur when students analyze the learning task, set specific learning goals, and plan or refine the strategy to attain the goal.
3. Strategy-implementation monitoring occurs when students try to execute a strategy in structured contexts to monitor their accuracy in implementing it.
4. Strategic-outcome monitoring occurs when students focus their attention on links between learning outcomes and strategic process to determine effectiveness.

The model is cyclical because self-monitoring on each learning trial provides information that can change subsequent goals, strategies or performance efforts. An important part of this model is initial self-evaluation, because this typically initiates the learner’s attitude toward belief in his or her own competence, or self-efficacy.

Zimmerman and his associates have been instrumental in tracing the relationships among self-efficacy perceptions, self-efficacy for self-regulation, academic self-regulatory processes, and academic achievement. This line of inquiry has successfully demonstrated that self-regulatory efficacy contributes to academic efficacy. Self-efficacy is a critical component of self-regulated learning theory. Self-efficacy is a person's sense of being able to deal effectively with a particular task; a belief about personal competence in a particular situation. If an individual student believes they are capable of learning the concept or regulating their own acquisition of the knowledge, then their ability to learn will increase. Schunk and Zimmerman (1998) indicate that this factor provides a bridge between the cognitive and the contextual forces, such as informal settings, by way of increasing self-regulatory learning. Zimmerman, Bandura, and Martinez-Pons (1992) used path analysis to demonstrate that academic self-efficacy mediated the influence of self-efficacy for self-regulated learning on academic achievement. Academic self-efficacy influenced achievement directly as well as indirectly by raising students' grade goals. Results of these investigations demonstrate that acquisition of cognitive skills, modeling effects, attributional feedback, and goal setting influence the development of self-efficacy beliefs and that these beliefs, in turn, influence academic performances.

Schunk’s (1990) definition of self-regulated learning includes the beliefs that learners hold with respect to their capabilities for learning (self-efficacy). It is Schunk's view that self-efficacy, as a predictor of motivation and skill acquisition, can help explain students’ self-regulated learning efforts (Schunk, 1988).
Students who attribute successes to their abilities and efforts are likely to feel efficacious about learning and engage in self-regulatory behaviors that further increase their skills (Schunk, 1990).

As far as tools for assisting self-regulated learning, there are several characteristics of computer technology that make it a desirable vehicle for examining the concept. Computers make it possible to independently store data collected via interaction with the student, thus providing the possibility for improved efficiency in data collection process. Computers also have the capability of monitoring and recording user interaction and/or progress providing immediate feedback to the learner. This capability has both research and instructional benefits: first, profiles of the step-by-step process of learner interaction with ideas or concepts can be stored and retrieved for later analysis; second, the immediate feedback that the learner receives allows a greater degree of learner control by providing individualized opportunities for review of the material. Mandinach (1984, 1987) has used the computer as a vehicle for studying the concept of self-regulated learning in the strategic planning knowledge of self-regulation in intellectual computer games. Mandinach concluded that the high and low ability students displayed different patterns of cognitive engagement and the those who utilized self-regulated learning, task focus, and resource management forms of engagement were more successful in completing the game.

At this point, little is known about self-regulatory or self-reflective learning in informal educational settings. Winne (1993) admits that little is known about instructional design issues that affect student’s learning with technology. Weinstein (1996) agrees that relatively little is currently known about the development or acquisition of self-regulation and what can be done to facilitate its development with new technology. Concerns such as what influence can different self-monitoring strategies, learning tools, and physical and social arrangements exert on student learning when students use them before, during, and after they use the resources of an informal setting require further study.

Learning Approaches

Two types of learning approaches typical of instruction settings and often seen in informal settings are free choice or constructivism and structured or objectivism.

Free Choice - Constructivism

Free choice learning places the responsibility for learning on the learner. They are typically considered to be synonymous to informal learning settings such as museums, aquariums and science centers. Basically, a free choice environment allows the learner to select what and how they are to attend and acquire information. Potential positive attributes are similar to benefits from learning in an informal setting, in addition to possible increase in longer concept retention due to increased learner control. A free choice learning setting resembles a constructivist approach in that it allows the learner to build upon their prior experiences at their own pace and in their own particular direction of interest and perspective. A true constructivist environment in Cyberspace would allow the user to access any and all areas of the Internet. However, for this study, a constructivist environment has been operationally defined as one, which allows the participant to access several internal links to build their knowledge of the subject.

Perhaps the first constructivist philosopher, Giambatista Vico commented in a treatise in 1710 that one only knows something if one can explain it (Yager, 1991). Immanual Kant (18th century) further elaborated this idea by asserting that human beings are not passive recipients of information. Learners actively take knowledge, connect it to previously assimilated knowledge and make it theirs by constructing their own interpretation (Cheek, 1992). Inferences, elaboration’s and relationships between old perceptions and new ideas must be personally drawn by the student in order for the new idea to become an integrated, useful part of their memory. The learner must actively construct new information onto their existing framework for meaningful learning to occur.

Although constructivist theory has become popular in recent years, the idea of constructivism is not new. Aspects of the constructivist theory can be found among the works of Socrates, Plato, and Aristotle (ranging from 470-320 BC), all of which speak of the formation of knowledge. Saint Augustine (mid 300's
AD) taught that in the search for truth, people must depend upon sensory experience. This of course left him out of balance with the church. More recent philosophers such as John Locke (17th to 18th centuries) taught that no man's knowledge can go beyond his experience. Kant (late 18th to early 19th centuries) explained that the logical analysis of actions and objects lead to the growth of knowledge and the view that one's individual experiences generate new knowledge (Brooks & Brooks, 1993). Although the main philosophy of constructivism is generally credited to Jean Piaget (1896-1980), Henrich Pestalozzi (1746-1827), also from Switzerland, came to many similar conclusions over a century earlier.

Pestalozzi maintained that the educational process should be based on the natural development of the child and his or her sensory influences. Pestalozzi's basic pedagogical innovation was his insistence that children learn through the senses rather than with words. He labeled rote learning as mindless, and he emphasized instead linking the curriculum to children's experiences in their homes and family lives (Fabricius, 1983). Manges and Wigle (1997) believe that through constructivist teaching, students can tap into their natural learning potential because their experiences, their prior knowledge, and their personal interpretations become essential components of all classroom activities.

However, Piaget provided the foundation for modern day constructivism and it’s hybridization. In Piaget's view, intelligence consists of two interrelated processes, organization and adaptation. People organize their thoughts so that they make sense, separating the more important thoughts from the less important ones, as well as connecting one idea to another. At the same time, people adapt their thinking to include new ideas, as new experiences provide additional information. This adaptation occurs in two ways, through assimilation and accommodation. In the former process, new information is simply added to the cognitive organization already there. In the latter, the intellectual organization has to change somewhat to adjust to the new idea (Berger, 1978).

Constructivist theory in education actually is a branch of neo-Piagetian thought, which is rooted in personal constructivism (Novak, 1977; von Glasersfeld, 1989). Soloman (1987), Millar (1989), and Cobern (1993) have taken personal constructivism and have paved a way for contextual constructivism. Contextual constructivism is defined by how the learner interprets phenomena and internalizes these interpretations in terms of their previous experience and culture.

The basic idea of constructivism is that the learner must construct knowledge, the teacher cannot supply it (Bringuier, 1980). This is vividly expressed by the Farsi proverb, a well must produce its own water. The constructivist approach is a view that emphasizes the active role of the learner in building understanding and making sense of information. Constructivist approaches to learning assume that subjectivity is critical because learners take in information and process it in unique ways that reflect their needs, dispositions, attitudes, beliefs, and feelings. Constructivism espouses creating meaning from experience (Jonassen, 1991). Constructivism stresses the interaction between learner and the environment and learning is embedded in the context in which it occurs. Thereby learners are encouraged to develop their own understanding of knowledge. Brooks and Brooks (1993) state that constructivism is not a theory about teaching. It is a theory about knowledge and learning that process and learning occurs daily and relentlessly in classrooms. It is a philosophy that encompasses knowledge, learning and thinking. They have compiled a list of characteristics of a constructivist teacher that include encouragement of student autonomy; utilization of manipulative, interactive and physical materials; use of cognitive terminology such as classify, analyze, and create; inquiry understanding; encourage engagement of dialogue; ask open-ended questions; pursue elaboration of student responses; provide time for students to construct relationships and create metaphors; nurture students through frequent use of the learning cycle method. Inquiry learning is an approach in which the teacher presents a puzzling situation and students solve the problem by gathering data and testing their conclusions.

Bradt (1992) has determined a similar list for a constructivist approach, engage students in authentic tasks, assist students with producing knowledge bases that promote the application of information, and diversity of thought; build learning communities linking students and promote substantial, applicable learning rather than mere credentialing. Students who plan to get through a course by regurgitating content also resist learning independently; they are probably not interested in developing critical thinking or problem-solving skills.
Von Glasersfeld (1995) argues that knowledge and reality do not have an objective or absolute value or, at the least, that we have no way of knowing this reality. He indicated in relation to the concept of reality, that it is made up of the network of things and relationships that we rely on in our living, and on which, we ultimately believe in. Rather than thinking of truth in terms of a match to reality, von Glasersfeld focuses instead on the notion of viability. To the constructivist, concepts, models, and theories are viable in they prove adequate in the contexts in which they were created. As to the role of the instructor, von Glasersfeld (1996) indicates that their role is not to dispense knowledge but to provide students with opportunities and incentives to build it up. Mayer (1996) describes teachers as guides, and learners as sense makers. In Gergen’s (1995) view, teachers are coordinators, facilitators, resource advisors, tutors or coaches.

With respect to learning, von Glasersfeld (1995) argues that from the constructivist perspective, learning is not a stimulus-response phenomenon. It requires self-regulation and the building of conceptual structures through reflection, abstraction and an integrated thought process. It is reasonably easy to learn something that matches or extends an existing mental model that we may possess. This principle states that mental models are not only the way that we organize our interactions with the world, but they also control how we incorporate new information and experiences (Bransford & Johnson, 1972). Rather than behaviors or skills as the goal of instruction, concept development and deep understanding are the foci. In this paradigm, learning emphasizes the process and not the product. How one arrives at a particular answer, and not the retrieval of an objectively true solution, is what is important. Learning is a process of constructing meaningful representations of making sense of one’s experiential world. These models derive their validity not from their accuracy in describing the world, but from the accuracy of any predictions which might be based on them (Hanley, 1994).

Zahorik (1995) believes the constructivist model is best suited for situations when goals are for students to use higher-order (critical) thinking skills, to understand the cause or effects of ideas or actions, and to become fully engaged in their learning. Zahorik (1995) asserts that knowledge is constructed by humans; not a set of facts; conjectural and fallible; grows through exposure; and is created or constructed by humans as they attempt to bring meaning to their experiences and can never be stable.

There are three types of constructivism according to their different points of view.

1. Radical constructivism emphasis subjectivity or the absolute impossibility of being objective and, in the extreme, even a rejection of realism (Goodman, 1984; Molenda, 1991). The center of the whole learning process, students are given the freedom, as well as the responsibility, to decide what and how to learn (Perkins, 1991).

2. Moderate constructivism acknowledges that there is a realism in which there are enough spaces for people to construct their own understanding of the world (Cognition and Technology Group at Vanderbilt, 1991). They believe that knowledge is a dialectical process, the essence of which is that individuals have opportunities to test their constructed ideas on others, persuade others of the virtue of their thinking, and be persuaded (Cognition and Technology Group at Vanderbilt, 1991).

3. Rational constructivism recognizes the dynamic nature of learning or the mediation of new knowledge by old during the interpretation-reflection process (Winn, 1991). What distinguishes them from the radical and moderate constructivists is their recognition of the dynamic nature of learning, the impossibility of predicting how students will learn, the understanding that knowledge is an ever-changing process, and the weakness of being anti-empirical in human cognition (Cognition and Technology Group at Vanderbilt, 1991).

One particular research study in support of constructivist teaching was performed by Caprio (1994). In the study, the constructivist approach was employed and compared to the traditional lecture format for the second semester of a two-semester anatomy and physiology sequence in a community college. The two student groups were matched for academic ability and prerequisites. Both courses were night classes and most of the students were hoping to major in health-career programs. The testing instrument was the first exam. The same exam was given to both sets of students at midterm. A drawback to the study was that the two groups were studied seven years apart. The results showed that students taught by the constructivist methodology obtained better exam grades. The average exam score for the constructivist group was 69.7% (n=44) while that taught by the traditional lecture method was 60.8% (n=40). A t-Test showed that the grade difference was significant (p
In support of this study, Lord (1997) compared student learning in two sections of an introductory college biology course. Groups were taught in the traditional teacher-centered, lecture/laboratory format (n=86), and in a student-centered constructivist format (n=98). The latter group performed significantly better on the same tests, maintained a better attitude throughout, and through a post-test survey, enjoyed the course more.

However, a study by Chang (1994) compared a constructivist approach to an objectivist approach to teaching chemistry in a junior high school class provided different results. Students in the constructivist student-centered approach produced much higher explanation scores than students in the conventional approach. However, students in the constructivist approach did not perform significantly higher than students in the conventional treatment on multiple choice scores; and they did not produce higher scores in higher-level questions (non-recall). A retention test revealed that regardless of the teaching strategy, no student performance differences persisted two weeks after instruction.

Carey et al. (1981) probed the nature of student views on scientific inquiry. Despite instruction in the scientific method in the traditional mode, many students do not understand the nature or purpose of scientific inquiry. Science is seen as a random activity that has little meaning in real life. Students were rated by interviews on a scale of one to three about their conception of how science is investigated before and after a constructivist style learning unit on the topic. Prior to the unit, most students fell in the Level one category. Level one students view science as a way of understanding facts about the world. After the learning unit, most of the students had moved to a Level two understanding; they saw scientific inquiry as being guided by questions and ideas. They also understood the difference between an idea and an experiment. Only a few students achieved level three understanding. At this level, the student understands the cyclic, cumulative nature of science and recognizes the goal of science as the construction of deeper explanations of the universe.

One specific feature of constructivist philosophy directly relates to learning in informal settings. The notion of experimentation or exploration is valuable forms of learning (Daiute, 1989; Garvey, 1977; Herron & Sutton-Smith, 1971). Exploration involves the consideration of novel combinations of ideas, and the hypothetical outcomes of imagined situations and events. It is a form of mental exploration in which children create, reflect on, and work out their understanding. Actual experimentation, the manipulation and testing of ideas in reality, provides learners with direct, concrete feedback about the accuracy of their ideas as they work them out. Experimentation and exploration are self-structured and self-motivated processes of learning. Both encourage the learner to reflect on ideas in ways generally not promoted by current school curricula.

Another approach to pedagogy, but more specifically related to science education is Saunders' (1992) approach. Saunders (1992) states that in being a constructivist in science education does have implications and that the implications lead to a certain approach to teaching science. His first step is to organize hands-on investigative labs. These are problem centered and differ from the traditional recipe labs in that there are no prescribed methods or procedures to solving the problem or exploring the phenomena. Saunders (1992) states that in using the inquiry approach the students must utilize their own schema to formulate expectations about what is likely to be observed. Another implication is that there is active cognitive involvement. This is in contrast to the passive learning that takes place in many teacher centered classrooms. Saunders (1992) explains that learning is made meaningful through activities like thinking out loud, developing alternative explanations, interpreting data, participating in cognitive conflict (constructive arguing about phenomena under study), development of alternative hypothesis, the design of further experiments to test alternative hypothesis, and the selection of plausible hypotheses from among competing explanations.

Constructivism in the undefined limits of virtual space (informal setting) frees pedagogy. Virtual space enables: faculty drawn from anywhere in the world, linked by Internet resources, thereby encouraging an endless array of multicultural learning environments (Winn, 1991).

The bottom line is that constructivism is philosophy that views the student as a thinker, creator, and constructor of knowledge. This is certainly a change from a traditional view of a student as an owner of knowledge.
Structured - Objectivism

Briggs (1967) defined structure as meaning the description of the dependent and independent relationships among component competencies, arranged so as to imply when sequencing can be random or optional and when sequencing must be carefully planned, on the basis that transfer will be optimal in order to build up from simple skills to more complex ones.

Educationally, structure and sequence serve a number of purposes that include the design of instruction (Reigeluth, Merrill, & Bunderson, 1978). In museums, these considerations should encompass the design and placement of exhibits, adjunct material, and other related activities such as tours, classes, etc. Ellis (1993) found that exhibit sequencing in museums can enhance visitor acquisition of cognitive and affective information. Visitors who are informed about the structure and sequence within an exhibit may invest greater energy than if they perceived it as having no real structure or sequence (Salomon, 1983).

Objectivists believe that knowledge is outside of the learner, truths exist and learners must memorize them. The objectivist model is best seen in behaviorist methodology such as in direct instruction, where the goal is usually to have the student acquire and repeat factual information. According to the objectivist view, objects have intrinsic meaning, and knowledge is a reflection of a correspondence to reality. In this tradition, knowledge should represent a real world that is thought of as existing, separate and independent of the knower; and this knowledge should be considered true only if it correctly reflects that independent world. Jonassen (1991) summarizes objectivism: Knowledge is stable because the essential properties of objects are knowable and relatively unchanging. The important metaphysical assumption of objectivism is that the world is real, it is structured, and that structure can be modeled for the learner. Objectivism holds that the purpose of the mind is to mirror that reality and its structure through thought processes that are analyzable and decomposable.

Objectivism holds that the world is completely and correctly structured in terms of entities, properties, and relations (Duffy & Jonassen, 1991), and that knowledge is stable, staying independent of the individual because the essential properties of objects are knowable and relatively unchanging. It assumes that people can gain the same understanding, and this understanding can be completed when rational or systematic rules are used to draw conclusions (Winograd & Flores, 1986).

The objectivist model has resulted in somewhat of a stereotyped portrayal of teaching and learning which is widely criticized and often evoked as the target of educational reform. The idea that there is a fixed world of knowledge which the student must come to know is common to an objectivist. Information is divided into parts and built into a whole concept. Teachers serve as pipelines and seek to transfer their thoughts and meaning to the passive student. There is little room for student-initiated questions, independent thought or interaction between students.

Learning Settings

Informal Learning Settings

Many educators call for more doing and less talking in our educational system. Jean Piaget (1974) and many of his students have shown the importance of direct experience for students in learning, especially in learning the concepts of science, and for young children (Elkind, 1976). Nearly the whole of our knowledge about the natural world has come form investigators who had direct experiences with phenomena of natural science outside of the formal classroom (Keown, 1986). There is no classroom equivalent to observing a river--clean, clear and healthy as it enters a city--and later to find it green and oxygen deficient with the community of pollution organisms as it leaves the city. These informal settings are where encounters occur that engages all of the students’ senses.

Informal settings are typically places where learning takes place in museums, zoos, aquaria, science and technology centers, homes, and clubs. They are also characterized where motivation is internal, the content is variable and possibly unsequenced, attendance is voluntary, displays and objects are provided, learners are of all ages, and there is more diversity in the learners’ backgrounds.
The modern museum with its manipulative exhibits and free-choice format invites visitors to explore by looking, touching, manipulating, experimenting, and hopefully thinking. As informal educational institutions, museums and science centers can do more than entertain and amaze visitors. If exhibits are designed correctly, they can attract and hold the attention of visitors long enough so that they become engaged with the information and learn from them. Millions of people visit museums every year. For various reasons, they seek these experiences out and appear to be intrinsically motivated once there. A considerable amount of sensory stimulation, learning, and affect appears to be influenced in these “free-choice” settings (Koran, Longino, & Shafer, 1983).

Informal settings are ideal for introducing, enhancing and incorporating new and novel ideas into previously developed schema. However, one of the criticisms for informal learning environments, such as museums, is the lack of focus for young learners and the tendency for realizing only the fun aspect and overlooking the educational benefits. Therefore, many of the attributes that increase the power of informal settings could also be seen as their weakness. Attention is captured, but substantial learning may not be the outcome; knowledge acquisition could result, but reconciliation of prior knowledge and new experiences may not occur. The self-guided/self-reflective advantage of this type of learning setting could be detrimental to the non-regulated learner or a poorly constructed informal setting. Especially, if they had been enticed with promises of amusement and entertainment as the primary goal. Science is a great intellectual adventure and can be fulfilling as well as enjoyable in these settings. At the very least, exhibits in such settings may capture student’s attention and enhance their intrinsic interest in science learning which could lead to further engagement (Friedman, 1995). Johnson and Butts (1983) found that engaged time measures were significantly related to achievement, which indicates an instructor should endeavor to keep the students as engaged as possible. Students who are engaged or pay attention or perceived they are engaged or paying attention during lecture classes achieve more than students who are observed as nonengaged do.

For many years, attention has been known to be a critical factor in visitor learning in informal settings such as museums (Wittlin, 1968; Shettel, 1973; Koran, Koran & Longino, 1986; Koran, Koran & Foster, 1989). Many have observed that in order for an exhibit to be educationally effective it must attract viewer attention, maintain attention, and provide useful information. Hands on activities have been shown to attract attention and holding power (Koran, Morrison, Lehman & Koran, 1984). Questions inserted into text materials have been shown to converge attention on specific content, when they precede the content, and to produce divergent memory search, when they follow the content. Acquisition and retention of specific kinds of information results (Rothkopf, 1970). For a learner with higher expectations, attempting to be self-reflective while attending could be advantageous to their personal knowledge acquisition.

Roschelle (1995) states that informal learning setting such as hands-on science centers can provide students with open-ended challenging activities that can provide a context for complex thinking and reasoning, thereby promoting the integration of prior knowledge with new information and experience.

Falk and Dierking’s (1992) model suggested that visitors construct their own unique meaning for the visit experience according to personal background and interaction with the social and physical environment. Memories are persistent in the minds of children and remain with them into adulthood. Falk and Dierking (1994) interviewed middle school children and graduating college students and found that 80% of them were able to recall three or more specific things linked to a field trip (informal setting) during their first, second or third grade. Balling and Falk (1980) found that children familiar with a setting tend to learn more than children who are not do. It is clear that students’ prior knowledge is important in determining how they interact and what they learn from exhibits in informal settings (Beiers & McRobbie, 1992; Falk, Koran, & Dierking, 1986; Gottfried, 1979). Falk (1983) found that both the time spent at an exhibit and the nature of the interaction affect the amount of learning which occurs. Falk also indicates that time in informal settings is a measure of constraints, needs, and values. Therefore, time is the most frequent measure used for evaluating exhibit's quality/effectiveness and assessing visitor behavior. Interaction with exhibits is most effective when learner’s thought processes match those required to understand the exhibit (Boram & Mark, 1991; Feher & Rice, 1985; Javlekar, 1989; Tuckey, 1992). An important aspect of structure is the means by which students are cued to
Salient features of the exhibits. The most universal cue is the labeling, or signage of the exhibit, which Screven (1986) discusses at length. Koran and Koran (1986) suggested that besides learning, curiosity, psychomotor development, interest, appreciation, motivation, and generalization all could be considered among the desired outcomes of a visit to an informal setting such as a museum.

Serrell (1997) indicates that tracking and timing data suggest that visitor’s go where they want to go (in informal settings). They skip elements, visit only one-third of them, and spend much less time (typically less than 20 minutes) than often assumed. She also points out concerns for effective communication of didactic objectives. These include when the exhibits require extensive label reading, the majority of visitors will not be able to understand them; when the exhibit contains unnecessary sections, visitors will become confused; however, if the exhibition is clear and concise, high time and high use will not be necessary for understanding.

Falk (1983) compares museums to department stores and museum visitors are like shoppers. In a store, a customer’s monetary resources determine behavior; in a museum, time plays the comparable role. There are serious shoppers who know exactly what they wish to buy, just as visitors who know just what they want to view. There are also window shoppers who never buy anything, bring a social partner and may become “impulse buyers”. In the same token, window shopper museum visitors casually stroll into the informal setting and leisurely stroll by exhibits with minimal holding time, engagement, attention and therefore learning. In the same analogy, similar learners can be identified using the Internet as an informal setting. However, as anyone who has experienced surfing the net, it can capture the attention of the best intended window shopper. Even for the serious shopper who only wishes to get in the system, obtain that one piece of information and log out, finds themselves distracted onto a plethora of possibilities which are presented during the simplest of searches. To minimize this phenomenon for the learner, a focus vehicle is required. This may be in the form of available software, time limitations, oversight, or more likely limited access to the World Wide Web (WWW) through internal or intent networking capabilities.

Internet, WWW Pages and Cyberspace

There is a cultural shift from the importance of possessing knowledge in one's own memory to be able to effectively search for and use the information needed for particular purposes. Therefore, it becomes increasingly important for the individual to possess some knowledge of computer technology. Undoubtedly, the individual would be greatly advantaged if they could gain this knowledge at an early age, perhaps as a student. There can be little doubt about the advantages the computer possesses over any textbook as a tool for learning. Firstly, the student is able to access a vastly more superior range of information from the computer, as too is the teacher. Available computer programs, such as the Internet, provide an excellent opportunity to access an astronomical quantity of information. In fact, the Internet provides greater access to a larger bank of knowledge for teachers and it enhances the quality and quantity of information that teachers provide for their students. The teacher as the primary source of knowledge no longer suffices in a world where knowledge doubles every seven years and 10,000 scientific articles are published every year (Forman, 1987). The Internet is highly valuable as a resource tool for education. Moersch (1997) has described levels of technology implementation (LoTi), an instrument to measure the degree to which computers are used to support concept-based or process-based instruction, consequential learning, and higher order thinking skills in the classroom.

At present, computers in schools could be better conceptualized as a source of energy. The energy metaphor is applied to three categories of functions associated with computers in school: curriculum functions, teaching functions, and learning functions (Scriven, 1989). Juliano (1997) discusses the computer environment in terms of power pedagogy, which refers to any set of instructional methods designed to increase faculty productivity and to accommodate more students with existing facilities. It is a mechanism to use the WWW to supplement traditional instruction, focusing on use of the WWW as an intent teaching tool that establishes an extension in the regular classroom. Forman (1987) indicates that technology adds the ability for students to choose how, when, and where they participate in the learning experience and to bring together a vast wealth of previously unavailable learning resources.
There are several reasons why educators, administrators, and parents should support the use of the Internet in schools: equity, an infinite resource, students as active participants, self-motivation, student inquiry, assessing and improving student progress. On-line education provides the flexibility and efficiency of computer-assisted instruction as well as the individual attention of instructor-guided instruction (Huang, 1997). Berge (1997) discusses the advantages of on-line instruction in terms of meaningfulness, open communication, organized essential ideas, learning aids, modeling, active appropriate practice, pleasant conditions and consistency. Results also show that on-line use can increase student performance (Follansbee, 1997). Technology can help some people to participate more easily in education, to learn more effectively, and to enjoy learning more (Palmieri, 1997). Palmieri also realizes that technology will continue to be important in education because it will allow learners to access knowledge in their homes, in their workplaces, (informal settings), at times in which they want to learn. Although Conlon (1997) warns that technology enthusiasts and politicians portray the Internet in unrealistic and misleading ways that inflate its suitability for school education. The Internet is not a library, community or panacea for difficult problems of teaching and learning. Determining the benefits and pitfalls for education requires extensive research and evaluation of the Internet and its alternatives. Saunders-McMaster (1997) points out one alternative in the Internet 2 project currently being developed by research universities and affiliate members to accelerate Internet development for higher education with the next generation of communications and technologies. Goodman (1997) describes the importance of learning to connect separate university of knowledge into a coherent whole. It is a mistake to emphasize connecting schools to the Internet without considering the kinds of thinking processes students need in order to learn from the information they access.

The nonlinear organization of text and graphics on the WWW allows greater user control. However, materials must be structured coherently by establishing associative and conceptual links without eliminating multiple pathways. A constructivist approach permits clear mental representation of concepts and the freedom for each learner to explore them (O'Carroll, 1997). Tillman (1997) has provided recommendations for applying hypermedia research to educational theory for WWW homepage design. Each destination should be able to stand alone; incorporate appropriate metaphor; provide visual clues indicating users’ selections are being processed; include graphic or text-based organizers; include comparative, casual, sequential, associative, exemplary, and componential links; employ labeled and unlabeled links; and use multiple complementary stimuli.

Using the Internet in the context of the classroom is advantageous to both teachers and students. Teachers benefit from the wealth of resources available on the Internet and children benefit from further communication with the world around them and resources developed especially for their needs. In a sense, the Internet can be seen as collaborative teamwork, in that teachers publish their work and it is pooled with other teacher’s work from around the world hence being an invaluable resource. Through the Internet students are better able to experience first hand other cultures in the world. There are, however, a number of disadvantages of using the Internet in the context of the classroom. Such disadvantages include the loss of valuable teacher/student interaction. There needs to be some form of censorship which will prevent the students from gaining access to detrimental types of publication that are too easily obtainable within the Internet. The computer does not necessarily act as a facilitator for student learning, it merely acts as a resource. Computers are a valuable resource for learning. It has been reported (Comber, 1997) that children using computers focused on tasks for longer periods; found previously boring tasks more interesting; were more eager to participate in and contribute to discussions; asked more questions; and improved their use of the standard conventions of print.

There is substantial evidence to suggest that the computer also offers the advantage of making work more stimulating, thereby motivating the individual. The search for information is made considerably easier, thus making one's workload less tedious, and perhaps more interesting. It is possible the difference in types of computer software can be used to motivate various kinds of students. Poorly motivated students may be so due to lack of understanding or interest. If appropriate software is used, they may be enticed with the sheer novelty, the implied prestige of using a computer and the benefits of drill and practice of tutorials they are able to work
through at their own pace. On the other hand, highly motivated students or students who know how to use computers well can be directed to enrichment coursework which is mind-provoking, features games and avenues of learning how to create through the medium of the computer.

The Internet is a valuable resource for teachers and students alike. When it is used in conjunction with other classroom practices, it is a valuable technological tool that furthers education in today’s world. Like all classroom practices it has its advantages and disadvantages. Computers allow students to become self-regulated learners and with further training for both teachers and students, the Internet will have a big place in classrooms of the future.

Gender, Age, and Racial Identity

Gender, age, and racial identity have been found to have an effect on learners in general and user of electronic media, such included on the Internet. Wallace and Sinclair (1995) found female students to be more anxious and less confident with computers than male students. In another study, Comber (1997) found that in a survey of British secondary students, males reported significantly more experience with computers than did females; younger students had significantly more experience and positive attitudes than older students did. Durndell (1995) surveyed Scottish secondary students and found that females were less experienced with computers at school, but played computer games as much as males; males were more likely to own and use computers outside of a formal school setting. Also, males had more positive attitudes and were more likely to have sex-stereotyped views about computer use; and older students were less enthusiastic about computers. According to a recent study, about 90% of current Web users are male, and 87% describe their race as white (Pitkow & Recker, 1994). Maurer (1994) has explored the correlation between age, gender and computer anxieties; generally older, female students are more anxious about computer experiences than younger, male students. Kay (1992) has examined gender relationships of computer attitudes and realized that it depends on various factors. These factors include what attitudes you are measuring; what skills you are assessing; what the computer is being used for; and what age group you are sampling. Morris (1989) developed a Computer Orientation Scale (COS) to determine the relationship between age, education and computer attitudes. Generally, younger, less educated individuals had poor attitudes about computers. Laguna and Babcock (1997) examined the construct of computer anxiety in young and older adults in the context of a computer-based cognitive assessment. Results indicate that older adults had significantly higher computer anxiety than younger adults, however the anxiety was unrelated to performance as measured by percent correct on the task. However, the anxiety was related to performance as measured by decision time. Comber, Colley, Hargreaves, and Dorn (1997) investigated the effects of age, gender and prior computer experience upon attitudes toward computers. Males from both two different age groups reported greater experience with and more positive attitudes toward computers than females. Younger pupils, both male and female, had greater experience with and more positive attitude toward computers than older pupils did. Polyakov and Korobeinikov (1996) examined age-specific features of human training in two different groups. Results showed that 33% of the older participants succeeded in training compared to 73% of the younger participants, implying that the ability to train decreases with age. Whitley (1997) performed a meta-analysis of studies of gender differences in computer-related attitudes and behavior using 40,491 U.S. and Canadian participants found that males exhibited greater sex-role stereotyping of computers, higher computer self-efficacy, and more positive affect about computers than did females. Bernhard (1992) found that in spite of equivalent instruction, boys completed a significantly greater number of computer tasks than did girls. In addition, boys showed more stereotypic attitudes towards computers than did the girls. In a cross-cultural study, Collis and Williams (1987) found a significant difference between the attitudes of males and females regarding their perceptions of each other’s computer abilities. Hatti and Fitzgerald (1987) found that more girls than boys disliked computers. Newton (1991) reports that in a survey conducted of fourth and fifth grade students, he found that only 22% of girls, but 56% of boys were likely to have a computer in their home. And similarly, Sutton (1991) reports that families of male students were more likely to own a computer than families of female students.
Simon (1996) presents several statistics, which represent the inequitable distribution of information in Cyberspace. In this, technophobes are relatively older, have negative attitudes towards computers in general, have had little exposure to them, and are female. National statistics in 1993 reveal that the highest percentage of computer usage by students at school occurs in grades' one through eight (68.9%), however, the same age bracket of students have the lowest usage of computers at home (24.7%).

Kominski (1988) provided statistical information on computer usage in the United States in 1984. The data show that over 15 million American adults owned home computers, but only 53% actually used them. About 8% of U.S. households or 7 million had a computer, and households with school age children were three times as likely to have one. Among adults, 63% of the men and 43% of the women used the computer if it was present at the house. Although African Americans were less likely to have home computers, children who did have them used them more than white children.

**Aptitude-Treatment Interactions**

Aptitude-treatment interactions (ATI) reflect the notion of tailoring instruction to important student characteristics. They refer to differences in student outcomes as a function of the interaction of instructional conditions with student characteristics. ATI research examines how individual differences in aptitudes predict students’ responses to forms of instruction. The notion that instructional conditions affect student outcomes differently depending on students’ attributes is intuitively plausible (Corno & Snow, 1986). For the purposes of ATI research, aptitude has been defined as any characteristic of the individual, which functions selectively with respect to learning; that is, which facilitates or interferes with learning from some designated instructional method (Cronbach & Snow, 1977). Cronbach and Snow (1977) indicated that although a wealth of evidence can be obtained from ATI, they also noted that the findings cannot be replicated and may not be reliable.

Individual differences among learners constitute an important class of variables for research on instruction. Their study has been of interest because measures of these variables usually predict learning outcomes. Practical interest for science educators stems from the possibility that such interactions may be used to adapt science instruction to fit different learners optimally (Koran & Koran, 1984).

While the educational research community has shown interest in ATI, the concept is not limited to these traditional settings. Just as the Darwinian view of natural selection operates to favor species with characteristics suited to a particular set of conditions, there are many circumstances whereby individuals excel with respect to their distinctive approaches. Learning via computers is no exception to this rule. Differences between young and old, male and female, racial cultures, aptitude, etc. have already been demonstrated in literature to provide various results. Therefore, ATI is based on the premise that there is no one best educational treatment for everyone and electronic media in education may act as a supplement to the overall curriculum program. The general approach of ATI research is to match instructional methods to selected learner characteristics. For instance, in this study computers are used in studying the same content by different learning strategies—one with a variety of links; the other being unidirectional. In this manner, it may be possible to detect differences in individual capabilities with different approaches to the same learning goal.

It has been shown that the structure of a task interacts with a learner’s ability, the studies show that mostly low structure benefits higher ability students and high structure is more beneficial for low ability learners (Cronbach & Snow, 1977; Snow & Lohman, 1984). This differential will be explored in the present study, which compare these learning strategies to determine attention, knowledge acquisition and retention of learners. However, the type and level of content as well as the level of cognitive ability is critical to the outcome. A dissertation study by Thede (1995) compared constructivist and objectivist frameworks for computer aided instruction. The results showed that the objectivist group scored significantly higher on recall questions, although the difference between the groups were insignificant on the comprehension and application questions. Therefore, one type of instruction format may be better than another, depending on the type of knowledge acquisition and retrieval, which is expected following instruction. Since interactions with instruction, structure and ability occur, aptitude tests have been used an index of general ability (Koran, Koran, & Baker, 1980).
In summary, ATI research suggested that for a learning strategy task that involves attention, knowledge acquisition, and retention for strategies of constructivism, objectivism, and self-regulated learning in electronic/web-based media, aptitudes of general and verbal ability, learning strategy ability and attitudes were appropriate to test for aptitude-treatment interactions.

Summary

Electronic educational information via the World Wide Web may be the ultimate informal learning setting and as such could provide another powerful mechanism to supplement instruction. One of the many strengths of informal settings is the capability for it to occur anytime, anywhere and anyhow, which is capitalized with computers and the increasing availability and access of computers in society. Therefore, the results of this study has implications for how we may be better able to serve the general educational principles of knowledge acquisition while encouraging self-regulatory learning in the ultimate informal learning environment--Cyberspace.

Hypotheses

Based on the prior literature review, the following null hypothesis were formulated (all hypothesis were tested at an $\alpha = .05$):
1. There is no significant difference in post-assessment scores between the constructivist and the objectivist presentation formats on web-based learning.
2. There is no significant relationship between post-assessment scores and the student’s gender, age or racial identity.
3. There is no relationship between the aptitudes of verbal comprehension and the post-assessment score.
4. There is no significant relationship between attitudes towards computers and post-assessment scores.
5. There is no significant relationship between self-regulation/self-efficacy and post-assessment scores.