A Theory of Education and Teaching

A Thesis

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TABLE OF CONTENTS

Section   Page

LIST OF TABLES

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Abstract

The new science of *memetics* is one of several emerging sciences that falls under the umbrella of the study of complex systems. Memetics treats ideas, called *memes*, as *replicators* and applies Darwinian principles of evolution to understand how ideas are passed from individual to individual and how these ideas evolve through time. If we understand the underlying mechanisms of this replication, we are in a position to devise more efficient means of carrying out that very process in our educational systems by developing a *theory of teaching*. Such a theory, solidly rooted in science, could take the guesswork out of the evaluation of pedagogy that currently divides educational leaders. This evolutionary change in the way we approach education must begin with the education of teachers and educational leaders.

INTRODUCTION

The Status of Pedagogy

The amount of knowledge that is available to be learned is growing exponentially. Each generation has more educational demands placed upon it. Educators must either improve the way they deliver educational services, or students must remain in an educational setting for ever-increasing amounts of time. To this end, educators have experimented with and debated the virtues of innovative pedagogy, such as new math, outcome-based education, and many experiential learning techniques. Proposed uses of computer technology in classrooms will continue to fuel this debate well into the 21st century.

Since the inception of the common school, many changes in education in the United States have centered on pedagogy. There appears, however, to be a need for more fundamental changes in our educational systems that will allow them to adapt to the rapidly changing needs of our culture: While educational systems have always been organizations for learning, it is now critical that they become what Peter Senge (1990) calls *learning organizations*. Educational systems themselves must be able to rapidly learn and adapt to the needs of culture.

Educational systems probably will never become efficient learning organizations without enlightened leadership. Thus, it is important for educational leaders to create a climate for organizational learning, not just a climate for teaching students. First, educational leaders are quite literally at the control point of a time

machine. They reside at the nexus of a cultural hourglass where they oversee and control a process that transfers the vast knowledge of our accumulated past cultures into our cultural futures. Unlike a real hourglass, which is a complex but non-adaptive system that ultimately must pass all grains of sand through the constriction, the cultural hourglass is a *complex adaptive system* and educational leaders can be selective. Educational leaders, therefore, are central agents in filtering our cultural past. In earlier times this filtering process was relatively simple and stable: Cultures changed slowly over a period of several generations. In modern cultures what is filtered is far more complex and cultural changes can frequently occur rapidly during periods of months, or even weeks. Clearly the filtering process that is controlled by educational leaders is an important mechanism of cultural evolution. It is vital, therefore, that educational leaders mold their educational systems into learning organizations in order to enable them to adapt to the rapidly changing educational requirements imposed by modern culture.

Second, educational systems sitting at the nexus of the cultural hourglass are important cultural artifacts in their own right. Thus, educational leaders have the power to selectively propagate the education system itself into our cultural futures. This means that as instructional leaders, educational leaders that evaluate pedagogy and work with teachers to implement pedagogy that is appropriate to subject matter are effectively defining the future role of education itself.

It is fair to conclude that dynamically changing subject matter requirements demand equally dynamic approaches to teaching. It is difficult for educational leaders

to make objective evaluations of teaching strategies when there is no generalized theory of pedagogy. Educational leaders in their roles as instructional leaders would benefit greatly from such a theory.

It is my belief that current pedagogy is not based upon its own solid theoretical foundation. I will show in this thesis that educators have historically looked towards revelations in the areas of memory, learning and philosophy from which to spawn new "theories" of teaching. The underlying assumptions are that teaching techniques must somehow reflect the mechanisms of memory and learning, or must be compatible with a particular philosophical worldview. These assumptions remain untested. Each new "theory" has supporters that make essentially unfounded claims that theirs is the "latest and the greatest," and that older pedagogy is outmoded, ineffective and should be virtually abandoned. This black and white worldview of education has often resulted in an "all or nothing" approach to pedagogy that reminds one of the fervors of a religious belief. Even many of the underlying assumptions upon which our educational system is based have not been adequately challenged in an impartial scientific forum. For instance, should education provide tools for learning (Kohn, 1999) or is the role of education to provide intellectual capital (Hirsch, 1996) that can be invested in future learning? How do these underlying assumptions affect pedagogy? Upon what basis can these underlying assumptions be qualified?

Most recently, declining educational standards and apparently inadequate student learning have been blamed on Constructivist-based theories of pedagogy (Kohn, 1999), yet there is no solid scientific theory or research-based evidence upon which to refute or

support Constructivism. This same lack of scientific robustness is true of all pedagogy. Piaget addressed issues of memory and learning and theorized that learning involves constructing concepts in the mind. Well known Constructivist educators, like Seymour Papert and Jerome Bruner, have taken that theory and applied it to teaching. The justification for such a redirection of learning theory is unsupported. Another unsupported redirection of theory is pedagogy based upon Behaviorism. Skinner, for instance, studied how learning changed behavior. Whether or not changing a learner's behavior should be a goal of *teaching* remains unanswered. The assumption is that if learning "X" causes behavior "Y" then teaching behavior "Y" assures that "X" has been learned. That is verifiably not true. For instance, if I have efficiently memorized my multiplication tables for combinations of numbers from 0-9, I can nearly instantly "multiply" two single-digit numbers but I do so without knowing anything about the process of multiplication. Similar arguments can be made for nearly all pedagogy.

Evaluations of pedagogy, therefore, must address two important questions:

1. What is the theoretical basis for the pedagogy and is the application of this theory to pedagogy justified by logic and supported by research?

2. If the pedagogy is determined to be robust, is there a problem with the implementation?

Furthermore, it is vitally important that pedagogy be (a) based upon a theory of teaching rather than simply an inference of legitimacy passed on from learning or memory theories, or from philosophical worldviews; (b) supported by extensive impartial research

that has been replicated in interdisciplinary scientific environments; and (c) approved by a scientific consensus as to its robustness.

There is no pedagogy that meets all of the criteria stated above. Consequently**,** educational leaders are forced to evaluate the efficacy of what may appear to be conflicting pedagogic techniques while possessing neither a theoretical basis nor a research base for their evaluations. It is educational leaders who are ultimately held accountable for the quality of education delivered to the students in their schools. It is educational leaders who are responsible for staff development. Educational leaders must justify the budget needs of their districts. It is extremely important that educational leaders be equipped with the tools they need to improve the efficiency of the teaching that takes place in their schools. Pedagogy based upon a solid scientific footing would be such a tool.

It may be time to separate scientific concepts of memory and learning from the acts of educating and teaching - presenting information to be constructed into "learning" by students. One of the new sciences of complexity, *memetics,* has the potential to offer insights into this teaching process and to allow us to improve the efficiency of teaching and educating. Memetics may offer the needed theoretical base upon which to build new educational theories. The sciences of complexity may offer educational leaders the tools they need to judge the efficacy of pedagogy and to truly improve the efficiency of the educational processes they administer.

From the perspective of educational leadership, current educational reform movements are uncoordinated. The validity of current teaching theory notwithstanding,

educational reform is often seen as an all or nothing issue that demands instant and significant change. Moreover, incentives for reform come from diverse sources such as private business and state and federal government agencies as well as from professional organizations. Thus, educational leaders are often hit with a barrage of different reform incentives that are not seen as a part of a coordinated mechanism for change. Consequently "educational reform" has always been happening but never seems to really happen.

Memes are elements of evolutionary change and an educational theory based upon memetics is therefore an evolutionary theory. Complex adaptive systems evolve through the interplay of control elements Howard Bloom (2000) calls conformity enforcers, diversity generators, inner-judges, and resource shifters; and through a mechanism he calls intergroup tournaments. Educational leaders are often called upon to fill the role of the inner-judge as they adjudicate arguments for conformity, change, and the allocation of resources. Educational leaders who adopt such a theoretical approach to their management will come to see change as a slowly evolving series of events that must take place at a rate that can be processed by the changing complex adaptive systems themselves.

If an evolutionary theory is to motivate change in education it must be done through what can best be described as a three-step recursive process. First, those who educate future teachers and future educational leaders must apply and teach the principles of the theory. In so doing, teacher education itself evolves. Second, teachers and educational leaders, having learned the theory, must then apply the principles of that

theory in their daily practice. Third, educators must replicate these same theoretical principles in their students and the parents of their students. Parents, within the society of the family, after all, are the first teachers students encounter.

Research Questions

1. Has scientific research shown a correlation between theories of education and pedagogy and the theories of learning and memory from which they were derived?

2. Should teaching and learning be analyzed as interdependent but separate processes?

3. What are the features of memes and memeplexes that cause them to be robust and lead to their replication in human minds?

4. Can the science of memetics provide a sound theoretical basis for judging the effectiveness of education and pedagogy?

Assumptions and Delimitations

Assumptions

This thesis will assume that the meme meets all the criteria of a true replicator, as defined by Dawkins in *The Extended Phenotype* (1982). As such, it is assumed that ideas evolve in human society in a Darwinian fashion through "natural selection." It is important that the reader understand that "natural selection" is applied to the meme, itself, and not to its *phenotypic affects*.

<u>**Delimitations**</u>

This thesis will attempt to show that human society represents a memeplex that abides by the laws and principles of memetics and that education and teaching can be defined as *assisted meme replication*. The thesis will propose a *theory of education and teaching* which addresses ongoing issues of pedagogy, makes predictions concerning the efficacy of future pedagogy, and is testable. This thesis will not test the validity of the theory.

Definition of Terms

Adaptive is a characteristic of a complex system that allows it to change and improve its fitness. The optimum adaptive point for a complex system is at the phase transition between stability and chaos. At this point average fitness can increase to a high value (Lewin, 1992).

Complex Social System is a complex adaptive system that consists of a network of interconnected members that functions and is recognized as a single social entity.

Conspecific refers to a member of the same species (Merriam-Webster's Collegiate Dictionary, 1993)

Gene is the fundamental replicator of biological evolution. The species to which Darwin refers are actually the carriers of the replicator-genes and are the phenotypic results of those genes (Dawkins, 1976).

Fitness is a measure of the ability of a complex adaptive system to enable its fundamental replicators (genes or memes) to replicate (Kauffman, 1993).

Local Enhancement is learning that takes place because the learner's attention is directed towards a specific place. For example: "Birds and rabbits learn not to fear trains by following others who are not afraid and therefore become used to the frightening noise (Blackmore, 1998).

Natural Selection is the mechanism whereby major system change takes place through a series of small events that are replicated and have a significant cumulative effect (Dawkins, 1976).

Meme is the fundamental replicator of human society. Memes are ideas or thoughts that are passed from human to human through imitation and copying. Human brain size may have increased in order to more effectively store and process memes, which, if true, is a phenotypic result of those memes (Dawkins, 1976).

Operant or Operant Behavior is an identifiable part of behavior that cannot be correlated to a stimulus (Skinner, 1938/1966).

Phenotypic Affect is the physical manifestation of a gene or meme. Gene phenotypic affects include bodies of creatures and specific characteristics of those bodies, such as eye color. Meme phenotypic affects include artifacts, such as machines and books, courses of action and other products of human society (Dawkins, 1976, 1982).

Reflex is a highly correlated stimulus-response relationship (Skinner, 1938/1966).

Reinforcer is a stimulus that is presented in a time-related manner with either another stimulus or a response (Skinner, 1938/1966).

Response is a behavior that correlates with a stimulus(Skinner, 1938/1966).

Stimulus is a modification of the forces affecting an organism that elicits a

response(Skinner, 1938/1966).

Zone of proximal development is a term conceived by Vygotsky to describe the distance

between a child's unassisted capability and that child's capability to perform with

support (Vygotsky, 1978).

Methodology

A Discussion of Theories of Memory and Learning

This thesis will briefly review three of the theories of learning that have served as

foundations for the development of parallel theories of pedagogy. In particular, this paper

will deal with Behaviorism, Constructivism and Sociocultural theories. The discussion

will consider these theories in order of their increasing complexity, which closely

parallels the chronology of their development.

A Discussion of Learning and Teaching Theories as Different Processes

This thesis will link the learning theory base to current pedagogy and will briefly

discuss problems with pedagogy that have arisen from this theory base. This thesis will

show that many concerns of pedagogy are not addressed in theories of memory and

learning.

The Science of Memetics – Literature Review

This thesis will review the literature that leads up to meme centered Darwinian evolution of human society. It will first discuss the gene as the fundamental replicator of Darwinian biological evolution. It will review the characteristics of a replicator and will emphasize that the replicator blindly follows simple rules without the benefit of foresight. This thesis will show that to understand the evolution of the species, one must first understand that it is the survival of the replicator that drives the process. It will show that the extent to which the survival of an individual or a species is improved is justified only by the increased chances of the survival of the replicators (genes). In some cases, the survival of the genes may actually lead to premature death of the individual organism.

This thesis will next show how the evolution of humans and of human society can be adequately explained by the presence of a second replicator. It will further show that this second replicator, often called the meme, may have had a major influence on human biological as well as social evolution. This thesis will describe how the meme, by enabling humans to take shortcuts to learning, has allowed our species to grow in knowledge and to create an evolving social structure.

This thesis will discuss the earliest memes and how they evolved to become complex memes and "memeplexes." It will then look at several memes and memeplexes and discuss how they replicate and evolve by isolating factors that increase their *memetic robustness*.

<u>A Theory of Education and Teaching</u>

This thesis will develop a theory of teaching that is a complement of but separate from theories of learning and memory. This theory of teaching will be independent of a philosophical worldview other than that of science.

DISCUSSIONS OF RELEVANT THEORIES

Theories of Memory, Learning, and Pedagogy

Behaviorism as a Learning Theory

Behaviorism is perhaps the first of the great theories of learning. Although the study of Behaviorism continues today, most Behaviorist pedagogy is rooted in the research of B. F. Skinner who first proposed a formal science of Behaviorism. Skinner (1938/1966) defined Behaviorism as a theory of learning that goes directly and exclusively to the interaction of the learner with the outside environment. This interaction is evidenced by changes in behavior. The research of Pavlov and Thorndike predated Skinner and influenced him as he built his science. While new theories of learning have been proposed, Behaviorism continues to be a primary research topic in psychology where it is an important part of an extensive study of body, mind and complex adaptive systems. Skinner was extremely methodical in his approach to learning and learned behavior. His goal was to frame Behaviorism entirely within the boundaries of natural science. Consequently, his theory precisely defines static and dynamic laws that he was able to confirm by experiment. Skinner argued that a science of behavior and a science of neurology must be independently established. He resisted attributing behaviors to neuron activity that could only be postulated and not directly observed.

Much of Skinner's work was with animals but in later years he began to generalize his theories to human behavior. For instance, he used the word *superstition* to describe a category of learned behaviors in pigeons (Skinner, 1948). Finally Skinner completed his generalization of Behaviorism as a learning theory and solidified its

connection to human learning in his book, Science and Human Behavior (1953/1967). In

securing the connection between the science of Behaviorism and a scientific study of

human activity, Skinner stated:

> If we are to use the methods of science in the field of human affairs, we must assume that behavior is **lawful** and **determined**. We must expect to discover that what a man does is the result of **specifiable conditions** and that once these conditions have been discovered, we can anticipate and to some extent determine his actions [emphasis added]. (p. 6)

Skinner (1953/1967) noted, however, that such an approach would fly in the face of

philosophical worldviews of humans as free agents that possess internal will and

creativity.

Operant behavior was the key to Skinner's studies of human behavior. While

stimulus-response behaviors certainly existed in humans, it was operant behaviors that

offered the most interesting possibilities for explaining uniquely human activities. For

instance, Skinner attributed superstitious and religious behaviors to accidental operant

conditioning. He asserted that such conditioning could take place when an organism

incorrectly attributes a causal relationship between an operant and a reinforcer. As noted

previously, Skinner had produced such behaviors experimentally in pigeons (1948). Later,

Skinner (1953/1967) acknowledged but did not explain the mechanism of the role of

culture in passing religious behaviors to each generation. This is a key process that this

thesis addresses in the discussion of memes. Skinner further noted that group behaviors

could be explained by treating the behavior of the group as individual behaviors with

strong positive group reinforcement.

Fundamental in Skinner's application of behavior science to humans was the need

to grapple with behaviors generally thought to be unique to humans. Behaviors such as

self-control, emotion, thinking, behaviors of the self, and social behavior had to be

framed in the context of natural science. With respect to self-control and Behaviorism,

one must ask, do humans have the ability to control their behavior? If so, what does this

concept of self-control imply? Can self-control be accounted for within the framework of

Skinner's science of behavior? Skinner recognized the importance of addressing the issue

of self-control and he did so by defining self-control itself as a behavior (1953/1967):

> He controls himself precisely as he would control the behavior of anyone else – through the manipulation of variables of which behavior is a function. His behavior in so doing is a proper object of analysis, and eventually it must be accounted for with variables lying outside of the individual himself. (p. 228)

This introspective analysis is called forth, for example, when there are positive and

negative consequences of a single response. The alternative response, which may change

the nature of the positive and negative responses, actually becomes a part of the analysis.

In essence the response that wins is called the controlling response and the response that

loses is called the controlled response (Skinner, 1953/1967). The alternative behaviors in

Skinner's version of self-control can be specified in advance and "The issue is resolved

before control is exerted" (p. 242).

Thinking, like self-control, presented Skinner with unique problems. Unlike self-

control, the actions that may result from thinking cannot necessarily be known in advance

of the behavior. All or some of the variables that may come into play when thinking may

be "private events within the organism" (Skinner, 1953/1967, p. 242). It is at this juncture

(the concept of thinking) that Skinner is forced to acknowledge the existence of

something that natural science could not directly measure. He called this something

covert behavior and asserted that when we think, we are behaving covertly in a fashion

that will become overt when we carry out the behavior that was the object of the thinking process. It is important to note that during Skinner's time there was no theory that could directly link non-material concepts like thinking to natural science. He had to link the unobservable behavior of thinking to the outward manifestation of thinking through the resulting behavior. The idea of covert behavior was the mechanism Skinner used to accomplish this. In effect, when we think about a course of action, we are covertly carrying out that course of action. Thinking then became a behavior that was simple, easily analyzed, and directly observable in its overt form. Finally, Skinner applied this same general framework when he described specific kinds of thinking behaviors, such as the behavior of recall and the behavior of deciding (Skinner, 1953/1967).

As noted, Behaviorism continues to be an important theory of learning. It is obvious that learning brings about behavioral modifications. When we have learned to spell, we spell words differently. When we have learned to ride a bicycle, we can often be seen riding bicycles. When we learn new perspectives of philosophy, we think differently about the world we live in (thinking is a covert behavior). This last example pinpoints the real problem: How do we deal with the idea that if we think differently about the world we live in we may act differently – that is change our *overt* behaviors? How does a covert behavior within an organism change one or more overt behaviors of the same organism? Skinner dealt with this problem by allowing behaviors including covert behaviors to become one of the variables in the calculations that determine overt behaviors. Such a perspective did not allow thinking processes to change future behaviors. Thus, thinking merely pre-played a behavior that had been in a sense pre-

ordained by all of the input variables (Skinner, 1953/1967). It was this inability of

Skinner's Behaviorism to deal with the process of thinking as an independent behavior

that led to the search for other, more complete theories of learning.

Behaviorism-based Pedagogy

Historically, learning theories have become the basis for approaches to education

and pedagogy. Skinner (1954/1968a) did not miss his chance to suggest changes to

education and the art of teaching. What is most interesting is that Skinner begins his

discussion by pointing out serious flaws in the current educational reform movement.

> It was part of the reform movement known as progressive education to make the positive consequences more immediately effective, but any one who visits the lower grades of the average school today [1954] will observe that a change has been made, not from aversive to positive control, but from one form of aversive stimulation to another. The child at his desk, filling in his workbook, is behaving primarily to escape from the threat of a series of minor aversive events-the teacher's displeasure, the criticism or ridicule of his classmates, an ignominious showing in a competition, low marks, a trip to the office "to be talked to" by the principal, or a word to the parent who may still resort to the birch rod. In this welter of aversive consequences, getting the right answer is in itself an insignificant event, any effect of which is list amid the anxieties, the boredom, and the aggressions which are the inevitable by-products of aversive control. (pp. 15-16)

It is notable that this same litany of problems with education has been repeated by

Constructivists and other educational theorists. For instance, noted Constructivist, Alfie

Kohn (1999) laments:

> The use of punishments, even if referred to euphemistically as negative incentives, sanctions, or consequences, creates a climate of fear, and fear generates anger and resentment. (p.97)

This striking similarity does not end with the evaluation of what's wrong. Skinner

(1954/1968a) was in agreement with three then predominant theories of teaching, but felt

that they were individually incomplete.

1. Skinner acknowledged that we learn by doing. He emphasized the fact that students don't passively absorb knowledge. They must be actively engaged in the learning process. Skinner further noted that such actions could not simply be talking. He asserted that a nonverbal component was necessary to learning. Skinner claimed that this approach to learning was not complete. Something more was needed. According to Skinner, learning was solidified by doing repeatedly. This repeated doing – drill - was then and still is a characteristic of Behaviorist pedagogy.

2. Skinner also believed that we learn from experience. Experience in the real world is important. Experience is what makes education relevant. Skinner believed that experience alone did not enable learning and that a combination of doing and experience were necessary. From Skinner's perspective "'experience' represents stimulus or input and 'doing' represents response or output" (1968c, p. 6-7). In that way Skinner was able to link current theories of learning and teaching to his science of behavior.

3. Learning by trial and error also played a role in Skinner's educational theory because consequences are an important element of operant conditioning. Skinner stressed, however that success, not error was the single most important feature of the trial and error theory. While we may learn not to make the same errors again, it is successful trials that teach desired behaviors.

   Skinner's science of behavior coupled with these three theories of teaching and education led to a movement to create *teaching machines* and *programmed learning texts*

(1958/1968b). Such devices were designed to teach complex learning in a series of small steps. Each learning step was accompanied by immediate positive reinforcement. As a result, the student was actively doing or participating in the learning process by operating the machine or progressing through the workbook. Learning steps were selected to minimize or eliminate *aversive control* of behavior. Machine programs and programmed texts were, therefore, written in a manner that most if not all students would successfully move to the next learning step by completing the present learning step during the first trial. That such machines and programmed texts might have been extremely successful in teaching memory intensive skills such as spelling and arithmetic tables will not be challenged in this thesis. Skinner does make a statement that reveals the inner flaw of a pedagogy that is based strictly upon his Behaviorist theory:

> It is true that the techniques which are emerging from the experimental study of learning are not designed to "develop the mind" or to further some vague "understanding" of mathematical relationships. They are designed, on the contrary, to establish the very behaviors which are taken to be the evidences of such mental states or processes. (Skinner, 1958/1968b, p. 26)

Skinner's conclusion is demonstrably false. Skinner himself noted that it was possible to teach extremely complex almost humanlike behaviors to pigeons (1948). There is no support for the contention that similarly complex behavior, when taught to human subjects, results somehow in understanding. If understanding was not necessary for pigeons it is certainly not a given for humans who have undergone the same training approach. Skinner's statement represents the leap of faith that Behaviorists must take when moving from the realm of learning and memory into the realm of education and teaching. The "evidences" that Skinner speaks of can be false. Memorizing a

multiplication table, for instance, clearly does not guarantee any understanding of the process of multiplication.

Skinner had several other concerns that are shared by modern day Constructivist educators, although sometimes for different reasons:

(a) Skinner strongly opposed aversive control. He rightfully noted that teaching an organism what not to do (aversive control) doesn't guarantee that the organism will learn what to do. He also noted that desired learning takes place primarily by reinforcing correct behavior rather than by punishing incorrect behavior (1968c).

(b) Skinner saw no need for a grading system. In Skinner's view, since all students complete the program of instruction (whether on a teaching machine or in a programmed instruction text), and since they do so at the same level of proficiency (they successfully complete the program), the only grading that is necessary is something equivalent to pass or not pass (1958/1968b). Constructivists view grading as a method of aversive control, which should be avoided (Kohn, 1999).

In light of the above, even Skinner would be surprised by modern implementations of Behaviorist pedagogy. E. D. Hirsch, Jr. (1996) advocates a rigidly structured lock-step curriculum and favors aversive control including standardized testing. Indeed Skinner's vision of self-paced teaching machines and programmed texts with frequent positive reinforcement has been replaced in one instance by a lock-step commercially available curriculum called *Direct Instruction* (Viadero, 1999; ECS, 2000). This Behaviorist pedagogy developed by Siegfried Engelmann, is backed by extensive research and features PK-6 curricula for reading, language arts and mathematics.

Teachers of *Direct Instruction* follow a "highly scripted" strategy for which they are especially trained. Direct Instruction is one of the more famous of the current Behaviorist – based educational programs in use. Direct Instruction was introduced in 1968 and has been a highly controversial pedagogy since its inception (Duffrin, 1996). Engelmann began development of the Direct Instruction concept beginning with initial research in 1964. The reading program in particular has been revised five times since the introduction of the curriculum. Each revision was extensively field tested before becoming a part of the Direct Instruction curriculum. Duffrin (1996) notes that with the recent shift in emphasis to accountability and standards in education, Direct Instruction is becoming increasingly popular.

In addition to the performance arts, Behaviorist pedagogy in general maintains its foothold primarily in mathematics and the sciences where concepts of absolute truth often fly in the face of *post modernism* and where truths or facts supported by theory and observation are fundamental constructs of the subjects. For example, Behaviorists argue that Constructivist pedagogy fails to convey a true understanding of the Pythagorean theorem. In essence, Behaviorists argue, the Constructivist pedagogy is a verification of the theorem and little else. Behaviorists assert that what they call traditional approaches lead to true understanding and a proof of the theorem (Chakerian & Kreith, 1996).

Constructivism

Interestingly, the work of Swiss developmental psychologist Jean Piaget concerned the development of mind in young children. His research, however, led to a

generalized theory of learning called *Constructivism*. Piaget (1952) asserted that knowledge and meaning are constructs in the minds of young learners and that these constructs evolve through four stages of development. When new information is made available, learners incorporate that information into the unique model of reality that they are constructing. Discrepancies between what a learner "knows" and new experiences result in a changed mental construction. In essence we all live in a virtual reality modeled upon (or constructed from) the experiences which we have had. Since no two learners have identical histories, opportunities to learn result in different constructions. Unlike Skinner, Piaget not only assumes that mental processes are actually occurring, he proposes mechanisms for how the processes evolve into an action model of reality. Piaget maintains that intelligence is an adaptation whose "function is to structure the universe just as an organism structures its immediate environment" (Piaget, 1952, p. 4). The structures to which Piaget refers are mental. Based on these mental structures humans can connect thoughts with things.

Piaget's (1952, 1954) describes learning as an evolving process that passes through four rather distinct stages from birth to adulthood. The *sensorimotor* stage (Birth to about age two) deals with learning about objects in space. The *preoperational* stage (Age 2 to age 7) concerns learning about symbolic representations. The *concrete operational* stage (Age 7 to age 11) involves logical problem solving. Finally, the *formal operational* stage (Age 11 to adult) enables abstract thinking and higher order reasoning.

Piaget's mechanism of construction involves three processes. These processes enable transitions from one stage to another. The process of *assimilation* is defined as

"the incorporation of any external reality whatever to one part or another of the cycle of organization" (1952, p. 408). In Piaget's case, he is referring to the construction of a virtual reality in the mind, which is an assimilation of the external reality. This process takes place as the mind "organizes" during the early years of a child's life. The process of *accommodation* is defined by Piaget as "an adjustment of the [behavior] pattern to the details of the things assimilated" (1954, p.351). Assimilation and accommodation work together to achieve a stable mental *organization*. This final process, one of organization*,* represents the results of assimilation and accommodation. It is this organization of mind that ultimately represents the construction that is handed off to the next stage of development.

While Piaget's theory is generally consistent with new knowledge in the related fields of neuroscience, cultural evolution, and the new sciences of complexity some researchers have taken issue with certain of Piaget's conclusions. In particular, Piaget's assertions concerning the crucial need for manual object manipulation have been questioned by modern researchers (Bandura, 1977; see also Baillargeon, 1996 and Spelke, 1990 as cited in Tomasello, 1999). Bandura (1977) states:

> The limitations in infant imitativeness observed by Piaget in the longitudinal study of three children are not entirely corroborated by other investigators. Infants can acquire by observation new skills and transfer them to different situations (Keye, 1971). It is assumed by Piaget that during initial stages children do not differentiate between self-imitation and imitation of the actions of others. If they cannot distinguish modeled activities from their own, the theory must include additional assumptions to explain why a child's own behavior can originally induce matching responses but identical actions initiated by others cannot. (p. 31)

The Constructivist view of learning introduced by Piaget is also viewed as inadequate in explaining how humans differ from other primates with respect to a concept of mind and intellect. Referring to Piaget's research, Tomasello (1999) asserts "these are

all cognitive skills possessed by nonhuman primates" (p. 58). These and other

inadequacies of Behaviorist and Constructivist learning theories in explaining how human

learning differs from that of other creatures are being addressed by sociocultural learning

theorists.

Constructivism-based Pedagogy

Most Constructivist pedagogy is based upon the research of Piaget and it has been

controversial from its inception. While Behaviorist styles of pedagogy have concentrated

on basic elements of learning that constitute a large body of knowledge, Constructivist

pedagogy starts with models of the large body of knowledge itself. Alfie Kohn, a leading

proponent of Constructivist pedagogy, states, "In academics, too, we learn most readily,

most naturally, most effectively, when we start with the big picture – precisely when the

basics *don't* come first" (1999, p. 53). It is interesting that Kohn takes this position,

which actually seems to fly in the face of the Constructivist approach theorized by Piaget.

How, for instance, does starting with the "big picture" allow students to construct a

reality? To some, it appears that the "big picture," having already been constructed, may

well require that students first perform some sort of "deconstruct" operation.

> The whole-language approach makes the asssumption that learning to read is analogous to the
> original, natural learning of the mother tongue: the child should be exposed to print in meaningful,
> lifelike contexts and should be encouraged to figure out the oral-written correspondences by the
> same sort of trial-and-error processes that characterized his or her learning of the mother tongue.
> (Hirsch, 1999, p.221)

It is the need for a trial-and-error "deconstruct" operation that Hirsch challenges in Whole

Language pedagogy.

Whole Language is a well-known Constructivist pedagogy for the teaching of reading and writing. The Whole Language approach to reading and writing emphasizes Kohn's "big picture" approach to learning. Its proponents argue that the purpose of reading is to read something interesting. Thus, the story is the important element of reading. Kohn (1999) says "It's just not true that one must learn to read before being able to read for understanding; it makes a lot more sense to learn to read *by* reading for understanding" (p. 53). Whole Language stresses reading over phonics instruction and writing over spelling and grammar. Proponents, like Kohn (1999), argue that the latter follows naturally from the former.

Central to Constructivist pedagogy is the view of the teacher as a *facilitator*. Teachers must become skilled at asking open-ended questions. They must create learning environments that encourage students to "make their own sense of things." Students rather than teachers are expected to explain concepts, to support their own thinking, and to ask the same of others (Kohn, 1999, p. 185). Grading is seen as a Behaviorist form of external motivation that is to be avoided and forms of *authentic assessment* have been designed to measure student progress in Constructivist classrooms (Kohn, 1999).

Some of Piaget's research has been refuted by modern studies (for example Boyd & Richerson, 1985; see also Baillargeon, 1996 and Spelke, 1990 as cited in Tomasello, 1999). Interestingly, Constructivist pedagogy often relies on the physical manipulation of objects, called manipulatives, as a fundamental requirement that assists students to build or construct mental models of the realities around them. It is this very need for physically

manipulating objects that has been questioned by recent research conducted by these sociocultural learning theorists.

Like Skinner, Piaget was a strong proponent for a pedagogy that seemed to complement what he had discovered about human learning. Like Skinner, Piaget, too, might be surprised to see how this pedagogy has evolved. For instance, while Piaget studied the construction of mind as an early developmental process, educators extended this early developmental model to all levels of human learning. Constructivist pedagogy is now promoted in all grades elementary through college (Wells, 1997).

Sociocultural Learning Theories

Human learning is now being studied as a cultural phenomenon. It is in the realm of culture that humans differ most from other creatures, thus, the role of culture in human learning is the subject of much recent research. The work of Soviet psychologist Lev Semeonovich Vygotsky represents the cornerstone of *sociocultural* learning theory. Vygotsky (1962) was concerned with how the construction of mental models might take place and how that construction might culminate in higher level psychological processes. Among other things, he saw language as the primary building block for such construction. It was the realization that language is a sociocultural phenomenon that led Vygotsky to inquire more deeply into the effects of culture on the development of mind. Subsequent educational theorists (Bruner, 1975; Tomasello, 1999) have made efforts to revise several of the claims of Vygotsky in the light of new developments. Tomasello arrived at the concept of *cultural learning* from Vygotsky's sociocultural approach. He credits a single

biological adaptation "the understanding of conspecifics as intentional beings like the self" and asserts that it "is a uniquely human cognitive competency" (1999, p. 56) which in effect "turns on" human social learning. Tomasello and Bandura (1977), like Vygotsky, acknowledge that language and symbolic processing is fundamental in this social learning process.

Boyd and Richerson (1985) define social learning very simply as "the transmission of stable behavioral dispositions by teaching or *imitation* [italics added]" (p. 40). They concur with Bandura's social learning theory, which asserts that a strictly Behaviorist approach to social learning is not economical. Bandura and Walters (as cited in Boyd & Richerson, 1985) maintain that social learning must also include a strong element of imitation, which they call *observational learning*. Subsequent research on observational learning by Bandura (1977) has shown (a) the observer has the ability to collect and organize the information about behavior in the absence of immediate reinforcement, and (b) the observer has the ability to abstract rules from a series of modeled behaviors. It well may be this element of imitation or observational learning that differentiates human learning and culture from that of other creatures, including other primates.

While Vygotsky has had a great influence on educators, there are actually a number of competing views of sociocultural learning. Many of these views reflect disagreements among researchers concerning the nature of the cultural transmission in social evolution (Boyd & Richerson, 1985):

(a) **Guided Variation** – "When individuals learn…the frequency of certain (usually favorable) variants [in the cultural repertoire] is increased. If such learned variants are culturally transmitted, the result is a force that increases the frequency from one generation to the next of the same variants whose frequency is increased *within* [italics added] a generation by learning" (p. 82). This force is called *guided variation*.

(b) **Direct Bias** – The people's acceptance of "some cultural variants rather than others based on their judgements about the properties of the variants themselves" (p. 10) is called *direct bias*.

(c) **Genetically Transmitted Traits (Innate Characteristics)** – Individuals that are genetically predisposed to become inculturated are selected if being *inculturated* increases their fitness. This in turn increases the frequency of such genetic predispositions in the population of the culture.

The impact of sociocultural learning is becoming increasingly important in a wide range of academic disciplines. Schild (1999), writing in a completely different context, emphasizes the importance of socially constructed reality. Speaking to the importance of *letters to the editor* as a social learning environment that led to a successful school referendum outcome, Schild says:

> Ultimately the reality that decided to build a new middle school was not a pronouncement by the school board or superintendent or the department of Children, Families and Learning; it was each letter writer's—and each voter's—conclusions about the everyday realities of financial and educational values. (pp. 44-45)

Schild in the instance of letters to the editor is legitimizing the concept of social learning. Implicit in his statement is the idea that the social discourse conducted via the

letters didn't merely reflect the reality, it played a role in constructing the reality; and that the social discourse was part of the evolutionary process that led to the outcome of the election.

The view of human learning as a social process is an important element of all cultural evolution theories. The perspective of cultural change as an evolutionary learning process has led researchers to seek to isolate the *unit of change* of culture. This thesis will define the meme as the unit of change of human culture.

Pedagogy based on Sociocultural Learning Theories

Sociocultural pedagogy in its present form consists of the socialization of Constructivist approaches to teaching. As students learn to support their thinking and question the thinking of others, cultural interaction is the inevitable result. In discussing sociocultural approaches to mathematics education, Wilson, Teslow and Taylor (1993) emphasize "the need for social interaction and expert guidance within the zone of proximal development…[by means of] group activities, learners internalize the goals and methods of more expert problem solvers" (p. 13 on-line). Teaching strategies must be consistent with Vygotsky's Theory of Mind: (a) They must emphasize the importance of social interaction, (b) they must address motivation and attitude development, (c) they must acknowledge the role of dialog, and (d) they must function in the zone of proximal development (Wilson, Teslow & Taylor, 1993).

While there are many striking similarities between Constructivist approaches to pedagogy and sociocultural learning approaches there are important differences. First,

teachers are not simply facilitators. In a sociocultural context, teachers must function in the zone of proximal development. Thus, they must become active participants in the learning process by providing opportunities for modeling, imitation, and observational learning. Second, learners do not independently discover or construct meaning. They discover and construct meaning jointly and within social contexts.

Learning and Teaching Theories as Different Processes

Learning theories such as Behaviorism, Constructivism and the many sociocultural theories have traditionally been used to support philosophical worldviews of appropriate goals for education and teaching. The resulting arguments for and defenses of pedagogy are, for the most part, circular arguments. Behaviorist pedagogy is deemed better by Behaviorists because it produces measurable changes in behavior. Constructivist pedagogy is deemed better by Constructivists because the students successfully construct unique ideas and concepts. Lastly, sociocultural pedagogy leads students to successful internalization through social interactions and the use of language. That any pedagogy does what it is intended to do is no surprise. Again, the roles of education and teaching as described in pedagogy represent philosophical positions. These philosophical positions are justified by being attached to specific learning theories. A central thesis of this paper is that such "attachments" are not supported by good logic or good science.

Each of the three theories of learning discussed in this thesis must be joined with many other memory and learning theories that have not been discussed. Scientifically, human memory and learning can be understood most accurately by "thinking these

theories together." Educators and teachers must also come to realize that no single one of these theoretical approaches results in universally "good" pedagogy. While the theoretical foundations of memory and learning may be applicable to all children, there still remain several variables that pedagogy must take into account when educators step from the world of theory into the world of the classroom.

First, the histories of students are unique. They come to classrooms with different levels of emotional, cognitive and social skills. Researchers, have attempted to categorize and pigeonhole these differences by proposing theories of *multiple intelligences* (Gardner, 1983) or defining and measuring *assets* that increase the likelihood of success (Benson, Galbraith, & Espeland, 1994). However these differences in children are measured, they demand unique approaches to pedagogy not implied in memory and learning theories.

Second, pedagogy is often designed to comply with the philosophical positions of educators, as legitimized by memory and learning theories when the subject matter itself is the more appropriate source for selecting an appropriate style of pedagogy. The subject of reading, for instance, has two quite different objectives and these objectives cannot best be met by a single pedagogical style. For instance, children must be taught to want to read. This thesis will assert that children must acquire the *reading meme*. Additionally, children must be taught how to read. This thesis will assert that they must acquire the *reading skill meme*. These memes are quite different. This thesis will show that the related pedagogy must also be different.

Third, while educators often talk about "age appropriate" learning, there is little evidence that such thinking has actually been translated into the selection of a

pedagogical style. The style seems always to be preordained by the philosophical positions of educators. Behaviorist pedagogy has been designed to be "age appropriate," as have Constructivist and Sociocultural pedagogies. Memetics will show that such decisions should be based upon age appropriate needs of the children and the particular memes being replicated, not on the need to conform to a particular philosophical style.

Educators must move away from the world of either-or thinking when designing or selecting pedagogy. The science of memetics offers educators a chance, as Parker Palmer might say, "to think the world of teaching together" under a single theoretical framework.

The Science of Memetics

Complex Adaptive Systems

Much of the modern study of complex systems began as an attempt to understand *complex biological systems*, such as the *immune system*, the *respiratory system*, or the complexity of entire organisms (Kauffman, 1993, 1995). Fundamental to this early research were attempts to understand just how such systems could have *evolved*. The parallel evolution of systems, such as sight, in diverse species seemed to indicate that more than mere chance was involved in the evolutionary process (Kauffman, 1995). These questions led researchers to seek out the rules that govern how complex systems evolve into more fit variants. The resulting patterns and rules have been shown to be valid for many types of complex systems, including several *complex social systems* (Mainzer, 1994; Kauffman, 1995). Many of these rules may in fact be universal in nature.

The Need for a Replicator

Biological evolution is driven by the "need" for a *replicator* to survive and reproduce. The definition of a replicator is somewhat circular: that which makes copies of itself is called a replicator and a replicator makes copies of itself. Replication is not a conscious act. If an entity can replicate, it will. If it cannot, it will not and it will not be a replicator. In fact, a replicator that fails will eventually cease to exist. Biologists have argued about the nature of the fundamental biological replicator. Most recently, the *gene* has been proposed as the fundamental replicator of biological forms (Dawkins, 1976). Although genes blindly follow a series of natural laws, scientists treat them as conscious entities that are striving to survive and replicate. By treating the gene as the replicator nearly all questions concerning biological evolutionary behavior can be adequately answered. It is the survival of the gene, therefore, which drives biological evolution. Living organisms, plant and animal, are emergent characteristics of gene evolution that enhance the gene's chances of survival and replication. A few questions not adequately answered by assuming the gene to be the fundamental replicator pertain to human evolution and specifically to human social evolution.

The Meme as a Replicator

What makes human socialization different from that of other social animals? Is there a single factor that can explain why we are "different?" We certainly are not the only species that can learn. However, while other animals learn solely or primarily

through cause and effect relationships (classical conditioning) and by trial and error

(operant conditioning), human beings have found a short cut to learning – we copy each

other. Only a few other species, most notably certain songbirds and some primates, have

discovered how to copy and they only use their copying ability in a rudimentary manner.

So far, only humans have raised copying or imitating to the level that it represents their

primary means of learning (Blackmore, 1999). Blackmore notes that the ability to imitate

requires that you "put yourself in another's shoes; to take the other's point of view; to

imagine what it would be like to be that other" (1999, page 76). Tomasello (1999)

describes what he considers the only biological adaptation necessary to enable such

imitative learning:

> These three types of cultural learning [imitative learning, instructed learning, and collaborative learning] are made possible by a single very special form of social cognition, namely, the ability of individual organisms to understand conspecifics as beings *like themselves* who have intentional and mental lives like their own. This understanding enables individuals to imagine themselves "in the mental shoes" of some other person, so that they can learn not just *from* the other but *through* the other. (pp. 5-6)

When an individual creature copies the idea of another, that idea takes on a life of

its own. Like the gene, the idea becomes a replicator. It begins to evolve, like the

evolving species of Darwin. Richard Dawkins (1976) was the first to call such ideas,

copied from individual to individual, *memes*.

While Dawkins first coined the word meme, he was not alone in the investigation

of ideas as evolving entities. Boyd and Richardson (1985) also investigated the concept of

the evolution of human society by the selection of ideas. As early as 1965 Campbell

discussed socio-cultural change as an evolutionary process. Campbell (1965) also linked

the evolution of culture, based upon natural selection, to several of the established learning theories of humans as individuals and as members of social groups.

Reader and Laland (1999) contend that any social learning process, such as *local enhancement*, that causes ideas to be replicated transforms those ideas into memes. They contend that this explains why many animals have developed "proto-cultures" that are also subject to evolving processes. Other researchers contend that there are different types of memes. Langrish (1999) asserts that memes are not "units" (like atoms). According to his view, memes are fundamental patterns that come in different forms:

(a) **Recipemes** are "competing ideas of how to do things." Recipemes are replicated by copying or imitating. They involve *doing* something, like learning how to ride a bike.

(b) **Selectemes** are "ideas that form the basis of selection." Selectemes are ideas that are competing for replication. Recipemes for Christianity and Judaism, for instance might compete and the basis for selecting one religion over the other is the selecteme. Selectemes are transmitted by society in a process that involves copying or imitating. Recipemes and selectemes can be combined in what Langrish calls "black box" systems. In such systems recipemes are ideas about inputs" and "selectemes are ideas about outputs."

(c) **Explanemes** are "competing ideas that are used in answering questions about why things work or work better." Explanemes are "ideas about what is happening inside the black box." Langrish notes that explanemes cannot be replicated by imitation. Their replication requires a language (spoken, mathematical, or symbolic).

Langrish has postulated that many memeplexes are in effect "black boxes" within which may reside a hierarchy of structures of recipemes and selectemes. He further states that recipemes serve as inputs to a hierarchy of memes in black box systems and selectemes serve as outputs from the hierarchy of memes in black box systems. Langrish, in describing black box systems has revealed more of the nature of what Blackmore has called memeplexes. Langrish sees these three types of memes as filling a void in Blackmore's definition, because certain memes, scientific ideas for instance, are not passed on or replicated through imitation. It is clear that explanemes could not exist without recipemes and selectemes, which in a way supports Blackmore's assertion that it all started with imitation (1999). While explanemes cannot be replicated by imitation, the tools of replication (language and math) are themselves memes that are replicated by imitation and copying. Clearly it is this imitative or copying ability of humans that distinguishes human culture from the proto-cultures of other animals.

If humans had not learned how to copy, there would be no schools. If humans did not imitate, each individual would have to learn from scratch and each generation would be locked into a repeating cycle of learning from scratch that would not advance. Eventually, through natural selection, human genes might precondition individuals to learn certain things (Dawkins, 1976, 1982), like the discovery that each sea otter makes when it begins to use a stone on its stomach to break open shells.

When humans learned how to imitate and copy, a new factor was added to the evolution of our species (Bandura, 1977; Blackmore, 1999; Boyd & Richerson, 1985). Knowledge and culture, acquired over the generations, became as important a factor in

human evolution as the genes that were passed down through those same generations. In

fact, the subsequent evolution of the human brain may have preconditioned us to learn by

copying (Blackmore, 1999).

Central to the study of evolutionary science is the discussion of the fundamental

replicators as if they were conscious entities. Studying replicators from this perspective

allows scientists to construct meaning out of the process of evolution and to explain how

complex adaptive (life) systems evolve. In reality fundamental replicators like memes and

genes are not conscious. They blindly follow the rules of natural selection that lead to

their replication (Dawkins, 1976, p. 196).

Long ago, the act of copying another person's ideas created a new class of

replicators often called the meme. It was at that instant that humans became different

from other animals (Blackmore, 1999). It was at that instant that the profession of

teaching was invented.

Memes and Memeplexes

It is easy to imagine an early instance of imitation or copying of an idea. Perhaps

it was the use of a *stick* to bludgeon a small animal. What made such an idea important is

not that early humans had that particular idea. What made it important was that other

early humans, who did not have the idea, copied the actions of those who did and

benefited from the results. Eventually, the idea evolved into finding a pointed stick,

which was copied. In time, the idea was to sharpen the stick, which was imitated. In this

way technology developed from a single idea to a large collection of related ideas. (Find a

stick to use as a weapon. Big sticks can be used as clubs, but they are heavy. Small sticks

can be used as spears, but they must be sharpened.) Ideas that get copied are memes.

Complexes of ideas that form a single more complex whole – such as a technology – have

been called memeplexes (Blackmore, 1999). The individual memes inside a memeplex

are more successful replicators because they are members of the memeplex. The idea of a

moving electron, for instance, is of little value in and of itself. New scientific discoveries

are new memes that inevitably lead to memeplexes of technology. Thus, the moving

electron led to the technology of electronics. The meme of a moving electron would have

succumbed long ago, if the memeplex of electronics technology had not been created.

Eventually early humans were faced with a dilemma. How does one consider the

relative merits of heavy sticks (clubs) and sharp light sticks (spears)? More importantly,

how does a human imitate the intellectual concepts represented by those merits? Without

a symbol system, early humans had each to experience the merits of the spear and the

merits of the club and to decide for themselves. As memeplexes became ever larger and

more complex it became necessary to create symbols to represent non-physical aspects or

features of these memeplexes - qualities that could not be directly copied or imitated. The

result was the creation of the first *copying memeplex* – spoken language (Blackmore,

1999). With the creation of spoken language abstract ideas could be copied and

memeplexes became even more complex.

Even small memeplexes are complex intellectual objects. They are made up of yet

smaller memeplexes and individual memes and these memes come in several different

types. A simplified description of a memeplex, using the terminology developed by

Langrish can serve as a clarifying example. Consider a relatively small memeplex, such as riding a bicycle. A child who wishes to learn to ride a bike has already acquired the *bicycling selecteme*. The child has already determined that riding a bicycle is a desired activity. Often this determination has been made through observational learning. Other children and adults are seen riding bicycles, which replicates the meme (the idea) of bicycling. These others appear to enjoy riding bicycles, which replicates a fun meme. They can also go fast, which is another popular meme in our culture! Such memes lead the child to want to learn to ride the bicycle. In so wanting, the child has selected the bicycle riding meme.

It now becomes necessary to replicate the skill of riding a bicycle. This recipeme requires much repetition in order to build the skill. The recipeme of riding a bicycle is actually a small memeplex (a recipemeplex) that, itself, consists of memes and memeplexes. For instance, the child must learn the importance of balancing the bike. Bikes don't balance themselves and the child must replicate that idea. That selecteme is a part of the recipe for riding. Another part is the process of turning and the need to tilt the bicycle into the turn as a function of speed. Such basic selectemes become part of a recipemeplex and are learned as one integrated function. Older learners might also replicate explanemes that relate the functions of riding a bicycle to the laws of physics, but such memes are seldom replicated in young children who are learning to ride a bicycle.

There are other memes and memeplexes that must be replicated as a child learns to ride a bike. Children cannot be allowed to ride a bicycle in the street until they have

replicated the applicable traffic regulations. Most importantly, they need to replicate a fundamental selecteme that gives meaning to the relative dangers of other vehicles, like cars and trucks.

This is only a cursory discussion of the memeplex of riding a bicycle. There are many other individual memes and small memeplexes that are a part of this skill. It is, however, a fair example of how complex such an apparently simple memeplex can be. The following paragraphs describe three far more complex memeplexes.

The Selfplex

Perhaps the most complicated memeplex is that which resides in the human brain. As Blackmore (1999) contends, humans are literally *Meme Machines*. She defines a *selfplex* as the vast memeplex in our brains that defines who we are. Piaget (1952, pp. 1-20) uses different words to discuss a kind of virtual reality construction that leads to a concept of mind and intelligence. His constructions are collections of thoughts (ideas) which he calls *schemata* (memeplexes). Piaget (1952) defines six stages of development that, when completed, leads the child to a sense of self-awareness and "invention" (creativity). So, it can be said that these stages of development in children create the beginnings of massive complexes of memes that uniquely differentiate human minds.

While Blackmore (1999) defines and discusses the selfplex as that memeplex that represents the "I" in our reality, she fails to recognize its validity. Blackmore says, instead, that the selfplex is a false self. She resists the idea that the selfplex represents the window through which "we" look upon reality (p. 243). While rightly acknowledging that

there is no separate "I" that controls the selfplex, she fails to make the essential connection that the selfplex itself is the "I" that individuals perceive. "The illusion of self in control" (p. 245) is not an illusion. It is a meme.

Religious Memeplexes

Probably the most successful of the large memeplexes are those of religions. Religious memeplexes begin their replication when the receiving minds are very new (Blackmore, 1999). Consequently, religious memeplexes often become an essential element of selfplex constructions. Thus, humans take on a degree of ownership of their religions that is very difficult and often impossible to change. Religious memeplexes are most often replicated in a manner that results in extremely accurate replication fidelity. This accuracy insures that religious memeplexes will survive for long periods of time with an evolution rate that is usually much slower than the rates of evolution of societies.

Because religious memeplexes often become an integral part of the early selfplex, they can become a part of the "me" or the "I" that looks out upon reality. Therefore, changing religions or abandoning religion altogether can be a lengthy and painful process that is often precipitated by a life crisis.

The Memeplex of Culture

This thesis views culture, like religion, as a memeplex that begins its replication in the early stages of human development. In fact, many early and present cultural memeplexes incorporate religion as a fundamental component. Language is another

fundamental component of the culture memeplex that is often inseparable from it. Cultures and languages appear to co-evolve. If this is so, it could be said that American English differs from British English because the cultures have evolved differently. It could therefore be said that language dialects are manifestations of *culture variants*. Like religions, languages are most often replicated with very good fidelity. It can be argued that the intimate relationship between language and culture requires that language evolve with culture. In contrast, while religions may be a part of the cultural memeplex, the evolution of religions is not necessarily enforced by the overall culture. Like religion, culture becomes an integral part of the early selfplex. Erikson (1950) reaches a similar conclusion:

> We are speaking of goals and values and of the energy put at their disposal by child-training systems. Such values persist because the cultural ethos continues to consider them "natural" and does not admit of alternatives. They persist because they have become an *essential part of an individual's sense of identity* [italics added], which he must preserve as a core of sanity and efficiency…They [goals and values] must continue to be anchored, generation after generation, in early child training. (p. 138)

Many humans find it quite impossible to lose or change the culture memeplex that they acquire at an early age. Like changing religions, changing cultures often takes place as a response to a life crisis.

How memes and memeplexes replicate

Memes replicate by getting themselves copied in the minds of humans. If a spear is a good idea, early humans will imitate the success of the spear "inventor" and more people will have the idea of the spear in their minds. Memes compete for space in the minds of humans. The laws of natural selection operate on memes. If an idea is a good

idea it will be copied. The meme will replicate. If a newer or different competing idea is perceived to be "better" it may be replicated while the old idea is not. The same is true of memeplexes.

Blackmore (1999) defines three directions of memetic replication. Each direction is characterized by varying degrees of replication accuracy and by the speed with which a meme can be replicated.

Vertical Replication

Memes are replicated from parent to offspring. When memes and memeplexes are replicated vertically, the fidelity of the replication is high. Replication, however, is limited to the number of offspring so it takes many generations for a meme or memeplex to be replicated into major percentages of the population. Examples of memes that are often replicated vertically are language, religious beliefs, folk art, other family cultural memeplexes, and skilled trades. It is important to note that memes that are replicated vertically travel forward through time. The role of parents as teachers is critical in vertical replication.

Horizontal Replication

Memes are replicated to individuals, often in the same generation or peer group, in the wider community. Such replication ranges from low to high fidelity but the memes and memeplexes can be replicated in large percentages of the population in a very short

period of time. Examples of horizontally replicated memes include language, religion, technology, fashions, and popular music.

Oblique Replication

Blackmore makes only a passing reference to oblique replication. She defines oblique replication as that which occurs downward in a family but not from parent to offspring. Meme replication from an uncle to a nephew would be oblique. Oblique replication shares an important fact with vertical replication: it passes memes forward through time in a culture and is of high fidelity. The meaning of oblique replication will be expanded in this thesis to include memetic replication intended to travel from any non-parental member of an older generation to *any* non-offspring member of a younger generation. Formal educational systems and the profession of teaching are about the business of oblique meme replication. When viewed from this perspective, the oblique replication of memes plays a role of major importance in culture.

The theory of education and teaching that follows is about vertical and oblique meme replication.

THEORY OF EDUCATION AND TEACHING

Education is a formalized system of learning by copying. No longer does each individual and each generation have to re-invent the wheel. As humans, we can now start where others have left off. It is true that we can construct a body of knowledge based on our own experiences, but more importantly, we can construct a body of knowledge based upon the accumulated experiences of thousands of generations of other humans. Educational systems are an important means of passing on this accumulated knowledge to new generations and into the future.

Why Another Theory?

Current pedagogy is justified by philosophical worldviews with a weak link to learning theories. It is evaluated as successful based upon the philosophical goals of its proponents. Thus, Behaviorists view Behaviorist pedagogy as successful while Constructivists do not. Socioculturalists see sociocultural pedagogy as successful while Behaviorists do not. Similarly, Constructivists view Behaviorist pedagogy as a failure. In each case the evaluation of the appropriateness and success of pedagogy is based upon the philosophical worldview that brought the pedagogy into existence. Such reasoning is circular and not valid. Educational leaders must work with teachers with varied philosophical positions. Politicians must judge the effectiveness of public education and school systems. Parents seek the best education for their children. Voters are called upon to make judgement decisions about school funding. All of these groups find themselves in the midst of illogical arguments between educators about what is "best for the kids."

Each of these philosophical positions is correct - but not universally so. Educators are being called upon to look beyond either-or thinking and to "think the world together" (Palmer, 1998, p. 62).

> The problem of arriving at a common set of goals and objectives for education in the United States is exacerbated by the complex social environment in the United Stated and the eclectic nature of the professional environment within the educational system. Teaching is viewed as an "art" not solidly rooted in theory. Members of the profession are of different philosophical persuasions and these differences are often painted as black-white, either-or. (Hittner, 2000, p. 3)

A theory of education and teaching that acknowledges the strengths of *each* philosophical worldview and that is solidly rooted in an appropriate scientific discipline is needed in order to put the logic back into choices of pedagogy. As noted previously, education and the art of teaching were created with the arrival of memes. Thus, a theory of education and teaching is appropriate if rooted in and consistent with the science of memetics. Such a theory, if correct, could be shown to be in agreement with the non-conflicting features of all philosophies of education.

The Purpose of Education

The purpose of education is to replicate memes. More specifically, the purpose of education is to replicate socially significant memes in the minds of younger generations. In so doing, education provides for the replication and continuation of a social structure by passing socially significant memes into the future. From the perspective of memetics, education itself is a very important memeplex. The memes of a complete culture reside within the educational memeplex. In addition, the philosophies and mechanisms of education itself are memeplexes. Whatever educators and others value as the role or the

purpose of education, it is overshadowed by this one purpose: Education replicates socially significant memes into the future.

What Is "Natural"?

Many philosophers address issues of what is natural by seeking answers to questions like "What is human nature?" Noted educational philosopher John Dewey devotes an entire chapter of his book *Democracy and Education: An Introduction to the Philosophy of Education* to the subject of "Natural Development and Social Efficiency as Aims" (Dewey, 1916, Chap. 9). However complex human nature may appear, the memetic answer to that question is very simple: We are each defined by our selfplex. That selfplex is in turn defined by our culture and our education and what appears quite natural in one culture can be quite unnatural in another. The belief structure that constitutes the early selfplex in each young child is the foundation upon which humans build their entire lives.

One truly unique feature of human nature is the *language instinct* (Blackmore, 1999, p. 88). Spoken language appears to be a "natural" for humans as does a more generalized ability for symbol manipulation. A second unique feature of human nature is the ability to understand conspecifics "as intentional beings like the self" (Tomasello, 1999, p. 56). As noted previously, this ability leads directly to the actions of copying, imitating and observational learning.

The Education Memeplex as a Replication Mechanism

According to noted theorist Steven Hawkings "[A theory] must accurately describe a large class of observations on the basis of a model that contains only a few arbitrary elements, and it must make definite predictions about the results of future observations" (1988, p. 9). The following sections of this thesis describe a theory of what education is, why it is, and how educators should select pedagogy. The theory will make predictions concerning the evolution of educational thought and pedagogy. This theory can guide educational leaders as they strive to bring the profession to a consensus regarding educational system goals and objectives and appropriate uses of pedagogy.

Education Replicates Socially Significant Memes.

The development of the selfplex is an evolutionary growth phenomenon like biological *morphogenesis*. Biological organisms are not stamped out of masses of living tissue in accordance with DNA "patterns." They do not suddenly emerge in a completed form. Rather, DNA actually represents instructions for growth (Dawkins, 1976). If the right raw materials are present at the right times, the organism will be formed with the "intended" characteristics. If the right raw materials are missing, the organism will be changed or flawed, even if the DNA instructions are correct. Throughout the process of morphogenesis, the organism evolves and grows from its earliest form (a single cell) to its final form.

Similarly, the selfplex is not stamped out of masses of "raw materials" memes and memeplexes. Education, too, is a growth process similar to that of morphogenesis. The

selfplex which represents individual personalities and knowledge structures is the result of this evolving growth process which starts from its earliest form (an unprogrammed human brain) and grows and evolves to its final form – a process that lasts a lifetime. Like biological morphogenesis, the development of the selfplex requires the right materials – in this case memes - to be delivered to human brains at the right times. The goal of the educational process, from pre-birth to death, should be to deliver the right memes at the right times.

From the very beginning of life, humans are in a sociocultural educational environment. As noted previously, the most important education is the education that human children receive from birth to about age 11 (Piaget, 1952, 1954). It is during this period that children construct the realities of the universe and place themselves within those realities. Thus, each selfplex is largely in place by puberty. Selfplex constructions of virtual reality, first studied and described by Piaget as a construction of *mind*, initially undergo extensive and rapid evolution. This evolution of mind slows but does not stop as individuals mature. This evolving construction of mind is the framework within which individual humans experience their lives. While these constructions certainly continue to change and evolve, their essential characters are determined by the time children have reached puberty.

The evolving construction of the selfplex places very different age-based requirements on educational delivery systems. For the most part, educational systems appear to have the correct order of delivery of subject matter. The importance of reading, for instance, as the initial learned skill finds little argument among teachers, educational

leaders, parents, or politicians. However, there continues to be considerable discussion about method. The topic of method – or pedagogy - is addressed by this theory.

The following sections discuss the evolution of educational subject matter from the perspective of memetics. The memetics terminology that was developed earlier will be applied to a sampling of school subjects. A discussion of appropriate pedagogy will follow this *memeticization* of educational subject matter.

The Pre-school to Early Elementary School Educational Environments

The pre-school educational environment is the single most important educational period for all humans. At the beginning of this period –birth – children are as alike as they will ever be. No matter how hard a society tries to standardize its members, they will never again be as similar as they were at birth. By age 7 the selfplexes of children are very nearly fully differentiated because by that time the design of the essential structures of those selfplexes has been determined. Seven-year-olds have good spoken language skills and have learned how to symbolically represent their realities (Piaget, 1952, 1954). They have also established a fundamental system of beliefs and may have experienced the basics of a religious or moral code memeplex. By a very early age, therefore, young children have built a mental structure that they will use for social interaction and modeling reality for the rest of their lives.

Language

Symbolic manipulation begins with the incorporation of spoken language into the young person's selfplex. Humans appear to be predisposed to acquire a spoken language.

A high-level language selecteme is not necessary. Nevertheless the memeplex of language must be acquired primarily through social interaction. In fact, the language memeplex is virtually non-existent when there is no social interaction (Tomasello, 1999). With the acquisition of language comes inculturation: Young children begin to learn about personal hygiene, expression of emotions, and other forms of acceptable social behavior.

If a culture has a written language the high-level selecteme of reading must be replicated at this age level. Educators know that it is important to read to young children. The reason is that frequent reading of interesting and exciting stories replicates the reading meme. The high-level reading selecteme is simply the idea that "Reading is interesting and exciting. I want to read." The key element in the replication of this meme is for older humans to read – and be seen reading – to themselves and to young children. It is important that the children know that the story is "coming from the book." If children do not acquire this selecteme, they may still be able to learn to read but they won't be readers. They won't want to read. They will be less likely to select reading from among other means of taking in information.

In addition to rapid development of the selfplex, young children undergo extensive changes in their physical abilities as well. These physical changes enable increasingly accurate modeling and skills-based imitative learning, such as improved eye-hand coordination or even bicycle riding. The ability to learn to perform such activities further develops the selfplex.

As noted, many religious, moral, and cultural memes and memeplexes become a part of the selfplex early in the lives of children. These memes and memeplexes including the high-level reading selecteme are in place before children acquire logical problem-solving skills. Because these memes are acquired prior to rational thought, they constitute the *fundamental belief structures* of young children. Such memes are not easily replaced. Therefore, it is imperative that early childhood learning results in the efficient replication of socially important and desirable memes. Once children have been "damaged" by inadequately or incorrectly replicated memes, they cannot be fixed. Like children born with fetal alcohol syndrome, such damage to the process of morphogenesis is permanent.

The responsibilities for educating this age group fall predominantly upon the parents in the social environment of the family or on social educational institutions designed for that purpose. If a society fails in the education of this age group that failure will echo through several generations because these young children are destined to become the parents of future generations. Through the process of guided variation a culture can undergo extensive evolution as a result of variations in the effectiveness of the educational process at this age level. Effective parenting is the single most important feature of a good educational system. Parents replicate memes and memeplexes in early childhood almost exclusively by means of observational learning. Parents, therefore, must be good role models because they teach by example.

The Early Elementary to Early Middle School Educational Environments

The selfplex is still in the midst of rapid evolution in elementary age children. During this part of the construction phase the design of the selfplex has already been determined. As noted earlier, Piaget defined six phases of reality construction that take place during the first years of a child's life through age 11. The educational system must provide the right memes at the right times during this developmental process, which culminates near the end of the middle school years.

Language

The educational system must provide young learners with a variety of memes that are critical to the rest of their education and that constitute what E. D. Hirsch (1996) has described as *knowledge capital*. The single most important of these meme structures is the continued development of language. If the culture has a written language, the high-level writing selecteme must be replicated. The human "natural" of spoken language serves as the raw material meme for the construction of written language. In such instances reading and writing jointly become part of the language memeplex. Replication of the high-level reading selecteme, therefore, must continue in this age group as children actually begin to learn to read.

Language is a fundamental element in the educational process and the memes and memeplexes of language are diverse. The learning of language, therefore, is suitable as a topic for a more detailed analysis of types of memes and their links to pedagogy. The language memeplex consists of a hierarchy of individual memes and memeplexes that

must be dealt with by the educational system. Listening and reading require decoding memeplexes of the type recipemes. Recipemes are memes of process that take raw materials – in this case words and sentences – and process them into finished products – in this case meanings and understanding. All language decoding and encoding recipemes require extensive raw materials selectemes - word vocabularies. Speaking and writing encoding recipemes require selectemes and rules recipemes – grammar. Reading decoding recipemes require symbol recognition and translation selectemes and rules recipemes – phonics. There is no way to get around these memes and memeplexes. If society wants its members to be readers, they must be replicated.

Phonics is the *recipemeplex,* or black box system, that allows children to translate written language into their native tongue – the spoken language. Whether or not phonics is taught, it is necessary for children to learn to translate written symbols into the sounds they have come to associate with word-concepts (except in the case of children who are deaf). The educational system must replicate the phonics recipemeplex as part of the replication of the reading memeplex. If it does not do so, individual children are left to invent their own decoding recipemes and society loses a measure of control over the replication of the language memeplex. This loss of control increases the likelihood of decreasing fidelity in the replication process with its attendant increased mutation rate. The result may be an undesirable evolution of language.

Grammar decoding rules can be, and often are, inferred in the early stages of listening and reading but may have to be explicitly replicated as children begin to deal

with ever more complex ideas and sentence structure. The selectemes and recipemes of grammar then become more important in the *encoding* activities of speaking and writing.

Vocabulary memeplexes are very near the bottom of this language hierarchy of memes. These selectemes are easily replicated by a process of definition and use. If children first acquire a recipeme for building their vocabularies it can become a nearly automatic process that takes place as children listen, read, talk, and write.

Mathematics

Other selectemes like the concepts of numbers and of counting must be introduced during the elementary years. The reading and writing of numbers, like all reading, requires the replication of certain recipemes. In this case a three-way decoding and encoding system of selectemes and recipemes is required. Young students are being asked to encode and decode the concept of the number (a numeric value), the name of the number (its written word and oral representation) and the symbol for the number (its mathematical symbol notation).

As children enter middle school, they enter into what Piaget describes as the *concrete operational* stage of development. This stage doesn't just "happen" over night. It is a natural outcome of the acquisition of the ability to manipulate visual and oral language and mathematical symbol memes that were replicated in earlier years. At this point, it is appropriate for the educational system to begin to introduce concepts of how and why things work. Such explanemes use the acquired symbolic tools and provide a wide range of opportunities for symbolic manipulation.

As in the case of very young children, parents and teachers must be good role models. While it is true that children learn by trial and error and by selective reinforcement, it must be remembered that it is observational learning (the ability to imitate) that sets human children apart from all other creatures. Extensive observational learning builds social structures by bypassing the trial and error and reinforcement processes of experiential learning.

The Early Middle School to Secondary School Educational Environments

Middle school and secondary education is largely involved with what might be termed the *post-construction* phase of the evolution and growth of the selfplex. The selfplex is not completed, but it is defined. To use a building analogy, the definition of the structure as a house, an apartment, a skyscraper, or a bridge has been determined and is irreversible, even though the structure itself is not done. In this formal operational stage (Piaget, 1952, 1954) students are capable of abstract thinking and higher order reasoning. As might be expected, advanced topics in mathematics, the sciences, history, and literature are introduced. Such topics are often explored from a more theoretical or analytic perspective as explanemes begin to be replicated in each of these subject areas. Explanemes answer questions about what is inside the black boxes of many memeplexes and how they work. Such topics are predicated upon a command of language and mathematics and other symbolic manipulation skills. As noted earlier, explanemes cannot be replicated by imitation.

It is important to note that in most modern societies education through the secondary level is primarily a process of replicating memes that have demonstrated social, scientific, and historical significance because of their survival across one or many generations. The educational process to this point has not had a primary goal of creating "new" memes. The primary product of education so far has been the construction and evolution of new virtual realities, the selfplexes of students. Post-secondary education differs from birth to secondary education in this respect.

The Post-secondary School Educational Environment

A primary goal of post-secondary education is to move learners toward the cutting edge of social, scientific, and technological change. Even trade schools move their students toward this critical edge. As learners move to the edge of their particular fields of specialization they enter a land of discovery where selectemes, recipemes, and explanemes become equal players in an environment of new memes and memeplexes that compete for their attention. It is at the edge of knowledge where advancing scientific, technological, and social evolution take place. Ideas introduced at this cutting edge are time-displaced; they are far removed from the early childhood memes that have become a part of the fundamental belief structures of the selfplexes of learners. At this stage new memes are not as likely to be seen as threats to fundamental beliefs. The competing environment of new memes is the learning environment that post secondary school educational systems work within. This is also the learning environment of "life-long" learners.

A Memetics Approach to Pedagogy

The process of learning is one of construction. The result of learning is changed

behavior and a changed internalized view of reality. Nowhere is the Constructive aspect

of learning more important than it is for young children. This construction, called the

selfplex, represents beliefs and worldviews of knowledge. For humans culturally acquired

Table 1	
High Level Selectemes	
Selecteme	**Primary Sources of Imitative or Observational Learning**
Language	Genetic predisposition
Reading	Parents, teachers, and other adults
Mathematics	Parents and teachers
Religion	Parents
Television	Parents, siblings, and the media
Smoking	Parents, relatives, and the media
Bicycling	Friends, siblings, and parents
Car mega-bases	Friends and bass sound broadcast
Poke'man cards	Friends and the media
Science	Teachers, parents, and the media
Driving	Parents, roadways, and the media
Alcohol	Parents, friends, and the media
Other drugs	Friends and parents

knowledge far exceeds knowledge gained by experience alone. The creation of the meme

and the evolution of human culture have created the need for education and teaching. The

object of education and teaching, therefore, is to replicate memes in the minds of newer

generations.

Teaching method – pedagogy – has a primary goal of replicating memes.

Philosophies of education and philosophies of government and social structure should not

be confused with pedagogy. These worldviews are simply additional memes and

memeplexes that can and should be placed into the selective environment of education.

Appropriate pedagogy can best be determined by investigating the types of memes

and memeplexes. Each lends itself well to specific teaching methods. High-level

selectemes, for instance, are most easily replicated through imitation and observational

learning. For example, the high-level reading selecteme must compete with many other

forms of information input in a modern technological society. Television, a combined

media of audio and video, is a strong competitor. The high-level "watch TV selecteme" is

easily replicated by children who live in a household where the TV set is always on, as is

often the case. Similarly, the high-level reading selecteme will be replicated in a

household where much reading takes place (see Table 1 for a listing of other high-level

selectemes).

Recipemes are replicated through imitation and application. In sports and other

physical activities the replication takes place through repeated practice experiences that

build physical skills and replicate the memetic content of process. Many recipemes do not

Table 2	
Recipemes and Recipemeplexes	
Recipeme or Recipemeplex	**Primary Sources of Imitative or Skills-based Learning**
Reading	Teachers and experience
Writing	Teachers and experience
Mathematics	Teachers and experience
Religion	Parents and ministers
Cooking	Mothers, siblings, and experience
Smoking	Friends, experience
Bicycling	Friends, siblings, and experience
Driving	Parents and experience

involve a related physical skill and are purely intellectual. Such recipemes include

mathematical process memes, such as addition, subtraction, multiplication, and division.

Efficient replication of recipemes requires that such processes eventually be memorized.

Such memorization takes place through mental practice or review (See Table 2 for a

listing of recipemes). Recipemes are more difficult to replicate if the high-level selecteme

for the activity has not been acquired.

A discussion of selectemes and recipemes would not be complete without

considering memeplex structures or black boxes. At some point in the educational

process, topics will become sufficiently complex that elements of a memeplex will

remain unexplained. A discussion of the function of multiplication in mathematics

pedagogy will serve to illustrate a process as viewed by Behaviorist, Constructivist, and

memetics approaches.

Young students could be taught math in three ways: First, using a the Behaviorist

approach, teachers could stress the replication of multiplication tables by treating the

operation of multiplication as a black box recipeme by which combinations of input

numbers are converted into output numbers. Such an approach stresses a combination of

quick calculation skills and memorization to accomplish the educational goal. Second, a

Constructivist approach would be more concerned with explaining, often through a

process of self-discovery, the actual concept of multiplication. In this instance, the goal is

to understand the process, which is an explaneme replication process. Rapid calculation

may not be a result of this approach. Third, memetics asserts that both approaches are

necessary and that they must be applied in an age-appropriate manner. Basic math

calculation memes must first be replicated. This can be done during the earlier years when students are not yet able to think in abstract terms and do not possess extensive higher order reasoning skills. As students get older, replicating explanemes of the multiplication process is possible and is even made easier if students have previously acquired rapid calculation memes that can aid in visualizing examples of the process. Thus, these two sets of memes become part of a quality control feedback loop that allows students to test and improve their own understanding of the multiplication explaneme. The resources of the earlier skills-building black box recipemes contribute to the replication of the more sophisticated explaneme (Other explanemes are listed in Table 3).

Table 3	
Explanemes and Explanemeplexes	
Explaneme or Explanemeplex	**Primary Sources of Learning**
Language	Teachers
Reading	Teachers
Mathematics	Teachers
Culture	Teachers, the media
Sciences	Teachers, the media
Economics	Teachers, the media
Politics	Parents, teachers, friends, the media

Some educators would argue that skills-based multiplication is not necessary because the student can create examples and test explaneme understanding by using modern electronic calculators. From a memetics perspective, a meme is not replicated until it has successfully occupied a new human mind. When students operates a calculator, they are demonstrating that they have successfully replicated a meme for running the calculator and not much more. They have not demonstrated that they have replicated a meme for calculating a product or adding two numbers. The author has

observed many college level students that need a calculator to add simple numbers (.5 + .024, for instance). It is difficult to believe that such students have a concept in their minds about the process of addition and the experiential foresight to visualize the end of that process (.524). In the case of the multiplication scenario above, memetics would have educators do both skills-based recipeme replication and knowledge-based explaneme replication by using a complex multi-faceted pedagogy. The memetics perspective asserts that this opens the black box memeplex and allows the explaneme replication to be more easily accomplished. Additionally, the fidelity of the replication of the entire multiplication memeplex is greatly improved.

This theory is generalized by the following four statements which relate meme replication to goals of pedagogy.

STATEMENT #1: Major high-level selectemes are replicated most efficiently by imitation and observational learning. High-level selectemes become a part of belief systems of the selfplex. Social-Constructivist types of pedagogy philosophy, to the extent that they address issues of imitation and observational learning, are most appropriate for replicating high-level selectemes. From a memetics perspective, motivation, both internal and external, is accomplished through the replication of major high-level selectemes.

STATEMENT #2: Major recipemes are replicated most efficiently by a combination of imitation, memorization and practice. The efficient replication of high-level recipemes requires an integrated pedagogical style. While educators nearly universally agree that building physical skills demands repeated practice they are often reluctant to acknowledge the value of the same type of approach to things intellectual.

Hence, educational catch phrases like "drill and kill" and "regurgitate information" have often been used to discredit Behaviorist pedagogy. Nevertheless, recipeme replication often does require repeated practice, in addition to elements of imitation and observational learning. An eclectic pedagogy is necessary.

STATEMENT: #3: **Black box systems of memeplexes can be treated as either selectemes or recipemes.** These large memeplexes also demand an eclectic pedagogy. Individual selectemes (inputs) and recipemes (outputs) are not high-level memes or memeplexes. Selectemes at this level, for instance, may employ recipemes as selection control mechanisms. Such black box systems of memeplexes are actually like "Russian dolls." They are nested hierarchies (Langrish, 1999), which implies the use of new types of recursive pedagogy.

STATEMENT #4. **Major explanemes are best replicated by the application of higher order reasoning skills and abstract thinking to the manipulation of language and other symbolic representational systems.** Explanemes may need to be approached in two ways. First, the black box memeplex that the explaneme describes must be replicated through a more strictly controlled pedagogy based upon elements of practice. In effect, students must first learn how to use the black box before they learn how it works. Second, if explanemes are representative of the cutting edge of the evolving knowledge and cultural memeplexes than experiential and discovery pedagogy is appropriate as a jumping off point to new meme creation.

Replication Fidelity – Implications for Cultural Evolution

If it were possible to replicate memes perfectly, culture would evolve much more slowly than it does. The biological replication of genes is extremely accurate and barely noticeable biological evolution requires hundreds or thousands of generations (Dawkins, 1976). Scientists are able to see noticeable evolution only in bacteria and virus life forms that have rapid generation turnover. Fortunately, meme replication fidelity is less accurate and human culture evolves more rapidly. Memes are intellectual replicators and the environment of selection is intellectual. Cultures control this environment of selection through the mechanisms of guided variation and direct bias (Boyd & Richerson, 1985). This thesis asserts that educational systems are the control mechanisms. Parents, teachers, and other educators must be sensitive to memetic replication fidelity, because it is not an issue of personal freedom. The replication fidelity of memes and memeplexes is a collective issue of the culture. All pedagogy, regardless of its philosophical roots, must be sensitive to issues of memetic replication fidelity.

Technological Improvements in Meme Replication

Memes not only "seek" to be replicated. They "seek" to be replicated more rapidly and more accurately. Recalling that this is not a conscious desire it is nevertheless true that replicators remain replicators only by being replicated often and accurately. This principle has driven human culture and technology, much of which is concerned with memetic replication. The first improvement was the development of spoken language and the refinement of symbol manipulation. Soon the technological innovation of written

language was introduced. Within just a few hundred generations, humans were able to quickly produce large numbers of copies of written works through the technology of printing. This "driving force" has led to highly accurate and rapid electronic meme storage, transmission, and retrieval systems. Just go to any modern dance club and listen to the local band. The band invariably sounds very nearly exactly like the nationally recognized band that originally recorded the modern day CD.

The increased fidelity and rapid replication rates of modern electronic recording and storage systems can be used to slow aspects of cultural evolution to a standstill because everyone hears the exact same thing. Such systems can also speed up aspects of cultural evolution to levels where it becomes critically unstable or chaotic because new ideas can be spread rapidly and nearly instantaneously. Technology does this routinely every day. It is important to note that technology itself does not replicate memes. Memes are replicated in the minds of people. Technology enables rapid and accurate meme replication.

The Need for High Fidelity Replication.

The social and political structures of a culture must remain stable for relatively long periods of time. Rapid and chaotic political evolution harms culture in general and is not in the best interests of the memeplex of the overall culture. The selective political environment remains relatively stable until the needs of culture force the political system to change. Political change is then usually rapid and chaotic. This chaotic period is a time when many political memes and memeplexes fail to replicate at all. Often the old political memes and memeplexes are literally replaced by new memes and memeplexes.

The educational system of a culture must strive for accurate replication of memes and memeplexes relating to the cultural and political structures within which it functions. Nevertheless, the educational system may choose also to be sensitive to the needs and desires of the culture at large, for it is often from within the educational system that political change memes are created.

The Need for Low Fidelity Reproduction.

When it is obvious that society perceives that it has social ills, it may be up to educators, both parents and teachers, to bring about social evolution by failing to replicate certain memes and memeplexes rapidly. Nowhere is this exemplified more dramatically in modern American society than with the high-level smoking selecteme. In fact, educators have joined with many other social institutions to ring a death knell for this meme. The result has been a very rapid evolution of our culture that began 35 years ago and continues to this day. Educators must be sensitive to replication fidelity because poor replication of a desirable meme or memeplex may bring about undesired or unexpected cultural evolution.

IMPLICATIONS OF THIS THEORY

FOR CURRENT PEDAGOGY

Extremes of Pedagogy

Modern teachers and educational leaders have been accused of being technicians who attempt to meet goals set by others in society. Professionals, it is said, would establish their own socially appropriate goals and design plans for the attainment of those goals. There is some credence to this position due in large part to the extreme philosophical positions taken by many educators. While educators may think of themselves as Behaviorists, or Constructivists, or experiential learning proponents; these "theories of pedagogy" are more akin to beliefs and philosophies. When educators cannot come to agreement on educational beliefs and philosophy, it is unlikely that they will come together to arrive at a common set of educational goals. Until they do so, educators will remain technicians in a profession controlled by others and educational leaders will be unable to build a cohesive profession focused on an agreed upon set of goals.

The memetics view of education and teaching gives educators an "out." By viewing extremes of pedagogy as manifestations of educational philosophies; and by acknowledging that such philosophies are, themselves, complex memeplexes of ideas; educators can begin to look at pedagogy in a selective memetic environment that is separated from their personal beliefs. For instance, educators may begin to realize that knowledge is a complex of selectemes, recipemes, and explanemes and that techniques of meme replication – teaching – are often different for each of these categories. If they

come to this realization, an eclectic pedagogy geared to the ages of the students and the efficient replication of the different types of memes may emerge.

The Need to Use the Entire Tool Box

As teachers and educational leaders begin to realize that the entire toolbox of pedagogy is necessary to do the job of replicating memes, new and innovative pedagogy, like recursive pedagogy, may evolve. As noted earlier, the educational system should evolve relatively slowly simply because it is the replicating mechanism of society. First, a rapidly changing replicating mechanism cannot be relied upon to accurately pass on socially significant memes. Therefore, the cultural memeplex will always "seek" to stabilize educational delivery systems somewhere near the status quo. In the United States, for instance, educators have struggled long and hard to bring about "educational reform," but culture and the political system, through the "standards movement," has sought to stem what it perceives as a too rapid and undesirable change. Second, while change may be necessary the memes that drive it must plod through a thicket of memeplexes representing well-established methods. Third, pedagogy that results in the most accurate replication of the wide variety of socially significant memes will differentially survive. At one time or another, educators may eventually be forced by this memetic selection mechanism to use nearly all the tools in their pedagogical toolboxes. Finally, completely new pedagogy justified by the science of memetics may eventually emerge.

Summary

Because of recent studies of complex systems in general and complex adaptive systems in particular, the theory of evolution has taken on new meaning. Scientists are beginning to study both biological and cultural change from an evolutionary perspective. Indeed, the idea of *natural selection*, first proposed by Charles Darwin, may be the single most important idea to come out of the past 300 years of scientific inquiry. The evolution of a complex adaptive system is a product of the successes and failures of the fundamental replicators within that system. Human cultural evolution is unique in our experience and Dawkins (1976) proposed that ideas, which he called memes, were the fundamental replicators of social and cultural systems. Thus, a new science, called memetics, was born. Blackmore (1999) has developed a theory of memetics. Others, such as Langrish (1999), have made contributions to a theory of memetics. With the copying of an idea, the meme came into being and the potential for rapid and dramatic cultural evolution became possible. When the first meme came on the scene, teaching came with it. The very concept of an idea that gets replicated implies that there must be a teacher. Education has its roots in memetics and solidly rooted theories of education and teaching may evolve out of the continuing study of memetics. This paper represents a first attempt at developing one such theory that well could affect the future of pedagogy and the professional activities of both teachers and educational leaders. As noted at the start of this thesis, the validity of this theory remains to be tested by further research.

Discussion

It is likely that education will have change forced upon it in the near future and there are indications that outside forces are already exerting pressures on the system of education in the United States. Government policies, industrial initiatives, international rivalries, two family wage earners, and high divorce rates are but a few of those sources of pressure. Educational leaders beginning with educators of new teachers and new educational leaders can benefit greatly by learning about evolutionary principles that can be used to explain the changing memetic world of ideas and culture. From a memetic perspective, it is clear that unless educational leaders open themselves to this evolving change mechanism and adopt its principles, change within the present system of education may be slow and difficult until a critical mass of pressure has been reached. If that happens, it is likely that massive change will take place during a very brief interval of time. Many old well-established educational memes and memeplexes are likely to be destroyed and replaced by new memes and memeplexes seemingly overnight. How much better it would be if such changes could come about through a slow and continuously evolving process.

To avoid this period of rapid chaotic change, educational leaders must be in a position to understand the nature of the changes that are actually taking place. They must be able to exert selection pressures on the memetic environment of the profession that will cause education and teaching to evolve slowly and continuously into a better and more efficient system. Educational leaders must have a legitimate theory basis for decision-making that can replace failed policies that are based upon philosophies and

beliefs. Once educators let go of philosophy and grasp a common set of theory-based goals, teaching can truly become a unified profession.

Recommendations

How should this theory-base be established? What kind of mechanism provides for the most reliable change in education?

This theory proposes that educational systems are complex adaptive systems not unlike that of biological creatures. Complex adaptive systems undergo change through an evolutionary process. Educational systems are social systems and the fundamental units of replication of social systems are memes. The educational system is driven by memes like other social systems but it is unique in that it also has the primary responsibility of replicating memes on behalf of human culture. While it can be said that education truly represents the DNA of a culture it is clear that the educational system itself is also a complex adaptive system. Systems of education "naturally select" based upon the influences of its own conformity enforcers, diversity generators, inner-judges, and resource shifters (Bloom, 2000, pp 46 – 48). Within the framework and context of current culture, educators build recipes for replication. The control elements in the complex adaptive system called education select from their culture those ideas, norms, and values that will be constructed into the culture of the next generation. At the heart of this selection mechanism are teachers and educational leaders.

If educators are to begin to think in evolutionary terms, this thinking must begin in the schools of education. The theory proposed in this thesis is but a beginning.

Educational leaders who teach in schools of education can benefit by studying the evolving nature of human culture and how this concept applies to education. They can then continue to refine and expand this theory, insuring that it is kept separate from theories of learning. Notwithstanding this separateness, a theory of education and teaching must be in a symbiotic relationship with theories of learning. The job of educational leaders who are inspired by this theory will not end with its refinement. They must next begin the task of replicating this theory, new pedagogy, and related new principles of organizational management, such as building learning organizations (Senge, 1990), in the minds of future teachers and future educational leaders.

Again, the mechanism is the recursive process introduced earlier in this thesis. First, the output products of schools of education (memeplexes of educational theory and pedagogy) become the input products in the greater educational system. Second, new teachers and educational leaders through their influence and practice replicate those same memeplexes of theory and pedagogy in the minds of co-workers. Third, teachers replicate these memeplexes in the minds of students, for that is the ultimate goal of any educational process. Fourth the educational system, as one of the control elements of society, must ultimately pass important features of this theory and pedagogy memeplex to society as a whole. In so doing, education closes the circle as the memeplexes are replicated in the minds of many varied groups such as parents, voters, politicians, textbook publishers, and businessmen. This theory then has a chance of being naturally selected.

As noted in the introduction to this thesis, educational leaders are at the constriction of a cultural hourglass. The more clearly defined separation between

educational philosophy and pedagogy offered by this theory enables educational leaders to concentrate their selection criteria more independently. They can do so as powerful agents of change at the nexus of our culture's past and its future and as instructional leaders who seek to improve the efficiency of the cultural transmission through this nexus. If educational leaders in schools of education begin to replicate this theory as a memeplex in the minds of new teachers and new educational leaders, change will slowly begin to happen in the educational system itself. This change need not be forced. It can be an evolutionary change driven by natural selection. Educators are like the frog that having been thrust into a pan of boiling water immediately jumps out. They tend to instantly reject change that is quickly thrust upon them. On the other hand, a frog that finds itself in a cool pan of water that slowly warms to boiling is likely to become dinner. It easily adapts to the slow change, in this case also to its demise. Educators, too, can more easily accept change that comes in small evolutionary steps. It will be up to educational leaders, beginning with educators in colleges of education, to insure that such changes do not lead to the demise of our educational system and of our culture.

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