QUANTUM REALITY: ALTERNATIVE METAPHOR FOR CURRICULUM TRANSFORMATION

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CHAPTER I

"AN AHISTORICAL POSTURE"

Introduction

Some individuals believe history seldom teaches anything about the present. Since it offers no agenda, the lessons are seldom lucid and always subject to translation. Historian Carl Becker's statement "Each man his own historian" is persuasive; for historians like educators observe the world with their vision of reality or paradigm.

Kuhn (1962) first introduced the concept of paradigm in the literature as it applied to scientific thought. According to Kuhn's thesis, scientists, just like the rest of humanity, carry out their day-to-day affairs within a framework of presuppositions about what constitutes a problem, a solution, and a method. Paradigms of thought constitute how we view the world (Kuhn, 1970). Paradigms become the filters by which we perceive reality. Kuhn (1970) maintains that shared assumptions makes up a paradigm, and at any given point a particular scientific community will have a prevailing paradigm that shapes and directs work in the field. Historians, as well as educators use prevailing paradigms to shape and direct their work in their respective fields.

Cycles of Reform

The history of curriculum reform is replete with ideas that return almost cyclically. Ever since the inception of curriculum as a field of specialization, curricular reform has been based on "a denigration of the past in favor of an enlightened and inspired present" (Kliebard, 1975, p. 40). Today's educational reformers lack adequate knowledge about the basic ideas of recent curriculum history. As a result, there exists a perpetuation of certain myths about curriculum reform that promote a tendency for educators to support a popular ideological and philosophical paradigm. Kliebard (1975) contends that a lack of dialogue exists between practitioners in the field of curriculum and their professional progenitors. When a curricular reform issue arises it usually takes the form of a bandwagon that often quickly disappears. Sometimes, curricular issues have a historical past, but this is seldom recognized, for the curriculum field is characterized by "an uncritical propensity for novelty and change rather than funded knowledge or a dialogue across generations" (p. 41).

On some issues, the history of curriculum reform is revealing. There has never been a golden age in education's past as previously believed. The tendency in recent years was to point to an earlier time in American history when schools functioned well, teachers taught, students learned, and academic knowledge was highly regarded. Many people believed that public criticism of schooling, hardly existed.

When one looks at the historical record it reveals something different. The persistent efforts to reform education from the early twentieth century on, suggest Americans have never been satisfied with their schools. The schools have reflected almost constant turmoil. For example, in the twentieth century, Americans were caught up in religious and ethnic controversies, in the place of women as citizens, in the fragmenting effects of a people on the move, and in a people caught between competing beliefs in individualism and community. The schools reflected and refracted these and many other problems. Kliebard (1975) describes, "The tenor of the times was a melange of post World War I nationalism, a drive for the "Americanization" of immigrants, a faith in the methods of science, and a concern for the uplift of the masses" (p. 40).

Curriculum reform proposals made in recent years, as well as those since the 1920s have suggested ideas and innovative ways to reform the schools; however, as history recounts, these ideas are not exactly new nor innovative. They were nothing more than recycled notions, notions that are premised on an epistemological base that has failed to achieve any significant change in the way schools operate. The argument I wish to advance is that past curriculum reform proposals have been founded on an eighteenth-century scientific and philosophical base that is highly technical, positivistic, and rational in scope (Eisner, 1979, Kliebard, 1975, Apple, 1975, Dobson, Dobson, & Koetting, 1985). The consequences of this epistemological foundation are that the prevailing theories of change simply do not fit the complex realities of schooling. Therefore, when attempts are made to apply an eighteenth century model in curriculum reform to modern curriculum problems, the repercussions are usually failure and disappointment (Goodlad, 1979).

Recent Reform Proposals

Within the last nine years Americans have been bombarded with reports about the state of American schools. Most of the reports suggest that schools and students are performing poorly. The document that kicked off the assault A Nation at Risk (1983) stated " the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a nation and a people" (p. 1).

Many reform reports written over the years have called for changes in schooling. Several reports: Action for Excellence: A Comprehensive Plan to Improve Our Nation's Schools (1983), The Governor's Report on the United States (1985), A Nation Prepared: Teachers for the 21st Century (1986), and the Holmes Report (1985) were conducted by panels of so-called educational authorities. These proposals criticized both the inability of schools to educate students and to prepare teachers effectively. The reports agreed that American schools were spread thin over too many educational objectives. Some educational institutions, they suggested, needed their priorities reorganized usually in the direction of increased standards and longer school years. Although the reports insisted on the primacy of the state and local governments' role in designing education, they also called for a new alliance between schools, businesses, and higher education. The reports carried the undertone of concern for the nation's economic prosperity reflecting the present economic problems. A Nation at Risk (1983), for example, warned that the "rising tide of mediocrity . . . threatens America's ability to compete in world markets" (Gross, 1985, p. 8).

Most of the reform documents strongly implied that educator's had broken promises to the public. The teachers, they claimed, were lax in preparing students for college and that elementary and secondary schools did not live up to the expectations of the American people.

At the outset, it should be recognized that these reform proposals were political documents. Gross (1985) maintains the case by stating that the arguments made by the reports "takes the form of a polemic, not a reasoned treatise," and other than carefully analyzing the facts to prove their case, the reports present a list of charges without proper veracity of their evidence or sources (p. 84).

Many educators are not aware that curriculum reform efforts such as these have been attempted almost on a cyclical basis. Cycles reflect the correction periods when power and priorities shift. Each cycle gives way to a new cycle because of external shocks and economic events.

Examples of these events are: the immigration movement at the beginning of the 19th century, economic depression in the 1930s, the Sputnik launch in the 1950s, civil rights in the 1960s, the Vietnam War in the 1970s, and the economic recession in the 1980s and 1990s (Kaestle, 1990, p. 81).

Kirst (1985) asserts that many reform documents lack historical context by not having a firm grounding in history. He states that they were a mere repetition of past reform cycles that emphasized some functions and overlooked others. A study of curriculum history reveals that during conservative political movements like those in the 1890s, the 1920s, the late 1950s, and the early 1980s, educational discussions focused on distinct academic subjects and traditional curriculum. Yet, during periods of political liberalism i.e, ; the 1900s, the 1930s, and the 1960s, the focus was on educational opportunity, equality, and vocational education. In the 1990s, a period of conservative political ideology (Apple, 1990), the pressures reflect a high priority for academics and the essentialistic philosophy.

If we analyze carefully the reform proposals in each historical period mentioned something very interesting becomes apparent. To recapitulate, reform proposals consist of nothing more than recycled ideas from earlier times. Cuban (1990) describes three examples of recurring school reforms:

1. the durability of teacher-centered instruction versus child-centered instruction

2. the centuries' old debate between the academic and practical curriculum

3. the resiliency of the issue of centralized and decentralized authority in the schools. (p. 4)

In each category, he documents the reappearance of many ideas and programs. For instance, the tradition of teacher-centered versus child-centered instruction has fired debates and shaped policies for years. Teacher-centered teaching can be identified by many names such as subject-centered, toughminded, hard pedagogy, and mimetic. Student-centered teaching has appeared under many guises such as child-centered, tendermined, soft pedagogy, and transformative instruction (p. 3).

The curriculum debate has for years centered over different values concerning knowledge and its relationship to students and teachers. Presently, we are seeing a rash of reforms that demand a common curriculum. This passion for certainty would be familiar to Horace Mann during the 1840s and Charles Eliot, (President of Harvard University) chair of the Committee of Ten in 1893. Not unlike the reform reports of today, the committee recommended, "that all highschoolers take 4 years of English, and 3 years of history, science, mathematics, and foreign language" (Cuban, 1990, p.4). By the latter 1900s, the progressive educators like John Dewey challenged the one best academic curriculum model (Cuban, 1990). The common school curriculum was redefined as one that allows different students to take different courses to cultivate varied interests. Still, the

1950s witnessed criticism of the multi-course reform in several books: Quackery in the Public Schools (Lynd, 1953), Second-Rate Brains (Lansner, 1958), and the more famous Educational Wastelands (Bestor, 1953).

The 1960s brought broad political and social unrest calling for individual freedom from bureaucratic constraints. Several possible solutions were suggested: compensatory education, desegregation, magnet schools, free schools, open classrooms, and flexible scheduling. Unfortunately many of these ideas disappeared by the 1970s "as efforts redoubled to differentiate courses and schools for low income and minority children" (Cuban, 1990, p. 4).

The late 1970s and early 1980s saw a return to a traditional curriculum and a demand for academic excellence. The reports called for more required subjects, longer school days, a longer school year, and more homework and tests (Cuban, 1990, p. 4).

The final category of persistent reform dealt with the concept of centralized versus decentralized school authority. The 1890s saw more than 100,000 school districts with some school boards consisting of over 50 members. Many progressives criticized this system because it was inefficient, corrupt, and too centralized. By the 1960s, centralization was under attack again by civil rights activists who questioned the legitimacy of big city school boards where officials were distant from the lives of minority families. The mid-1970s saw a decline in interest in decentralization only to rise again in the 1980s due to the increased research literature that promoted "school-based management" (Cuban, 1990, p. 5).

Why do curriculum reforms keep reappearing? First, they reappear because as previously discussed we as curriculum leaders have failed to read our history. Second, they return because of their failure to solve problems. Cuban (1990) maintains that educators have attempted to solve school problems using a rational model of organizational behavior. Wise (1977) claims that educational policies fail because they are premised on the idea of school as a rational organization--like a factory--which can be managed and improved by rational management procedures. The need to rationalize behavior can be demonstrated in the various attempts at the district and state levels to align curriculum with texts, tests, and outcomes. There are also efforts at increased national and state testing associated with evaluation practices drawn from research on teacher effectiveness. Third, many educational professionals consider education a science thereby promoting a classical scientific methodology in order to evaluate and solve problems (Eisner, 1985). In sum, twentieth century educational philosophy and practice has been and still is based on a classical science paradigm inspired by the work of Rene Descartes and Isaac Newton.

Foundations of Classical Science

Rene Descartes, usually regarded as the founder of modern philosophy, had a vision that, "all science is certain, evident knowledge . . . we reject all knowledge which is merely probable and judge that only those things should be believed which are perfectly known" (Capra, 1982, p. 57). To Descartes, the universe was a machine. There was no purpose, life, or spirituality in matter. Nature worked properly to mechanical laws, and everything in the world could be explained in terms of the arrangement and movement of its parts. Cartesian philosophy and the belief of the certainty of scientific knowledge created the conceptual framework for seventeenth century science.

The man that completed the Cartesian view was Isaac Newton. Newton, born in 1642, completed the mathematical formulations establishing the mechanistic view of nature. Einstein would later call Newton's work, "perhaps the greatest advance in thought that a single individual was ever privileged to make" (Capra, 1982, p. 63). Newton saw the world as one big mechanical system that could be described objectively, without the participation of an observer. Newton's mathematical system of the world established itself quickly as the correct theory of reality and generated enthusiasm among scientists and the public alike.

According to Prigogine and Stengers (1984), the world of Newton is simple, spiritual, and uniform or universal. The basic assumptions of classical science are that the world is simple and governed by time-reversible fundamental laws. Doll (1986) states,"this notion of simplicity is the basis of the reductionist movement in physical and metaphysical thought: Every complex is but a collection of simples; all complexes can be reduced to simples" (p. 11). Newton called God a "clockmaker" and viewed him as the chief engineer (Doll, 1986). In terms of curriculum and behaviorist learning the same assumptions hold: Pupils learn what is taught, and the curriculum is seen as a destination, a linear course, bureaucratically predetermined.

The scientific revolution of the seventeenth century also brought about another philosophical concept that furthered its cause: positivism. Auguste Comte (1798-1857), considered the father of modern sociology, claimed that scientific method also could be applied to the study of human affairs. Comte claimed that all the sciences are generally related in a linear way from mathematics. The central component of positivism is the verifiability principle which states "that something is meaningful only if it is verifiable empirically, or if it is a truth of logic or mathematics" (Phillips, 1987, p. 204). Thus, metaphysics is discounted because it is unverifiable through empirical means (Phillips, 1987).

The impact of positivism is evidenced in the social sciences and the behavioral sciences through the acceptance of behavioristic philosophy. Behaviorism, characterized by the work of Watson, Pavlov, and Skinner, employs the verifiability principle through operational definitions that focus on observable behavior. Guba (1985) lists five axioms of positivism:

1. The nature of reality. There is a single objective reality "out there" that can be broken down into distinct components, each can be studied separately and comprehended independently; the whole of reality is the sum of its discernible parts.

2. The relationship between the knower and the known. There is a clear separation between the researcher and what he or she studies; the former objectively observes but does not influence the latter.

3. The possibility of generalization. One undertakes research to discover, in a representative sample of manageable size, truths that can be generalized to the larger population and that are valid anywhere and at anytime.

4. Causality. Everything has a cause: a major goal of research is to understand causal relationships thus increasing our ability to predict and control the environment.

5. The role of values. Value free inquiry can be achieved through the application of objective methods. (p. 162)

It is a thesis of this study that curriculum reform proposals, for the most part, have premised themselves on this positivistic Newtonian paradigm thus resulting in its incapacity to reform education. Sawada and Caley (1985) describe Newtonian physics and positivism's view of the universe as a closed system. A closed system, as Doll (1989) describes, is one that has pre-set ends and seeks to limit outside forces. Doll states, "a closed system, like (B.F.) Skinner's teacher-proof machines, wants to protect itself from the fluxes that compose nature" (Doll, 1989, p.246). In the Newtonian universe all the parts are self-contained, isolated and each system can be separated and studied independently. The dominant metaphor in curriculum reform today is the Newtonian machine for as Sawada and Caley (1985) so accurately describe:

> The school is a more or less well oiled machine that processes (educates) children. In this sense, the educative system (school) comes complete with production goals (desired end states); objectives (precise intermediate end states); raw materials (children); a physical plant (school building); a 13 stage assembly line (grades k-12); directives for each stage (curriculum guides); processes for each stage (instruction); managers for each stage (teachers); plant supervisors (principals); trouble shooters (consultants); quality control (discipline); uniform criteria (standardized tests); and basic produce available in several lines of trim (academic, vocational, business, general). (p. 14-15)

Sawada and Caley (1985) refer to this paradigm as a "system at-equilibrium" the epitome of control and prediction. This system is stable, deterministic and objective. School reform founded on this system is characterized as a tight ship where administrators pride themselves on top down reforms. Time in this system is reversible; teachers direct learning, students passively sit in their desks listening and mandates come down from above. Under this old science paradigm any change is met with awesome stabilizing forces. Sawada and Caley (1985) state, "Being at-equilibrium prevents any real change except change in space and time, and such changes can hardly constitute education; they are merely permutations and combinations of existing information" (p. 16).

There are exceptions to any rule and schools do experience some accomplishments under the Newtonian paradigm. Program changes like Headstart, learning centers, and open schools have all garnered limited success (Cuban, 1990).

But, like the pendulum, the innovative forays have eventually returned to their place of origin. Progress simply becomes a more elaborate variation on a common theme. It is the belief of this author that unless something revolutionary happens in curriculum epistemology, "the 21st century will be a very unbrave old world, slowly but increasingly rushing to its own entopic death" (Sawada and Caley, 1985, p. 16).

Quantum Science

Science has also provided another possible alternative paradigm and language base for revolutionary change in curriculum thought (Rockler, 1990, Sawada & Caley, 1985). The new paradigm, born of quantum physics, is based on the work of Max Planck, Albert Einstein, Neils Bohr, and Werner Heisenberg.

Quantum physics and quantum theory are directly related to German physicist Max Planck's paper published in 1900. Planck addressed himself to what was still an unsolved problem of nineteenth-century physics concerning the distribution of radiant heat energy from a hot body among various wavelengths. Under certain ideal conditions the energy was distributed in a characteristic way, which Planck showed could only be explained by supposing that the electromagnetic radiation was emitted from the body in discrete packets or bundles, which he named quanta. The reason for this jerky behavior was unknown, and simply had to be accepted ad hoc.

In 1905 the quantum hypothesis was bolstered by Einstein, who successfully explained the so-called photoelectric effect in which light energy is observed to displace electrons from the surfaces of metals. To account for the particular way this happens, Einstein was compelled to regard the beam of light as a hail of discrete particles later called photons. Einstein's description of light seemed utterly at odds with the traditional view, in which light consisted of continuous waves which propagate in accordance with Maxwell's electromagnetic theory, firmly established half a century before,

The wave-particle dichotomy, however, was not restricted to light. Physicists were at the time also concerned about the structure of atoms. In particular, they were puzzled by how electrons could go round and round a nucleus without emitting radiation, because it was known from Maxwell's theory that when charged particles move along curved paths they radiate electromagnetic energy. If this were to occur continuously, the orbiting atomic electrons would rapidly lose energy and spiral into the nucleus.

In 1913 Niels Bohr proposed that atomic electrons are also "quantized," in that they can resided without loss of energy in certain fixed energy levels. When electrons jumped between the levels, energy was released or absorbed in discrete quantities. These packets of energy are, in fact, photons.

The reason for the strange behavior of the electrons was not revealed until the experimental work of Clinton Davisson and Louis de Broglie. Their discovery led to the idea that electrons as well as photons can behave both as waves and as particles, depending on the particular circumstances.

It soon became apparent that not only electrons but all subatomic particles were subject to similar wavelike behavior. Evidently the traditional laws of mechanics as formulated by Newton, as well as Maxwell, fail completely in the microworld of atoms and subatomic particles. By the mid-1920s, a new system of mechanics--quantum mechanics--had been developed independently by Erwin Schrodinger and Werner Heisenberg to take account of this wave-particle duality.

The co-existence of wave and particle properties leads quickly to some surprising conclusions about nature. Before the discovery of quantum physics the world was thought to be completely predictable, at least in principle. In particular, if identical experiments were performed, identical results were expected. But, in the case of photons passing through a polarizer, one might very well find that two identical experiments produced different results, as one photon passed through a polarizer another identical photon was blocked. Evidently the world is not wholly predictable after all. Generally we cannot know until after an observation has been made what fate of a given photon will be.

These ideas imply that there is an element of uncertainty in the world of photons, electrons, atoms, and other particles. In 1927 Heisenberg quantified this in his famous uncertainty principle. This principle simply states that one cannot measure the position and motion of a quantum object simultaneously. Furthermore, this inescapable constraint on our knowledge of the electron's motion and location is not merely the result of experimental clumsiness; it is inherent in nature.

The fact that electrons, photons and other quantum objects behave sometimes like waves and sometimes like particles often prompts the question of what they really are. According to Bohr, it is meaningless to ask this question because physics cannot answer it "Physics, he declared, tells us not about what is, but what we can say to each other concerning the world" (Bohr, 1963, p. 64).

The world presented us by quantum science refutes the ideas of the Newtonian paradigm by stressing that physical reality cannot be adequately explained as previously thought. Even the primary notions of the existence of an objective physical reality, the assumption of the universal reign of cause and effect, or the faith that the nature of the world is intelligible by a detached observer cannot be spared by the Newtonian paradigm (Schopen, 1989).

In keeping with a classical science tradition, curriculum reformers have traditionally built their beliefs on a paradigm that reflects a need for certainty in the world. Human beings though represent an uncertain quantity and their successes and failures cannot be determined by linear progress. Quantum reality allows curriculum theorists to change from an observed reality easily measured to one that can be perceived intellectually and qualitatively. Brown (1989) contends that since scientific thought has passed a reconceptualization of reality so to can education, "Conceptions of learning methodology and the usefulness and worth of education to individuals will change; it will change commensurate with changes in scientific thought" (p. 10).

Ilya Prigigone's Theory of Dissipative Structures provides a means of describing the notion of quantum irreversibility, randomness, and indeterminism. According to Prigigone, all open systems, are dissipative structures. Their form is maintained by the consumption, release or dissipation of energy. They are highly organized and always in process. Educational systems are very much like dissipative structures. They are complex organizations and continually in flux or process. Reform efforts which constantly bear on these institutions produces instability and this instability can lead to rapid change. The educational system of today, due to decades of pressure, is on the verge of a transformation.

Transformational Theory

Transformational theory, as applied in this study, seeks to explore changes which are taking place regarding our view of the world. Capra (1982) describes transformational theory as "a struggle to grasp a new reality" (p. 15).

Transformational theory views change as transformative, not incremental as in Newton's ideal universe. Terms and errors in transformative theory are necessary actions during development. Transformational theory is about a change in view, perspective, and methodology. It permanently alters one's relationship to nature, life, the environment, and learning (Doll, 1989). Doll (1989) explains, "It is characterized by the sort of gestalt switches Piaget describes as the child or youth moves from stages of action to those of representation, relations and systems (the pre-operational, the concrete operational, the logico-mathematical)" (p. 249). When a transformation occurs allowing new perpectives, there is a suddenness to the transformation. As Prigogine says, "all the red molecules turn blue" (1984, p. 243).

A transformation in curriculum reform requires a similar quantum leap in thought. Marilyn Ferguson (1980), in a controversial book The Aquarian Conspiracy outlines some of the important assumptions about a transformation in curriculum theorizing:

1. Emphasis on learning how to learn, how to ask questions and have access to information that is constantly changing.

2. Learning viewed as a journey or process.

3. Students and teachers see each other as people, not roles. Encourages autonomy.

4. Curriculum is somewhat flexible. There are many ways to teach subjects and learn subjects.

5. Flexible and integration of age groupings. Individual not automatically limited to certain subject matter by age.

6. Priority on self-image as the generator of performance.

7. Divergent thinking encouraged as part of the creative process.

8. Labeling used only in minor prescriptive role and not as fixed evaluation that dogs the individual's educational career.

9. Theoretical and abstract knowledge heavily complemented by experiment and experience, both in and out of classroom.

10. Education seen as lifelong process, one only tangentially related to schools. (p. 289-291).

Ferguson (1980) concludes her chapter on education with these words:

> If education cannot be mended, perhaps it can be metamorphose. As someone pointed out, trying to explain the difference between reform and transformation, we have been trying to attach wings to a caterpillar. Our interventions in the learning process to date have been almost that crude. It is high time we freed ourselves of attachment to old forms and eased the flight of the unfettered mind. (p. 321)

True curriculum change will never be successful unless there is a transformation of thought. This study shows that the reform efforts of the past are full of recycled ideas never implemented. Sarason (1990) suggests that curriculum reform is based on an "axiom that wholly or in large part was invalid" (p. 111). In short, we need a re-visioning of curriculum reform.

Purpose of this Study

The purpose of this study is to examine the philosophical and historical foundations of curriculum reform and suggest that quantum theory can provide new metaphors for curriculum transformation. The study discusses certain key questions:

1. Do curriculum reformers of the past and present share a Newtonian paradigm?
2. How has this paradigm affected curriculum reform efforts?

3. What potential impact can quantum theory have on curriculum reform?

Curriculum reform has been one of the most written about topics in American educational history; however, most scholars approach curriculum reform from a traditional, positivistic, Newtonian paradigm. The results are recommendations for change that are condemned to failure because they are premised on an approximated world reality, existing for the most part in the abstract. This study will examine how a new reality of curriculum reform can be implemented. Goodlad (1990) posits, "educators must rethink what education is, what schools are for and they must examine and rework the structures and practices that have always been out of sync for some students and are now revealed to be inappropriate for many" (p. 2).

Organization of this Study

This study is organized into five chapters. The general purpose of the study is to explore the thesis that curriculum reform is limited by being framed in an outdated empirical base and suggest that quantum theory may provide the necessary language base for a transformation in curriculum reform. Below I provide a brief description of each chapter and rationale.

Chapter I

Chapter I has established the ahistorical posture of many recent curriculum reform proposals. It shows that the epistemological foundation of curriculum reform lies in

Newtonian science. This chapter also suggests that to transform schooling quantum theory may provide language leading to an alternative means of framing and describing the reality that exists in our complex world of schooling

Chapter II

Chapter II contains a brief introduction in the philosophical and scientific development of the dominant Newtonian paradigm. The chapter also will connect the curriculum theorists' dependence on classical science methodology with the language bias used in the creation of curriculum reform.

Chapter III

Chapter III provides a brief history of curriculum reform establishing its tendency to promote scientism within a Newtonian paradigm.

Chapter IV

Chapter IV explores an alternative paradigm for curriculum reform based in the epistemology of quantum physics. The works of Einstein, Heisenberg, Bohr, and Planck are examined. This chapter speculates that quantum physics could present us with new metaphors upon which to make successful curriculum reform for schools of the next century.

Chapter V

Chapter V concludes by joining the language of quantum physics to a transformation for curriculum reform. The new metaphors developed through this study release new possibilities for describing the complex problems of modern schooling. The chapter concludes with my personal reflections on the implications of quantum reality for curriculum reform.

Statement of Intellectual Integrity

For the purposes of this study, quantum theory has been used to critique the affects of the dominant paradigm on the history of curriculum reform and to explore the implications of quantum theory as an alternative curriculum perspective. Schubert (1986) describes the problematic character of alternative curriculum paradigms stating:

> we all view the world and our own functioning in it through a paradigm or conceptual framework that accepts certain assumptions about such matters as the nature of inquiry, reality, and values. To view educational phenomena through different paradigms is analogous to viewing a society through the language and values of different cultures. (p. 7)

Kuhn (1970) speaks of incommensurability, the inability of language to translate effectively across paradigmatic borders. When we attempt interpretation, meaning becomes distorted and confused (Forester, 1992). To make matters worse the notion of confirmation bias intrudes. The questions we ask determines the answers we get. Furthermore, when we study nature we must remember the multitude of complex systems that comprise reality are dynamic and open to continual transformation. Thus any attempt to develop absolutes and concrete solutions to fundamental curricular problems would be a futile effort. According to Schubert (1989), "there are no pat answers, no recipes for solving fundamental curriculum problems . . . to expect generic answers to such questions is to expect magic" (p. 7).

CHAPTER II

THE NEWTONIAN PARADIGM

Introduction

Albert Einstein once remarked that most of the fundamental ideas of science are essentially simple, and may, as a rule, be expressed in a language understandable to everyone. Over the last seventy years, the language and prevailing paradigm of curriculum workers has been quite simple, maybe overly simplistic for the highly complex world of education. The language and scientific base of curriculum theorists has been premised on an eighteenth-century Newtonian paradigm.

A paradigm or intellectual gestalt, as described by Kuhn (1970), colors the way nature is perceived. Schubert (1986) asserts that paradigms are the "conceptual lenses through which curriculum problems are perceived" (p. 2). Dobson (1989) contends that paradigms provide a vision or a path not specifically a defined direction. The paradigm and value system that dominate today's curricular assumptions were formulated in sixteenth and seventeenth century science. Capra (1983) contends that this mentality of the cosmos gave Western civilization the features characteristic of the modern age. Between the 1500s and

1700s a shift occurred in the way people pictured their world and way of thinking. A new method of inquiry advocated by Francis Bacon involved the mathematical description of nature and an analytic method of reasoning previously conceived by Descartes. This became the basis of science in the seventeenth century.

The Copernican Theory

The preface to the "Age of the Scientific Revolution" began with Copernicus who overthrew the geocentric theory view of Ptolemy. For Copernicus the world was no longer the center of the universe but merely a planet circling around the Sun. This heliocentric view was followed by the work of Johannes Kepler, a scientist who formulated the empirical laws of planetary motion which gave further support to the Copernican system. But the real change in scientific opinion was brought about by Galileo who by using scientific experimentation and a new mathematical language of nature began to turn his attention to astronomy. With the use of the newly invented telescope and his abilities of scientific observation he discredited the old cosmology paradigm and firmly established the Copernican theory.

Galilean Theory

Galileo's accomplishments in astronomy were notable but it was his work with scientific experimentation and mathematical language that helped him formulate the laws of nature thus gaining him the title the "father of modern science." "Philosophy," he believed, "is written in that great book which lies before our eyes, but we cannot understand it if we do not first learn the language and the characters in which it is written" (cited in Capra, 1982, p. 55).

Galileo employed the tools of his scientific predecessors (e.g., logic and observation), however, it was through observation (aided by new technology) that he was able to realize that the natural world could be explained through mathematical principles. Galileo postulated that scientists should restrict themselves to studying shapes, numbers, and movement of all the essential properties of material bodies. These properties, unlike color, sound, taste, or smell which were merely subjective mental projections, could be measured and quantified. Capra (1982) quotes R.D. Laing's emphatic statement:

> Out go sight, sound taste, touch and smell and along with them has since gone aesthetics and ethical sensibility, values, quality, form: all feelings, motives, intentions, soul, consciousness, spirit. Experience as such is cast out of the scientific discourse. (p. 55)

For over four hundred years hardly anything has changed our world more that the fixation of scientists and later educators with measurement and quantification.

Francis Bacon

Another major contributor to the Newtonian paradigm Francis Bacon set forth the empirical method of science in England. Bacon, as described by Capra (1982), was the first person to develop a clear theory of inductive reasoning i.e. to make experiments and to draw general conclusions from them, which were tested in later experiments. Bacon became extremely influential with his advocation of this new method while simultaneously attacking traditional schools of thought.

The inductive methodology radically changed the nature and purpose of science. Before Bacon, science was pursued for the glory of God and thus the basic attitude of scientists was ecological. Since Bacon, the goal of science has been knowledge to control and dominate nature a goal profoundly antiecological (Capra, 1982, Sheldrake, 1991).

The organic view of nature completely disappeared with the Scientific Revolution soon to be replaced with the metaphor of earth as a machine (Capra, 1982, Brown, 1989). Sheldrake (1991) states:

> According to this new theory of the world, nature no longer had a life of her own: she was soulless, devoid of all spontaneity, freedom, and creativity. Mother nature was no more than dead matter, moving in unfailing obedience to God-given mathematical laws. (p. 49)

Two men who influenced this shift of thought more than any others in the seventeenth century were Rene Descartes and Isaac Newton.

Descartes

Rene Descartes, a well known mathematician and philosopher, created the conceptual framework for seventeenth-century science. His view of nature was that of a perfect machine, governed by exact mathematical laws. Sheldrake (1991) describes:

> The universe of Descartes was a vast mathematical system of matter in motion. Everything in the material universe worked entirely mechanically according to mathematical necessities...he applied this new mechanical way of thinking to everything , even plants, animals and man. (p. 49)

At the young age of twenty-three, Descartes had a vision which shaped his whole life and laid the ground work for his world as a machine metaphor. Capra (1982) describes the vision as one that produced a method allowing him to construct a science of nature based on mathematics or self-evident first principles. The vision implanted in him was the belief in the certainty of scientific knowledge. Capra (1982) quoting Descartes states, "We reject all knowledge which is merely probable and judge that only those things should be believed which are perfectly known and about which there can be no doubts" (p. 57).

In summary, the certainty of scientific knowledge lies at the heart of Cartesian philosophy and the Newtonian world view that derived from it. However, as will be explored in a following chapter, twentieth-century physics has shown us that there is no absolute truth in science, and that all our concepts and theories are limited and approximate (Zukav, 1979, Wolf, 1981, Capra, 1975). The Cartesian belief in scientific truth is still widespread today and can be found in most of our concepts and theories in modern science. Descartes created the conceptual framework for nature as a perfect machine, yet, he could only outline his theory of natural phenomena. The man who completed the story and realized the Cartesian dream was Isaac Newton.

Isaac Newton

Newton, born in 1642, the year of Galileo's death, developed a complete mathematical formulation of the mechanistic view of nature (Capra, 1982). This accomplished a grand synthesis of the works of Copernicus, Kepler, Bacon Galileo, and Descartes. Newton combined the ideas of Kepler on planetary motion with Galileo's experiments of the laws of falling bodies to formulate his own general laws of motion governing all objects in the solar systems (Pagels, 1982). Pagels (1982) states:

> Newton's laws brought order to the visible world of ordinary objects and events like stones falling, the motion of planets, the flow of the rivers and the tides. The primary characteristics of the Newtonian world view were its determinism--the clockwork universe determined from the beginning to the end of time. (p. 64)

In Newtonian science all physical phenomena are reduced to the notion of material particles by the force of gravity. Classical mechanics is based on Newton's mathematical equations which describe the effect of gravity on a particle or any other material object. Newton believed that these were considered fixed laws and that they accounted for all changes observed in the material world. For Newton, God created all particles, the forces between, and the laws of motion. In this way the world, the universe, was set in motion and continues to this day to run like a machine, governed by immutable laws. Capra (1982) states:

> The mechanistic view of nature is thus closely related to a rigorous determinism, with the giant cosmic machine completely causal and determinate. All that happened had a definite cause and gave rise to a definite effect. (p. 66)

Newton believed that any part of the system could in principle, if not in reality, be predicted with absolute certainty with its state known in detail.

Newton's perfect world machine implied an external, monarchical god ruling the universe from above by imposing a divine law on it. As science attempted to explain physical phenomena more accurately it became more difficult for individuals to believe in a god; thus the divine disappeared completely from the scientific world view. Purpel (1989) in his work The Moral and Spiritual Crisis in Education claims that this resulted in a spiritual vacuum characteristic of our mainstream culture. Descartes described the philosophical basis of the secularization of nature as a division between spirit and matter, a division creating a world believed to be a mechanical system, objectively describable without need of human observation. The objective description of nature, unfortunately, has become the ideal of all the sciences.

The brilliant success of the Newtonian science in astronomy extended our understanding of the continuous motion of fluids and the vibrations of elastic bodies leading to Dalton's study of gases and subsequent atomic hypothesis (Capra, 1982). Dalton's theories influenced the chemists of the nineteenth century producing a precise atomic theory of chemistry paving the way for the unification of physics and chemistry.

The tremendous achievement of the mechanistic model confirmed to the scientists of the eighteenth and nineteenth centuries that the universe was indeed a huge machine, operating accordingly to Newton's laws of motion. The Newtonian theory of atoms as building blocks of matter no doubt contributed to the reputation of physics as a "hard science". Newtonian physics combined with the Cartesian belief in the certainty of scientific knowledge has led to the emphasis on hard science in our culture (Dobson, Dobson, Smiley, 1991). With the establishment of Newtonian world view in the eighteenth century, physics became the basis of all the sciences including the social sciences. If the world is a machine then it is reasonable to assume that Newton's theory is the way to understand it.

Descartes drafted the profile of a mechanistic deterministic approach to physics, astronomy, biology, psychology, and medicine. The eighteenth century thinkers conveyed these ideas further by applying these principles of Newtonian mechanics to the sciences of human nature and society (Doll, 1989). The Newtonian theory and the belief in the rational approach to human problems spread rapidly in the eighteenth century becoming the basis of the "Age of Enlightenment" (Palmer, Colton, 1984). Two dominate figures in this era Thomas Hobbes and John Locke developed an atomistic view of society. Locke's analysis of human nature was based on Hobbes' belief that all knowledge was based on sensory perception. Locke adopted this theory of knowledge and in a famous metaphor, compared the human mind to a blank tablet on which knowledge is imprinted once acquired through the senses (Locke, 1960). Locke's view had a strong influence on two major schools of psychology, behaviorism and psychoanalysis, as well as, political philosophy. In short, the modern mind, whether it be "hard sciences" or social sciences by the end of the nineteenth century was completely dominated by the Newtonian paradigm.

Newtonian Paradigm and Curriculum

Thomas Kuhn (1970) in his enormously influential book The Structure of Scientific Revolutions has claimed that scientists carry out their day-to-day affairs within a framework of presuppositions about what constitutes a problem, solution, and method. Kuhn (1970) calls this framework of presuppositions a paradigm. Paradigms can be thought of as a map in which territories are outlined, but not too accurately (Casti, 1989, p. 41). Kuhn (1970) states:

> Men whose research is based on shared paradigms are committed to the same rules and standards for scientific practice. That commitment and the apparent consensus it produces are prerequisites for normal science, i.e., for the genesis and the continuation of a particular research tradition. (p. 11)

Dobson, Dobson, and Smiley (1991) believe that curriculum workers share a common professional culture, knowledge base and "convert to common rules and standards for theorizing" (p. 41). Curriculum workers, like scientists, seem to embrace theory based upon the dominate paradigm. Many curriculum workers claim that the Cartesian-Newtonian paradigm has dominated curriculum development and reform for over two centuries. Doll (1986) claims that the Newtonian paradigm governed not only science but also education thus, "It formed the basis for early and mid-20th century thought and it is the paradigm with which modernist alternative theories must compete. It forms the foundation of the measured curriculum" (p. 10).

Many curriculum workers have cited the emphasis schools have placed on production and management as evidence of the Newtonian paradigm. Eisner (1985) in The Educational Imagination asks an important question, Why do schools, so often pursue simplistic, mechanical solutions to complex educational problems? He answers, "Part of the answer, at least, rests with the assumptions of those who have shaped the thinking of the curriculum field and . . . the way in which school administrators and teachers have been trained" (p. 6). Eisner (1985) claims that educators aspire to develop a scientifically based technology of educational practice, similar to the fields of medicine, engineering, and agriculture. Two men who dominated in this area, Edward Thorndike and John Dewey, both looked to classical science as the most reliable means for conducting educational practice. Thorndike believed that through experimentation teachers could discover the laws of the learning so that "teachers could rely not on intuition, chance, artistry, or talent but rather on tested principles and procedures for managing the student's learning" (Eisner, 1985, p. 6). Thorndike also provided a control model of educational research that eventually lead to a highly predictive science of education.

John Dewey, too, believed that the pattern for educational inquiry ought to follow the classical scientific model. However, as he explained in his 1929 work, The Sources of a Science of Education, science had its limitations in its incapability of handling complex practical problems (Dewey, 1929). Both Thorndike and Dewey agreed that there was a huge potential in utilizing scientific method as a guide in educational practice; however, they differed in their view of ends and means in education. In short, Thorndike and Dewey laid the groundwork that other curriculum workers, such as, Franklin Bobbitt, W.W. Charters, Henry Harap, and Ralph Tyler have followed up in to the present day.

The structured view of curriculum was advanced by Franklin Bobbitt as early as 1918 (Schubert, 1986). He based his method of objectivizing curriculum on the production models found in business and industry. Tanner and Tanner (1975) state that "the notion of curriculum as a production system has been embodied in the doctrine of specific "behavior" objectives; behaviorism and the theory of operant conditioning" (p. 27).

In Bobbitt's (1918) signal work entitled, The Curriculum, he argued that curriculum development be approached scientifically and theoretically to:

> 1. study life to identify needed skills;
> 2. divide these skills into specific units;
> 3. organize these units into experiences;
> 4. and provide these experiences to children. (cited in Gress and Purpel, 1978, p. 359)

Six years later in How To Make Curriculum Bobbitt operationalized his assertions and demonstrated how the various curriculum components--especially educational objectives--were to be formulated. Thus through Bobbitt's work the Newtonian notion of the world as machine became a central tenet to the institution of school. Schubert (1985), Tanner and Tanner (1975) specify the influence of the behaviorists such as B. F. Skinner on curriculum development. Skinner emphasized the linear and mechanical aspects of human behavior consequently providing further the language base for structuring this type of curriculum.

Recent curriculum workers have continued to advocate a rational view for curriculum development (Powell, 1992). Ralph Tyler (1949) in the 1940s called for a planned school curriculum based on specific objectives. In his highly influential book, Basic Principles of Curriculum and Instruction, Tyler drew upon the concepts of Dewey, Bobbitt, and Thorndike to formulate four topics that frame curriculum study:

1. purposes,
2. learning experiences,
3. organization, and
4. evaluation. (Schubert, 1985, p. 82)

Tyler (1949) states that all parts of an educational program are really a means to satisfy basic educational goals and if we as educators desire to study an educational program systematically we must first aim at our educational objectives. Tyler echoed Dewey's summons for balance among students, society, and subject matter as footing for future curriculum development. In order for curriculum to be adequate it must serve a definite purpose and follow a precise direction. Tyler (1949) further defines his position stating, "We are devoting much time to the setting up and formulation of objectives because they are the most critical criteria for guiding all the other activities of the curriculum matter" (p. 62).

Clearly, here emerges the dominant paradigm of curriculum studies that continues to control curriculum decisions. Other curriculum workers such as Madeline Hunter have promoted the idea of a rational, orderly objective curriculum. Doll (1989) states:

> Direct correlations can be made between Madeline Hunter's or Ralph Tyler's notions of an orderly curriculum with ends preset and Newton's idea of a stable universe with planets rotating around the sun in perfect harmony. (p. 244)

Thomas Kuhn's (1970) position that scientists or in this case curriculum workers have a prevailing paradigm that shapes and directs the work in their field seems to fit the apparent application of Newtonian logic to curricular decision-making. The popularity of Madeline Hunter, William Spady's Outcome Based Education and America 2000 demonstrates a reluctance to leave the Newtonian paradigm. The history of curriculum reform, therefore, may be viewed as an attempt to solve complicated curriculum problems through a comfortable language based on eighteenth century science. It is to the history of curriculum reform efforts that we can turn to explore the relationship of the Newtonian paradigm on failed curriculum reform.

CHAPTER III

THE FAILURE OF CURRICULUM REFORM

Everything has been said before, but since nobody listens,
we have to keep going back and begin again.
--Andre Gide

Curriculum reformers of the past decade have attempted to solve the difficult problems of curriculum development with little attention to the historical dimensions. John Goodlad, a curriculum specialist, writing in 1966 critiqued the contemporary curriculum reform movement stating that a large number of so-called reformers had approached curriculum reform in the naive belief that no one had ever looked at them before (Bellack, 1969). Kliebard (1975) states that this ahistorical stance seems characteristic of most educators claiming curriculum building as their field of expertise. Recent reform efforts demonstrate the inability of curriculum workers to see their field in retrospect resulting in a tendency to repeat the slogans and rallying cries of what they considered to be major curriculum reform.

It is my contention that the failure of twentieth-century curriculum reform can be traced to its epistemological foundation. The Newtonian paradigm has become the dominant language base for curriculum theorizing. In this chapter a synoptic history of the reform documents will be presented to aid in confirming this thesis. Contextual conditions that serve to give form to diverse realities have historical and epistemological roots (Kliebard, 1986). "The way we know has powerful implications for the way we live" (Palmer, 1989).

The Dominant Paradigm

The story of curriculum reform dates back to the emergence of the curriculum field in the early twentieth-century (Schubert, 1986). Kliebard (1975a) described this period as "a crucible for curriculum change" because of the many interacting forces present. The period witnessed a great revolution in science producing Darwin's theories of evolution, Einstein's theory of relativity, and Max Planck's quantum theory. It was believed that these theories greatly affected many American psychologists and educators who were studying the Herbartians, Froebelians, and Pestalozzians. (Schubert, 1986). Many other educators sought the tutelage of Herbert Spencer, and the leaders of the psychological measurement movement, such as, Francis Galton, Alfred Binet, and Wilhelm Wundt. Schubert (1986, p. 70) stated "a sizeable proportion of the curriculum field can be traced to Wundt" who founded the first psychological laboratory in Leipzig, Germany in 1879.

The scientific theories of Isaac Newton have had a greater impact on curriculum theory than the newly developing scientific theories of Albert Einstein, and Max

Planck. Goodlad (1975) touched a responsive chord when he wrote the use of Newtonian science as a methodology for management and control of schooling was and is "inadequate, incomplete, and too narrowly restricted to have much significance for educational practice" (p. 34). Science has been conventionally conceived as a way to establish the reliability of claims to know; but in education, it is more often approached as away to manage than a way to explain (Sanders and Schwab, 1979). According to Elliot Eisner, the reliance upon scientifically-based technology in educational practice, similar to techniques in medicine, industry, and engineering, was established from the earliest works in curriculum development by E.L. Thorndike and John Dewey (Eisner, 1985). Both these men helped establish and legitimize a tradition that other reformers such as Franklin Bobbitt, W.W. Charters, and Ralph Tyler were to follow.

The dominant metaphor for curriculum theory and reform in the early twentieth century and one remaining today is taken from corporate management. Toffler (1975) stated in Future Shock that schools became modeled after the needs of an industrial society, he wrote:

> The most civilized features of education today--the regimentation, lack of individualization, the rigid system of seating, grouping, grading, and marking, the authoritarian role of the teacher --are precisely those that made public education so effective an instrument of adaptation for its place in time. (p. 39)

Ellwood Cubberly (1916) describing this model, called schools, factories in which raw products (children) are shaped and fashioned into products to meet the various demands of life. The specifications for manufacturing come from the demands of twentieth century civilization, and it is the business of the school to build its pupils according to carefully laid specifications. Children, in other words, were to become the "standard products" fashioned to the design of the social world.

The Committee of Ten

The first major curriculum reform efforts came as a result of the massive changes industrialization imposed on public education. By the 1890s, the schools had a new world on its hands. Corporations were gaining immense power undreamed of only a decade earlier. As the cities began to draw millions of recruits from the farms and abroad labor began to get restive and increasingly antagonistic toward the new social relationships of production. Violent strikes broke out as the workers clashed with massive numbers of immigrant workers. Social philosophers wondered if such institutions as the family and the church could continue to socialize the youth in more complex ways than the worlds of Thomas Jefferson and Horace Mann.

The Committee of Ten in 1893, made up of college presidents and professors, wanted to bring order to the curriculum and impose standards for the preparation for higher education (James and Tyack, 1983). The need for college students, especially well trained, were on the minds of these educators as they put forth their program of tracking and sequential course work. The committee created ten sub-committees in various curricular programs (classical, Latin/scientific, modern languages, and English) whose task was to specify curriculum, and order of difficulty within each program (Presseisen, 1985). After much debate, four uniform programs were created "to ensure the development of high intellectual ability among college-bound youth" (Presseisen, 1985, p. 13). The four uniform programs were; the Classical, which required both Latin and Greek, the Latin-Scientific requiring only Latin, the Modern Language sequence requiring neither Latin or Greek, and the English course of study which made Latin an option (Spring, 1990, p. 201). Chairman Charles Eliot, President of Harvard University and the other committee members were concerned about the "blight of standardization" pointing out that while standardization of the worker's movements in industry might result in increased productivity, "the inevitable result was the destruction of the interest of the workman in his work" (Kliebard, 1975b, p. 59). The plan created by the Committee of Ten, standardized though it was, was later reinforced when the Carnegie Foundation defined educational units and the secondary schools began granting credit acceptable for colleges and universities (Presseisen, 1985).

The Cardinal Principles

In 1918, a generation after the Committee's actions another group of curriculum reformers wrote a position paper titled Cardinal Principles of Secondary Education. The

Cardinal Principles focused on the needs of a democratic society. It established seven goals for secondary schooling: health, command of fundamental processes, worthy home-membership, vocation, civic education, worthy use of leisure and ethic character (Spring, 1990). Spring (1990) described the document as one reflecting the strong influence of social-efficiency rhetoric, which was attempting to shape the high school to meet the needs of the modern corporate state. The Cardinal Principles was a reaction against the prescribed classical curriculum of the Committee of Ten. Its writers opposed educational elitism, and sought to reject the notion of discipline and training "faculties of the mind" (Presseisen, 1985). They developed their ideas with the help of old and new writings such as Herbert Spencer's What Knowledge is of the Most Worth?, John Dewey's The School and Society, and Franklin Bobbitt's The Curriculum published in 1918. The Cardinal Principles reflected the needs of a new population invading the schools. As the number of students in secondary schools doubled every decade from 1880-1930, the Kingsley Commission, saw differentiation of course preparation and training for social adjustment as the keys to progress (Presseisen, 1985). Presseisen (1985) stated: The bureaucratized school, administered by a new breed of educational expert, was to become the mechanism for realizing a progressive national educational dream (p. 16). This report put educators at the very center of efforts to reform society, and with the rhetoric of scientific management and social efficiency, it sought to justify the enlarged power to which educators aspired. Educators saw differentiation and specificity of training as the key to progress. With the addition of the new intelligence tests educators had the power to determine who would succeed in academia and who would need a slower paced vocational emphasis. James and Tyack (1983) stated, "A bureaucratized school, designed and administered by experts would then fit pupils for their probable future destinies" (p. 401).

The 1920s were marked by numerous activities centering on curricular revisions contained in the Cardinal Principles. William H. Kilpatrick of Columbia University advocated the "project method" as a great way to teach the young, as opposed to the lecture method. Vocational education also became a major focus for older students who saw little purpose in tradition liberal arts. Further, colleges of education included in their programs new topics like child-centered schools and community education. But progressivism was not without its critics. Ravitch (1983) reported the era was faulted for a decrease in the number of students enrolled in college preparatory programs and for showing little evidence of actual social reform in the public schools. Unfortunately, though, as Cuban (1982) argued convincingly, the patterns of classroom instruction changed very little despite the plethora of conflicting reforms.

Reform After the Depression

James and Tyack (1983) called the 1930s the watershed of school reform because hard economic times forced educators to rethink the historic functions of public education. The problems of youth, unemployment, apathy, and unrest emerged as national concerns during this period (Presseisen, 1985). The general opinion was that education was necessary in order for the country to survive, but beyond that, individual philosophies diverged. Progressives like Harl Douglass saw innovative New Deal work programs as the salvation of young people with inferior academic ability. Strangely, it was John Dewey himself that condemned the extreme application of progressivism as a misinterpretation of his writings. In 1938, he published Experience and Education a major book condemning those educators who were misinterpreting his writings on educational freedom. Dewey stated that "the only freedom that is of enduring importance is the freedom of intelligence" not the activity which is based on whim and impulse (p. 59). In the same publication, Dewey endorsed the notion of knowledge from the past guiding learning about the present and the future. These arguments further fired the controversy between progressives and traditionalists.

In 1938, an Eight Year Study was begun to compare the college graduates from progressive schools to the success of graduates from more traditional programs. Sponsored by the Commission of the Progressive Education the study was conceived as an empirical research design. One of its objectives was to compare the college success of graduates of thirty or more so-called progressive schools to the success of graduates of more traditional educational programs. The study established that no particular plan of college preparation was superior to any other. (Presseisen, 1985). Even though the schools and reformers were receiving criticism through the depression years from the traditionalist and progressives, schools continued to expand throughout the rest of the decade.

Changes After World War II

In the 1950s, America experienced a reawakening of the Committee of Ten's elitists ideas, such as, that high schools be designed for those few students of high intellectual ability (James and Tyack, 1983). A variety of critics--academics, administrators, and even Admiral Hyman Rickover--attacked the anti-intellectual character of the secondary schools. Books such as, Why Johnny Can't Read (1955), Educational Wastelands (1953), and Quackery in the Public Schools (1953) were condemning a watered-down curriculum, incompetent teachers, neglect for the gifted, child-centered learning, and the like. The solution they gave was to place a greater emphasis on science, math, foreign languages, and the traditional liberal arts (James and Tyack, 1983). They wanted discipline and rigor back in the classroom. If the pendulum was swinging away from the Cardinal Principles in the reasoning of these reformers, it was definitely moving away from the child-centered beliefs of William H. Kilpatrick. The launching of the Sputnik I in 1957 heightened further the traditionalist's demands for discipline, order, and excellence in the public schools.

The response to Sputnik came from two instigators of curriculum reform James Bryant Conant, President of Harvard

University and Jerome Bruner of Harvard's Psychology Department. Conant's report, The American High School Today, and Bruner's The Process of Education, did much to characterize the curriculum reform in America over the next decade (Presseisen, 1985). Conant's report called for the strengthening of the academic program at the high school. He called for twenty-one recommendations ranging from ability grouping, individualized programs of instruction, to programs for both the gifted and the slow learners. Mindful of America's role in the world after World War II he also called for better instruction in math, science, and foreign languages. Conant's (1959) goals included the tightening of standards "such that students with less than average ability would have difficulty passing the courses" (p. 73). Conant's proposals were relatively conservative for he was convinced that any reform to American education could be achieved without any "radical" changes (Conant, 1959).

Jerome Bruner meeting with thirty-four scientists and educators at Woods Hole, developed the ideas and themes for his The Process of Education. Among the participants at this meeting were ten psychologists, six mathematicians, five biologists, four physicists, three educators, two historians, two cinematographers, one classicist, and one medical specialist. Utilizing Piaget's theory of educational process he wrote about four basic themes: the role of the structure of knowledge development, the importance of a student's readiness for learning, the significance of intuition in creative thinking, and the need for a desire to learn. The chief area of controversy that arose at Woods Hole was: Should the teacher be the main arbiter of how to present a subject or, should there be a massive effort to prepare films, tests, and programs for teaching machines. From the Woods Hole meeting came the concept of teacher-proof materials and a decade of new academic curricular that reads like the alphabet: SMSG, BSCS, SCIS, MACOS, AND PSSC (Presseisen, 1985).

Ever since Conant and Bruner published their reports we have witnessed a parade of new issues and problems confronting American culture and schools. As the number of teenagers desiring secondary education continued to grow educators were caught off guard having to cope with diverse needs of a heterogeneous population. As James and Tyack (1983) stated, "Blacks, Hispanics, women, the handicapped and other groups too long ignored in educational policy now demand a say in shaping the high school" (p. 405). In 1973, many of these reforms found their way into recommendations for a new commission to reorganize secondary education. By the mid-1970s new criticism of past reform efforts developed, combined with declining SAT scores and new scientific and technological advances, sparked a national concern about achievement and schooling. By the early 1980s, a new era of reform had begun. However, most of the issues date back to 1893--the first era of reform--and repeat the hopes and fears of curriculum reformers.

Reports of the 1980s

Between 1983 and 1985, dozens of studies on American schooling appeared in professional and lay publications. By far the most widely distributed in comparison to the other reviews of schooling was A Nation at Risk: The Imperative for Educational Reform published in 1983 by the National Commission of Excellence in Education. This thirty-six page report claimed that America was at risk because "competitors throughout the world are overtaking our once unchallenged lead in commerce, industry, science and technological innovation" (A Nation at Risk, 1983, p. 5). The Commission's report is assertive, and at times, militant; it demanded performance and spoke of educational failure in explicit quantitative language borrowed from the psychometric research. For example, the commission claimed:

> Many 17-year olds do not possess the higher order intellectual skills we should expect of them. Nearly 40 percent cannot draw inferences from written material; only one fifth can write a persuasive essay; and only one-third can solve a mathematical problem requiring several steps. (Nation at Risk, 1983, p. 9)

The case for reform, spelled out in A Nation at Risk (1983), involved the decline of student performance and the relaxation of educational standards. It claimed that high school graduates have fallen behind in meeting the nation's expectations as well as those in previous generations. To turn this situation around the report calls for the schools to be made "excellent." Eisner (1985) stated that their definition implies a limited notion of excellence which can be characterized by several curricular practices such as mastery learning, time on task, quality control, and higher accountability standards.

The Nation at Risk's (1983) effectiveness primarily rested on the ability of the ideas to evoke a sympathetic reaction of the reader. The hoped for reaction being "Yes we've heard that before, we're retreating from the academics" and why not let's get "Back to the Basics". In spite of the reports weak documentation the widespread perception of an undisciplined 1960s guaranteed a national acceptance of the commissions' arguments. Stedman and Smith (1985) stated:

> The commission used weak arguments and poor data to make their case. Neither the decline in test scores, the international comparisons, nor the growth of hi-tech employment provide a clear rationale for reform. By ignoring their background reports and carelessly handling data, their reports further lost credibility. (cited in Gross and Gross, 1985, p. 102)

They concluded that the report like many of the others "made simplistic recommendations and failed to consider their ramifications." (p. 102)

The eighties produced several other reform documents each directing itself toward making schools excellent again. A short list of the more famous ones are as follows:

1. Academic Preparation for College: What Students need to Know and Be Able to Do (1983).
2. Action for Excellence: A Comprehensive Plan to Improve Our Nation's Schools (1983).
3. America's Competitive Challenge: The Need for a National Response (1983).
4. Making the Grade (1983).

5. The Paideia Proposal: An Educational Manifesto (1983).

6. Horace's Compromise (1984).

7. High School (1983).

8. Educating Americans for the 21st Century (1986).

Gross and Gross (1985) in a comprehensive study of these reports entitled The Great School Debate asserted that the recommendations made were often simplistic and incomplete. For example, many of the reports propose increasing time in schools without altering pedagogy, instituting merit pay schemes without describing procedures, and adopting the so-called "new basics" without changing the old definitions. The reports also ignored numerous problems --teenage unemployment, teacher burnout, high dropout rates and the special needs of the poor and minorities.

Presseisen (1985) maintained that each of the reform reports was rooted in specific assumptions that influenced its meaning. These assumptions, established by tradition, use a language base and paradigm that predispose simplistic solutions to complicated schooling problems.

In order to understand the effects of these assumptions on curriculum reform, I will analyze the reform documents utilizing three models of curriculum development as developed by Tanner and Tanner (1975). These models are: content/excellence, society/efficiency, and individual/equity.

Content-driven schooling focuses on the subject matter of education such as those in the so-called disciplines of knowledge. This schooling is grounded in the essentialist notion that academic pursuits lead to truth and expertise. Collective and generalized wisdom from the past constitutes knowledge and enables educators to ask questions like "what knowledge is of the most worth?" However, with the cyclical nature of curriculum reform, intellectual concentration of knowledge has clearly not worked as a winning model in American educational history. Presseisen (1985) stated:

> The current of anti-intellectualism runs deep in our history and in our society. It comprises a resentment and suspicion both of the mind itself and of those who represent it. Intellect is regarded as a form of privilege and power. It is resented as a kind of excellence, a claim to distinction, that challenges the egalitarianism of America. (p. 61)

Content-driven curriculum has claimed a place in the history of education reform but for the most part, until today it has always been overshadowed by an education that values entrepreneurship and other more practical gains.

Society-driven schooling focuses on the pragmatic and utilitarian. Historically, the charge of American schools was to form character and inculcate sound principles rather than lead to the pursuit of truth (Presseisen, 1985). In early progressivism, Dewey was concerned with overall social needs. He believed, although his philosophy was often misunderstood and poorly applied, the responsibility of schools was to improve the quality of life and make education more useful. A school's worth, therefore, can be translated into productivity and the marketplace. By the twentieth century, schooling was prized because it enabled students to get jobs.

Individual-driven schooling is a concept that focuses on the experience of the two major participants in schooling: the teacher and the student. The heart of this humanistic concept of schooling is the belief that each citizen can acquire decision-making capacity and the will to employ it. There is a mixed view of the teacher in this model. As a citizen, the teacher shares the same democratic rights as the student. As a teacher, however, the instructor has not always been valued as a contributor to education. If knowledge of subjects is little valued in the society, then teachers of subject matter are also not very significant in the workings of the community.

Each of these curricular models reflect the policy positions and goals of school leaders. The reform documents can be further analyzed by examining their support for one or another goal. By sorting out the relationships of the reports to these three models it will enlighten us to the underlying meaning of a particular report and the cyclical nature of the reform ideals themselves.

Of the eight reform documents four of them can be classified as ones falling under the society/efficiency model: <u>A Nation at Risk</u> (1983), <u>Academic Preparation for College</u> (1983), <u>Action for Excellence</u> (1983), and <u>Making the Grade</u> (1983). <u>A Nation at Risk</u> (1983) is primarily concerned with the nation's welfare in a competitive world market. In arguing its utilitarian case, this report employed a data-based analysis of student performance--test scores and comparative analyses. Achievement is synonymous with test success. Excellence in society, as depicted by A Nation at Risk (1983), is realized through productivity in the same way that a corporation becomes more cost effective by enhancing the output of its labor force. It is not surprising that the report's recommendations are technical in nature. For instance, the report called for increased graduation standards, limiting course selections, requiring more homework, and higher expectations of student performance.

In Academic Preparation for College (1983) the report's authors view academic competencies as developed abilities, "the outcomes of learning and intellectual discourse" (p. 7). This report resembles A Nation at Risk (1983) by defining standards of educational success, namely acquiring those skills necessary for attending college and being able to demonstrate them. Although the concerns about what one needs to know are associated with the content/excellence model of schooling the report's subtitle puts content before competencies. Competencies are efficiency measures (Presseissen, 1985). There is a tendency in this report to suggest that it is the responsibility of the teachers and administrators to translate new standards into tasks. However, the report itself does nothing in the way to provide teaching or learning strategies. It simply presented an efficiency model, with improved test scores as its measure of success, and that depended heavily on the teachers teaching for the test.

Action for Excellence (1983) is another example of the efficiency-driven model of schooling. It differs from the other reports in that it does render some constructive criticism. For example, although the report focused on academic competencies it does not limit itself to just the college-bound student but seeks to understand the skills necessary for every American citizen. "The challenge" it says, "is simply not to better educate our elite, but to raise both the floor and the ceiling of achievement in America" (p. 7).

The report like the others poses improvements such as more time on task and better qualified teachers, but in addition it suggested revising the curriculum and working toward improved cognitive and motivational goals. Also like the other documents it never really addressed the questions of "how do students become better problem solvers?" or "how do teachers teach students to think in more complex ways?" Pedagogy is largely ignored in this report and the changes it recommended are mostly external to actual educational process. The efficiency model persisted in Action for Excellence (1983), even if driven by state and local efforts and requiring more complex technical skills.

Making the Grade (1983) resembled Action for Excellence (1983) as a society or efficiency driven model for schooling. It quickly discussed the societal concerns of a complex and competitive economy. Technology and skilled labor are again noted as necessary ingredients for success in world markets. Recommendations in Making the Grade (1983) are mostly on federal initiatives--literacy programs, science and mathematics development, and foreign language development. The weaknesses in this document center on its narrow focus on such issues as language literacy, and foreign language and whether these concerns are so central to education in a scientific and industrial age.

The second model of schooling: content/excellence has two reform documents: The Paideia Proposal (1983) and Educating Americans for the 21st Century (1983). The Paideia Proposal (1983) is concerned with the quality of schooling as embodied in the content of learning. This report immediately brings to mind the essentialist's recommendations of the early 1950s. It strongly suggested an education linked heavily to the past. The heart of the report consisted of three strands of knowledge and each strand took a different approach to learning and teaching. The content focused on the traditional, organized subject areas that reflected only the western heritage from Greek and Roman times through the twentieth-century Europe. The teacher is the font of all wisdom in this model. The Paideia Proposal (1983) treats pedagogy only as an expression of the content of learning and little is said about the instructional relationship of the learner to the teacher. Although student involvement is encouraged, the main mode of instruction is the teacher's activity, not the student's. In that regard, The Paideia Proposal (1983) is strongly reminiscent of Eliot's Committee of Ten, and about as far as on can get from A Nation at Risk (1983).

Educating Americans for the 21st Century (1983) resembles Making the Grade (1983) and Action for Excellence (1983), by first recognizing the content-excellence but later devoting its emphasis to individual-equity goals envisioning education for 1995. One of its first assumptions is that excellence is not an elitist condition but that all children need to be intellectually stimulated. The report developed two strategies to address this emergent problem: better curriculum and more effective instruction.

Educating Americans for the 21st Century (1983) stressed increased work in science and mathematics but does not limit itself to these content areas. Its emphasis is on practical skill improvement, recognized as developmental and integrative of all learning. The strength of this report as opposed to the others is that the content to be learned cannot be separated from how the individual learner both perceives and conceives it. Teachers cannot just pour in information or find it embodied in historic great works; they must take the learner into account. Of all the reform documents reviewed this one gives a new meaning to the students' active participation in the educational process. It called for a special relationship between the teacher and the taught and the confidence that the American public will support and fund such a relationship.

The last model of schooling to be addressed by the reform documents is the individual/equity model. Two reports are classified in this area: High School (1983) and Horace's Compromise (1983).

The most comprehensive and longest of the reform reports is High School (1983). It addressed issues of both content/excellence and society/efficiency yet its central thesis is the development of the profession of teaching. Ernest Boyer one of the reports authors sees the role of the high school as preparing students for life as well as for work or further education. A "core" of common learning provided the substance and the means of study, but is not an end in itself. The finishing touch to the high school studies is the "Senior Project" in which every student actually uses his or her acquired knowledge in service to his or her community.

High School (1983) is extremely critical of the bureaucratic nature of modern education. Bureaucracies prevent the development of nurturing climates in which goals are personalized and realized. The report called for rewarding teacher's creativity and upgrading the profession in the eyes of the community. Principals, the report stated, must be instructional leaders or head teachers in the transformation of the school. This commitment must be voluntary of all parties, not the external requisite of an efficiency/driven model. According to High School (1983), the commitment, plus the substance in the system, is the key to professional teaching and the antidote to curricular reform.

Horace's Compromise (1983), the second of the individual/equity models, offered a sobering view of education. Theodore Sizer, author of this report, described the school as a "dull bureaucracy" incapable of change in the near future. The reasons are complex, with the major issue being that the individual gets lost in the muck of the institutional bureaucracy (Sizer, 1985). This report is a study that fights uniformity and seeks the active involvement of all the parties in the learning process.

Horace's Compromise (1983) called for a radical restructuring of secondary schools. The skeletal structure of the school is made up of the intellectual skills it suggested, while the integrated departments it proposed are the platform of a new school design. The rest of the structure is left up to the students and teachers to determine in a collaborative way. Truly, the recommendations for class size, teaching load, and staff development are derived from the essential relationship between the teacher and the student, unlike the efficiency reports which focused on quantitative and not qualitative outcomes. What makes this school different is that the people count--more than technology and even more than the state. Sizer (1985) believed that public schooling has to leave room for human creativity; further, he maintained the nation's creative genius is currently at stake in curriculum reform.

Emergent Problems in Reform

An analysis of the reform reports show that the dominate interest is in the society/efficiency model of schooling. Reformers want schools to serve the many economic, social, and political needs of our society. However, this presents several problems, one being that there is a lack of a well-perceived philosophic position about the purpose of schooling (Goodlad, 1984). The purposes of schooling are many and are as unique as the individual people espousing them. Supporters of differing philosophical positions may be more concerned with political rhetoric than with what is appropriate for children (Apple, 1975, Dobson, Dobson and Koetting, 1987). Dobson, Dobson and Koetting (1987) stated:

> With only a superficial understanding of the philosophic roots on which curriculum and pedagogical decisions are based, educators often implement those decisions unwisely. When the implementation does not yield expected results or it is criticized by pressure groups, the philosophy and programs are rejected as hastily as they were adopted. (p. 5)

A second problematic aspect of the society/efficiency model is its almost exclusive use of the technocratic rationale. Dobson, Dobson and Koetting (1987) contend that schooling has become a highly mechanistic affair with an exclusive use of "a technocratic rationale in planning, designing, and implementing curriculum development and pedagogical reform" (p. 6). The epistemological base of this model of schooling is well grounded in the dominant paradigm established by Newton, that is, it is conceptually limited and it eliminates the possibility of extending beyond what is currently thought to be known. The goal of this rationale is to create knowledge that can be used to predict and to control human phenomena. The human being is viewed as an instrument to be molded to fit into someone's idea of reality. School practices that reflect this ideology are labeling, tracking, positive reinforcement, behavioral objectives, and quantified marking systems (Dobson, Dobson and Koetting, 1987).

The third problematic aspect is the ahistorical mentality reflected in the work of curriculum reformers. Many of the programs and ideas have been around for many years, some reforms having been renamed or modernized with the times. Kliebard (1975) asserted: "The field in general is characterized by an uncritical propensity for novelty and change rather than funded knowledge or a dialogue across generations" (p. 41). Dobson, Dobson and Koetting (1987) concluded:

> It appears that each new generation of curriculum and instruction practioneers is abandoned to rediscover the conceptual bases of the field. To build on successes of the past as well as to avoid mistakes of forbearers requires a clear understanding of historical roots. (p. 8)

The final problematic aspect and the central thesis of this study is the failure of curriculum reformers to perceive and comprehend the paradigm and language base that influenced their knowledge base and consequently, their view of reality. As Zukav (1979) stated:

> Reality is what we take to be true. What we take to be true is what we believe. What we believe is based upon our perceptions. What we perceive depends upon what we look for. What we look for depends upon what we think. What we think depends on what we perceive. What we perceive determines what we believe. What we believe determines what we take to be true. What we take to be true is our reality (p. 328).

The curriculum reform documents used a specialized vocabulary suggesting scientific accuracy, predictability, and control. Words used to discuss the complex educational system in the reform documents are metaphorical in nature. Soltis (1973) suggested the terms, industrial, military, and medical:

Industrial: Classroom management, efficiency, outputs, product, time management, time on task, institutional planning.

Military: discipline, teaching strategies, target population, decentralization of power.

Medical: diagnosis, treatment, remediation, deviant, impaired, referral, special needs.

In sum, the educational vocabulary has the power to explain, but it also has the power to dictate thought. The past as well as the recent reform documents continue to demonstrate an unwillingness to change the metaphorical language basis of the Newtonian paradigm. The result has been school reforms continuing to return again and again (Cuban, 1990). Whether it be the reform concepts of teacher-centered instruction or student-centered instruction; the debate between the academic versus the practical curriculum; or the persistent discussion of centralized as opposed to decentralized authority in governing schools, the reforms never seem to remove the problems they were intending to solve. Maybe the paradigm and language base on which these reforms are based are inappropriate for the complex world of schooling? If science provided curriculum theorists with a limited methodology for successful curriculum reform, that being eighteenth-century Newtonian science, maybe a look at twentieth-century science of quantum mechanics will provide us a paradigm of promise?

CHAPTER IV

QUANTUM THEORY: A NEW FOUNDATION

An argument has been made that Newtonian science is the epistemology that has been adopted as the paradigm for reform of schooling. This epistemology is deficient and too limited to have a significant impact for use by curriculum reformers (Sanders and Schwab, 1979, p. 349) There is a contingent of educators who recognize the inappropriate reductionism of this linear, ends-means paradigm for education (Apple, 1975, Eisner, 1985, Dobson, Dobson and Koetting, 1985, Sanders and Schwab, 1979). As Brown (1989) contends:

> American education has virtually been enslaved to a scientific model which has all but excluded any other view of the way in which inquiry in education can legitimately be pursued (p. 9).

Brown (1989) defines a model as a standard which can be used for imitation or comparison and accordingly the approach in education has been to follow model after model replacing one after another if it fails to accomplish the reforms of the differing reform groups. Brown (1989) continues: "Where does this end? When do we reach the ultimate model where all stops are closed and all outcomes predicted to precise specifications?" (p. 9).

Doll (1986) has described how western thought can be grouped into three broad paradigms. The first is the classical-Christian view developed by Aristotle, Ptolemy, and Thomas Aquinas. The second is the classical-scientific view summarized and guided by Isaac Newton. The third paradigm is presently in process of being developed out of the theory of quantum physics and the thoughts of Albert Einstein, Neils Bohr, Werner Heisenberg, and IIya Prigogine (Doll, 1986).

The Newtonian paradigm, as previously described, has governed science and the social sciences for almost 400 years (Doll, 1986). Doll (1986) states that the Newtonian paradigm has "formed the basis for early and mid-20th century thought and is the paradigm with which modernist alternative theories must compete. It forms the foundation of the measured curriculum" (p. 10). As described in chapter 2, the Newtonian paradigm has provided curriculum leaders with an educational paradigm that is "simple, spiritual, and uniform or universal" (p. 10).

The greatest challenge facing curriculum reformers is not technology, resources, or accountability but rather a need to discover a new way of thinking. This quest does not require merely different information but rather a whole new way of viewing the world (Crowell, 1989). Science is forcing us to change our view of the world. As Alfred North Whitehead has written: "The old foundations of scientific thought are becoming unintelligible; time, space, matter, pattern function etc.--all require reinterpretation" (Harris, 1983, as quoted in Crowell, 1989, p. 60). Thomas

S. Kuhn has written perhaps the most noted work in the area of how dominant ideologies change. In the area of the history of science, Kuhn uses the term paradigm to discuss how visions of reality are developed and changed.

Kuhn's Idea of a Paradigm

Kuhn (1970) posits that scientists come to share common beliefs and assumptions. Shared beliefs eventually become so widely accepted by scientists that they form a paradigm. Kuhn states that a paradigm "is an object for further articulation and specifications under new or more stringent conditions" (p. 23). Kuhn claims that after the formulation of a paradigm a period of "normal science" follows in which scientists solve puzzles within the framework of ideas of the paradigm. While scientists may enlarge the paradigm, for the most part they work almost exclusively within it's bounds of that paradigm (Phillips, 1987). As Kuhn (1973) states:

> Few people who are not actually practitioners of a mature science realize how much mop-up of this sort a paradigm leaves to be done or quite how fascinating such work can prove in the execution. Mopping-up operations are what engage most scientists throughout their careers. They constitute what I am calling normal science. Closely examined, whether historically or in the contemporary laboratory, that enterprise seems an attempt to force nature into the preformed and relatively inflexible box that the paradigm

> already supplies. (p. 24)

Kuhn describes conclusively how confining paradigms actually are and that there is little wonder why that dominant paradigms last for such a long time. For a scientist to deviate from the paradigm they must surely risk scorn from fellow scientists. Paradigms then tend to guide research problems. Moreover, scientists come to see in the paradigm their lifes work and often are unwilling to change or give it up (Casti, 1989). For example, Gleick (1987) describes how scientists reacted to the concepts expressed in chaos theory:

> Every scientist who turned to chaos early had a story to tell of discouragement or open hostility. Graduate students were warned that careers could be jeopardized if they wrote theses in an untested discipline, in which their advisors had no expertise. ... Older professors felt they were suffering a kind of midlife crisis, gambling on a line of research that many colleagues were likely to misunderstand or resent. (p.37)

Kuhn's Paradigm Shift

If Kuhn is correct that the dominant paradigm determines that which is regarded as legitimate science how do new paradigms emerge? Kuhn (1970) states that it is when the old rules begin to fail and anomalies become profuse that dominant paradigms are challenged. If enough anomalies appear the paradigm may be considered inadequate. Kuhn (1970) called this period of unrest as a "shift in professional commitments," and this transition to a new paradigm he designated a "scientific revolution."

As the early twentieth century saw the advancement of new scientific thinking-- quantum science --Newtonian science came into question. Christopher Lucas (1985) describes the abandonment of Newtonian mechanics:

> The abandonment of Newtonian mechanics as a paradigm for understanding reality is relatively well advanced. Yet, the metaphysical view of the world it once inspired has proved rather more durable. Perhaps because of cultural lag only in recent decades has the philosophical implications of quantum physics begun to reverberate through other knowledge domains. Overall, the new image of reality unfolded by modern science portends a radical revision of how the world and human consciousness itself is to be comprehended. (p. 165)

The science of quantum physics, that is, the study of subatomic particles, has rendered much of the Newtonian paradigm inadequate. Quantum physics has presented scientists with an abundance of anomalies far too many for the Newtonian paradigm to explain. Capra (1984) is convinced that quantum physics is sending us toward a new paradigm. Kuhn (1970) believed that the locus of a new paradigm is created by the problems resulting from the old, accepted paradigm. The new paradigm, therefore, blends with previously established theory and reconstructs and reevaluates the prior assumptions.

Quantum Origins

Quantum mechanics forced itself upon the scene at the beginning of this century (Zukav, 1979). What is "quantum mechanics" ? A "quantum" is a quantity of something, a specific amount. Mechanics is the study of motion. Therefore, "quantum mechanics" is the study of the motion of quantities. "Quantum theory or quantum physics says that nature comes in bits and pieces (quanta), and quantum mechanics is the study of this phenomenon" (Zukav, 1979, p. 19).

Quantum mechanics rose out of the contradictions of earlier theories, which its founders viewed not as indications of the limits of human logical understanding, but simply as limits of a particular theory, and the need to develop a new one. Zukav (1979) explains, "What we actually discover is that the way that we have been looking at nature is no longer comprehensive enough to explain all that we can observe, and we are forced to develop a more inclusive view (p. 19). In the words of Einstein (1938):

> . . . creating a new theory is not like destroying an old barn and erecting a skyscraper in its place. It is rather like climbing a mountain, gaining new and wider views, discovering unexpected connections between our starting point and its rich environment. But the point from which we started out still exists and can be seen, although it appears smaller and forms a tiny part of our broad view gained by the mastery of the obstacles on our adventurous way up. (p. 152).

The first impetus toward the idea that energy comes in discrete packages, "quanta" and can behave like particles, came from the study of black body radiation. At the end of the nineteenth century, scientists where studying the spectrum of light emitted by perfect absorbers--essentially black boxes with only a tiny hole for the measuring device. They discovered that the spectrum of light was always the same in shape, except that it grew in intensity and shifts in frequency as the temperature of the box increased. Lord Rayleigh, a leading authority on light, calculated what the spectrum should be theoretically--and the answer did not make sense. For long wavelengths the proposed curve agreed with observation. But the short wavelengths, the curve went off the charts. Lord Rayleigh concluded that the total intensity of the light emitted was, therefore, infinite (Lerner, 1991).

This sort of contradiction is exactly what bedevils present day physics. The laws of electromagnetism were indisputable for they had been tested thousands of times--yet they predicted an impossible result, infinite light intensity.

Max Planck in a landmark discovery in 1889 published his findings on his work dealing with radiation. He was able to prove that motion associated with nature was discontinuous, rather than continuous, as found in Newtonian physics. It was this belief in continuous motion that had allowed Newton to develop his three laws of motion, and according to Newton, not only was motion continuous but entities interacted with each other. These findings contributed to the concept of causality, which was defined as the belief that for every effect there must be a logical cause (Trusty, 1991).

Planck's discovery challenged the principle of causality as well as in later experiments demostrated mathematically that light waves travel in discontinuous motion. Through the use of a mathematical formulas, Planck introduced a new era into the scientific community, that being, no longer can scientists rely on direct observation for verification of experiments.

Neils Bohr (1987) expanded on Planck's concept of discontinuity through its application to electrons, which at time were considered the ultimate particles. Bohr compared the movement of electrons to the hopping of kangaroos (Bohr, 1987). This new knowledge led to the understanding of the motion of particles which opened the door to another major discovery by Rutherford and Soddy in 1903.

Rutherford and Soddy, somewhat like Planck, challenged the old notion of causality. Through their experimentation they presented to the scientific community the law of radioactive disintegration which said in essence that atoms of radioactive substances split spontaneously and not as a result of any particular condition. This discovery, in conjunction with Einstein's 1917 discovery of the wave-particle duality of light, closed the door on the concept of discontinuity.

Einstein's 1917 discovery was an attempt to connect Planck's findings on discontinuous motion with Rutherford and Soddy's laws of radioactive disintegration. Einstein demonstrated that the laws that governed radioactive disintegration of substances also governed the unpredictable jumps of kangaroos that Bohr had described earlier. The laws were of the simplest statistical forms. They showed that, out of any number of kangaroos. a certain percentage would jump within a certain time, yet there was nothing observable to determine what kangaroo's would jump from those that would not jump (Trusty, 1991). The conclusion reached was that the jumps could only be statistically predicted. This concept thus opened the door for Einstein to understand the nature of light.

Through his findings, Einstein proposed that light consisted not of light waves, as suggested by Maxwell in 1860, but of energy particles. This concept, however, presented a paradox to scientists for to them waves and particles had seemed to be independent entities. Einstein now claimed that light appeared to assume characteristics of both waves and particles thus leading to a wave-particle duality of nature. As the wave-particle duality began to sweep through the field of physics, so too did the concept of discontinuity. Jeans (1946) stated that, "As discontinuity marched into the world of phenomena through one door, causality walked out through another" (cited in Trusty, 1991, p. 31).

These new scientific concepts challenged the laws of Newtonian science. The new answers were altering the focus of the questions to be asked. Where Newtonian science had provided the ability to predict future behavior, quantum mechanics (physics) could only provide statistical probabilities because of the unpredictability of nature. Quantum mechanics now presented a totally new way of looking at nature; consequently, the scientists involved with the quantum world were on the edge of a new paradigm in science. Einstein, Bohr, and Heisenburg were the scientists that laid the foundation through their theories that forced scientists to reevaluate the total concept of reality. Bohr's Principle of Complimentarity and Heisenburg's Principle of Uncertainty, in particular, have spurred on discussions for years and still hold room for discussion.

Bohr's Complimentarity Principle

Neils Bohr introduced the term complimentarity in 1927, when he referred to the complimentary relationships that exist between spatiotemporal descriptions and causality. Bohr described complimentarity to mean that protons, electrons, and other particles could exhibit both wave and particle properties. These particles, however, could not exist at the same time. Further, Bohr claimed in order for one to gain a complete understanding of the whole entity, it required that both properties be considered.

The duality of nature, as explained by Bohr (1958), requires one to see the totality of a phenomena as something different than studying the phenomena through the data of one experiment. When compared to Newtonian science, Bohr (1963) explained that Newtonian science allowed one to understand or comprehend the total nature of an object through experimentation, whether it be one or several experiments whose results supplemented each other. As a result of the complimentarity principle, scientists were now being urged to accept that observations could only provide a partial picture of a phenomena rather than a complete picture as described by Newtonian science.

One final aspect of Bohr's study of the wave-particle duality was that the concept of waves and particles were both carryovers of Newtonian physics, and therefore, brought with them specific notions as to their nature. When Bohr attempted to apply these concepts to quantum physics the reactions were mixed. The question of causality, Bohr realized, reflected classical scientific methods and thus when speaking in terms of relative space-time it became exclusive of Newtonian mechanics (science) (Trusty, 1991). To reconcile these two views of reality, Bohr (1963) concluded that the meaning of a concept was dependent on the conceptual framework on which it functioned. Further, given a new framework from which to view nature Bohr was beginning to detect an element of randomness in nature. Lerner (1992) states, "In the quantum world the fundamental idea of rationality--that of cause and effect--no longer holds. Events can occur without cause, a particle can simply pop into and out of existence magically" (p. 360).

Heisenberg's Uncertainty Principle

The paradox of the quantum world became more complicated with the creation of the famous "Uncertainty Principle" by a then young German physicist, Werner Heisenberg. In 1925, Heisenberg barely twenty-five years old, had decided that "we can never know what actually goes on in the invisible subatomic realm, and that, therefore we should abandon all attempts to construct perceptual models of atomic processes" (Zukav, p. 109).

Heisenberg's theory confirmed the random characteristic of nature. Like Bohr, he attempted through his studies to understand motion associated with atomic particles. He argued that scientists should abandon the use of models, which had been used to explain scientific theories, and rely solely on mathematics. Therefore, Heisenberg was dumbfounded as to why he could not calculate something as simple as the trajectory of an electron in a cloud chamber.

While thinking about this question Heisenberg (1958) remembered Einstein's statement that scientific theory determines what scientists observe. He focused his efforts on the question-- what if nature only reveals situations explainable by the mathematics of quantum physics? His conclusion-- was that on the small scale of an atom, there must be limits as to the extent that an event can be known. Therefore, in the atomic world, if the position of a particle can be known, one must lose the information as to its velocity and vice versa.

Heisenberg like the other scientists found that they could not control quantum reactions. Therefore, when a new element is introduced in the atomic world the device alters the motion and position of the other particles. Heisenberg (1958) discovered that knowledge of position is complimentary to knowledge of momentum. Further, to know of one with accuracy requires that the other cannot be known with any degree of accuracy.

Heisenberg's discovery was that there are limits beyond which we can not measure accurately the processes of nature. In other words, there exists an "ambiguity barrier beyond which we can never pass without venturing into a realm of uncertainty. For this reason, Heisenberg's discovery became known as the "uncertainty principle" (Zukav, 1979, p. 111).

After a period of time, Heisenberg explained this concept of uncertainty through mathematics which produced statistical outcomes. In 1927, Heisenberg's theory marked the end of determinism in science (Trusty, 1991). No longer could science gain the complete knowledge of a particle; consequently, predictions concerning future actions became impossible. The only prediction that science could make would have to be statistical for now scientists could only predict the probabilities of a particle's motion or velocity.

However, determinism was not the only theory in classical science to be challenged by the uncertainty principle. This theory also marked the end of the concept of absolute truth as a pillar of the Newtonian world. Newton could gather information that allowed him to describe and understand whole entities; now scientists were being forced to accept trade-offs in knowledge concerning the subatomic world.

Not only were scientists forced to accept the idea of limited knowledge but that they were also having to accept the impact of the observer upon the observed. This concept along with the concept of probability provided the framework of the famous Copenhagen Interpretation.

The Copenhagen Interpretation

The Copenhagen Interpretation was the first consistent formulation of quantum mechanics (science) (Zukav, 1979). It consisted of the two major principles of Neils Bohr's Principle of Complimentarity and Werner Heisenberg's Uncertainty Principle.

The authors of the Copenhagen Interpretation contend that quantum theory is about correlations in our experiences (Zukav, 1979, p. 37). It is about what will be observed under specified conditions. The Copenhagen Interpretation rejects the notion that nature can be understood simply by comprehending the existence of entities in both time and space. Further, scientists believe that no one will ever be capable of fully understanding the nature of reality itself, but only the ideas about the nature of reality. The concepts of probability, uncertainty, and the active role of the observer now play a major part in the understanding of our world. Zukav (1979) states the importance of Copenhagen Interpretation as follows:

> The extraordinary importance of the Copenhagen Interpretation lies in the fact that for the first time, scientists attempting to formulate a consistent physics were forced by their own finding to acknowledge that a complete understanding of reality lies beyond the capabilities of rational thought. (p. 38)

Implications of Quantum Theory as an Emerging Paradigm

Capra (1991) has selected five elements for viewing what he describes as an emergent paradigm based on quantum physics. His elements are based on a holistic view of nature. He uses the terms systematic and ecological as descriptors of this new paradigm. Capra (1991) states:

> In the new paradigm, the relationship between the parts and whole is reversed. The properties of the parts can only be understood from the dynamic of the whole. Ultimately, there are no parts at all. What we call a part is merely a pattern in an inseparable web of relationships. (p. xii)

This statement of Capra's thesis is central to the meaning of quantum physics. Newtonian reductionism does not lead to a full understanding of nature. Quantum reality means looking at the whole in order to comprehend an object. David Bohm, Professor of Physics at Birkbeck College, University of London, agrees and proposes that quantum physics is, in fact, based on a perception of a new order. According to Bohm (1957), "We must turn physics around. Instead of starting with parts and showing how they work together we start with the whole" (as quoted in Zukav, 1979, p. 305).

Capra (1991) also maintains that quantum physics call for a process approach. He maintains that all relationships are dynamic and part of an underlying process. He states. "The meaning of individual dogmas can be understood only from the dynamics of the whole" (Capra, 1991, xxi). Pagels (1982) also suggests that process is integral to the method of quantum physics.

Capra (1991) describes the old paradigm of Newtonian science as objective; yet, the human observer plays no active role in the descriptions of science. Capra believes that the new paradigm focuses on "the understanding of the process of knowledge" (Capra, 1991. p. xiii). The observer, therefore, becomes integral in the process. The shift from an objective reality to an emphasis on the ways of knowing is reminiscent of the ideas of Einstein. Einstein indicated in his early works that understanding the universe would probably require the use of nontraditional scientific methods (Powell, 1992).

Finally, Capra suggests a shift in the use of metaphor with quantum science. This new paradigm is seen as replacing the metaphor of building to a metaphor of network. He places emphasis on the concept of interconnectedness of all objects (Capra, 1991). The language of quantum physics does not accept the fragmentation of the Newtonian paradigm. We are being forced to look at the world as a whole structure before any real understanding can take place. A new vision of reality is called for through the quantum metaphor that embraces the objective as well as the speculative.

Curriculum and curriculum reform, as has been demonstrated, seems mired in the language of Newtonian science. This is logical, given that educators have adapted scientific theory as the model for their theoretical foundation. Yet, by examining the alternative scientific paradigm of quantum physics, we are drawn to a conclusion that our current methods of curriculum theorizing and thus curriculum reform are far too limited.

In the concluding chapter, this study will center on the new metaphors provided us by quantum theory. It is believed that through new metaphors a fundamental reconceptualization of curriculum reform for twenty-first century schools will occur.

CHAPTER V

QUANTUM REALITY: METAPHOR FOR CURRICULUM REFORM

Introduction

The dominance of Newtonian science as an epistemology for curriculum theorizing has lead to a language base that has restricted curriculum methodology and reform. Huebner (1975) states, "Today's curriculum language seems filled with dangerous, nonrecognized myths; dangerous not because they are myths, but because they remain nonrecognized and unchallenged" (p. 218).

In order to reform schools adequately curriculum reformers must begin to challenge and question curricular language for its effectiveness, inconsistencies, and flaws. Dewey (1933) understood the relationship between thought and language when he stated "meanings are not tangible they anchor themselves in language for existence; language selects, preserves, and applies specific meaning" (p. 233). Language consists of invented words, symbolizing objects, or concepts, which are then combined into syntax for elucidation and meaning. The transference of meaning can be problematical, as Dobson and Dobson (1981) contend:

> Words serve to produce a paradoxical situation; both the freezing and unfreezing of reality . . . Humans invented words to serve them as a tool and now they are controlled by this tool. Language which was intended to explain or describe reality has become our reality. What we can't explain we tend to ignore and ultimately dismiss. (p. ix)

Evidently language is being used to elucidate complex phenomena and processes, often in an inadequate and inappropriate manner. Curriculum and curriculum theorizing are complex phenomena and are frequently conceptualized in metaphorical terms that also may be neither appropriate nor adequate.

Metaphors of Simplicity and Order that Shape Reality

Metaphors provide the basis for curriculum theorizing, through the mental images they promote that shape perceptions. Different metaphors have the power to elicit different realities or mindscapes (Dobson, Dobson, and Smiley, 1991). Kliebard (1972) emphasizes that educators think in metaphors. Three of the most common root metaphors found in curriculum literature are: production, growth, and journey. Production provides an industrial model that envisions the student as raw material to be converted by a technician who uses planned specifications, avoids waste, and carefully sees to it that the raw materials are used appropriately. The growth metaphor views the teacher as an insightful gardener, who carefully learns the unique quality of the plants (students) and nurtures their special kind of flowering. Finally in the travel metaphor, the teacher is perceived as a travel guide who leads students through a rich terrain of knowledge, skills, and attitudes. The travel guide knows each traveler very well and responds to their individual needs because of his or her background, ability, interests, aptitudes, and purposes (Kliebard, 1972, p. 403).

Lakoff and Johnson (1980) suggest that all human thought processes are metaphorical and that our conceptual system is metaphorically structured. That is, we understand one concept in terms of the other concepts that are more familiar to us. We do this by clustering the concepts and constructing gestalt structures that we find more fundamental than the individual elements alone.

Lakoff and Johnson (1980) further remark that our experiences take place within a background of cultural presuppositions and that the basic values of a culture are coherent with the metaphors selected for the basic concepts in that culture. They predict:

> Metaphors may create realities for us, especially social realities. A metaphor thus may be a guide for future action. Such action will, of course fit the metaphor. This in turn, will reinforce the power of the metaphor to make experience coherent. In this sense metaphors can be self-fulfilling prophesies. (p. 156)

Curriculum reform proposals metaphorically based in Newtonian science shape our social reality and influence the future direction of schools. These metaphors, illustrating the Newtonian tradition, set the stage for current curricular reform. For example, some educators treat schools as black boxes and look at their inputs and outputs (Sztajn, 1992). Some educators view schools as economic establishments and talk about costs and benefits (DeYoung, 1989). Other educators think of schools as factories and observe students as raw materials being processed (Eisner, 1985). In a recent issue of Educational Leadership Sztajn (1992) believes W. Edwards Deming's TQS model is simply an update of the business metaphor. Sztajn (1992) argues:

> Changing the school as a factory for the school as an enlightened corporation (Deming's model) is just updating the business metaphor. We are still using economic principles and vocabulary to express educational ideas. We are still allowing economy and production to shape and determine our understanding of education. We are still seeing students as raw materials to be processed in the most efficient way. (p. 36)

In addition, Newtonian traditions have encouraged curriculum reforms to predict, control, and standardize. The historically consistent emphasis in education on national testing and content driven curriculum is an example of a reductionist-cumulative mindset (Powell, 1992). Furthermore, current curriculum reform places a great deal of emphasis on objective outcomes. It is believed that we must be able to measure to maintain order. This mechanical view of reality permeates not only curriculum reform but colors the social sciences (Powell, 1992). Students in such a system are treated as objects (Lucas, 1985). Young people who are attending schools become batch processed in much the same way as automobiles both processed on an assembly line Dobson, Dobson and Smiley (1991) state "The assembly line becomes a metaphor itself, and that metaphor highlights the manufacturing and standardizing that such production connotes" (p. 44). Dobson et al. (1991) continue:

The dependence on a technocratic rationale results in a school reality designed accordingly on an industrial model which has, as its major purpose, designing humans to become standardized instruments of society. The Newtonian legacy simply describes objects and forces the mechanistic relationship inherent in both. (p. 44)

Thus, the traditional methods of Newtonian science in curriculum theorizing, as explained in this dissertation, have failed to provide adequate solutions to the newly emerging complexities of modern schooling. This results in school reform programs that keep recurring almost on a cyclical basis (Cuban, 1990). In response, to counter the results of the dominate paradigm, educators should adopt a metaphor from outside our conventional conceptual system. I would like to suggest Quantum science as an alternative metaphor for curriculum reform.

Quantum Science: An Alternative Metaphor

Mark Twain once described how he learned to be a river boat pilot in Life on the Mississippi (1883). His vision of learning incorporated basic skills as well as the capacity and commitment to move beyond. Twain learned how to navigate at a very young age. He first learned the basics, he studied every shoal, snag, and sandbar. This education was not unlike the predictable, rational, linear world as expressed by Newtonian technocrats. But Twain realized that no sooner had he memorized the locations and peculiarities of the river bottom the river changed and he had to learn to adjust his knowledge of the navigable course. The river was a constantly changing reality. Twain, the river pilot must face the reality of his past knowledge of the river while simultaneously imagining how different forces and conditions are likely to change it. Quantum science as a metaphor offers the idea that one can never know the position of an atom or a river's position with any certainty; knowledge about atoms as well as a river is always provisional. Knowledge is fluid, not solid; understanding is an ongoing process, never ending, never absolute. In the process of education, we, like Twain, continually remake our education, ourselves, and our ways of coping with and understanding our world.

Metaphors provide a vision of the paradigm with which curriculum workers live. Obviously as Twain's story illustrates, different metaphors create different realities.

The shoals, snags, and sandbars of the river become a metaphor implicitly derived from the Newtonian scientific tradition that encourages a standardized curriculum, and predetermined knowledge. However, the constantly changing river demonstrates the process-oriented quantum paradigm of an emerging curriculum. As Dewey (1938) explained, "experience is inextricably involved in any education. What one learns beyond the basic skills is hard to measure, for it is constantly shifting and being transformed. No single test can measure its total dimensions" (p. 47). What one knows must be manifested time and again, adjusted to new situations, criticized, evaluated, and expanded upon. The quantum vision of schooling, difficult as it may be to implement, should be central to schooling.

The metaphor of the everchanging river also suggests another view of reality. A reality that can be constructed in a variety of ways. This does not mean that there is no physical reality or that life is in a dream state. There are indeed tangible entities in the world such as people, objects, and events and we interact with these entities. But the reality within which these things exist is constructed by each individual, causing multiple constructed realities. Quantum theory boldly states that something can be this and that (a wave and a particle). Accordingly to Bohr's complementarity theory, light reveals either a particle-like aspect or a wave-like aspect depending on the context or the observer. For example, in education one need not dig too deeply into the literature to realize that there has been a continual argument over the definition of the "gifted child." What is gifted for one person is not gifted to another? To graft Guba's language onto the concept at hand, giftedness does not exist "in a form other than those constructed by the persons who recognize the term" (Guba, 1985, p. 84).

The major implication of this is that there is no single "best" or "truest" definition of giftedness. Giftedness like many things in schools is context-bound and inseparable from the peculiarities of time and place, also from the multiple constructed realities that are obtained within a specific social unit, such as a school system.

Another axiom of the everchanging river metaphor is the relationship between the knower and the known. The inquirer and the object of the inquiry constitute a discrete dualism, the two interact and are inseparable. One cannot simply observe and record without disturbing the natural order of things. The very act of looking determines what we see and that objectivity is an illusion. Heisenberg wrote that "what we observe is not nature but nature exposed to our method of questioning" (Heisenberg, 1958, p. 98). The river pilot by his or her act of observation affects and alters the state of what is being observed, something that is apparent to any educator who has conducted classroom observations or program observations.

Implications of Quantum Reality on Curriculum Reform

Quantum theory contains many implications for curriculum reform. One implication, which has been argued throughout this dissertation, is the limitation of the Newtonian paradigm. Quantum theory helps us to understand that reality is often non-linear and subject to unpredictable change. Newtonian thought is posited on predictable responses from established reinforcers leading to control. This paradigm is inconsistent with the new science of Quantum mechanics.

Related to this is an important implication for developmental psychology when it is narrowly conceived as a series of fixed stages through which all human beings must pass. This perspective has often been called into question when teachers note the way in which students skip some developmental stages and return to those stages that seemed to have been completed. Quantum theory questions all rigid systems. When human development is seen in this fashion it too, must be critically examined.

Another implication for curriculum reform lies in the age-graded classroom. The age-graded classroom is based on the linear, development and brain incompatible assumptions. Quantum theory can lend support to an approach to teaching that does not require that all six-year olds be housed in one room while all seven year olds are placed in another. Most of the reform literature of the 1980's, whether liberal or conservative, called for and end to the age-graded classroom (Rockler, 1991). Quantum theory supports this perspective.

Still another implication involves the non-linear approaches to the teaching of thinking. Often strategies for teaching thinking have been reduced to a series of steps that all thinkers must follow. Quantum theory disagrees with this kind of reductionism as it supports thinking processes that are divergent than convergent. Thinking should be viewed as an open-ended activity consistent with Dewey's notion of reflective thought and related to the process of cognitive conceptualization.

Still another implication for curriculum is the need for a greater emphasis on qualitative research to balance the almost exclusive use of quantitative methods that attempt to explain through by direct measurement. Information also can be obtained by careful observation and by seeking to comprehend systems from within as well as from outside. For example, Darwin's theory of evolution exists without a single measurement (Rockler, 1990). In keeping with this, educational systems can be moved to emphasize less testing of all sorts including standardized achievement tests, the measurement of intelligence, tests that attempt to determine learning styles, and the efforts to label persons as left-brained or right-brained. All these tests are linear in origin and do not provide for the non-linearity as described in Quantum theory.

Measurements should be approached skeptically with awareness that quantum theory has set limits on them. For instance, Heisenberg's uncertainty principle implies that both the position and the momentum of a particle cannot be established simultaneously with great accuracy. The better the position is known, the fuzzier will be its momentum or vise versa. For educators this implies that while attempting to undertake the precise measurement of one or two qualities of a student, the actions of the other escape our intellectual scheme. This limitation is not due to the imperfection of the measuring techniques, but is a limitation of principle. As Pagels (1982) describes, the uncertainty in position and velocity is like " . . . the man and woman in the weather house. If one comes out, the other goes in" (p. 71).

Another implication of quantum theory is that it allows one to assert truth in logically opposing models. For example, it is true that an electron can show the characteristic of a "particle" while at another time exhibit a "wave" quality. Given this epistemological point of view, it is assumed that either definition of an electron is true and that the current description is all that can be said about the entity at that specific time. This knowledge base embraced by Heisenberg and Bohr allowed them to advance into the field of science both free will and subjectiveness. Applied to curriculum theorizing, the element of freedom is extremely crucial for educators. Teachers should not be required to make decisions concerning students or curriculum that then becomes "cast in stone." Decisions made about curriculum or teaching should be viewed as appropriate for only a given time. For example, a teacher should have the freedom to develop a unit of study on a specific topic that the students are interested in one year and yet not teach it the following year. This flexibility can even be applied to every day lessons that are taught in individual classes. I do not suggest that curriculum should have no order or consistency; however, for the curriculum decisions to be prescribed by outside entities without the teacher and students, involvement in the decision makes curriculum become a restrictive rather than an enlightening force. The metaphor of quantum reality encourages enormous freedom in curricular decision making and allows the individual child to become an active force in the educational process.

Another integral part of quantum reality is Bohr's principal of complimentarity. It also offers an alternative way at looking at the child in the classroom. The child sitting at a desk assumes the role of a student, yet the child brings to class many other characteristics that contribute to their total person. The children are not only students but family members, workers, and may even assume the role as parent. As illustrated in the concept of complimentarity, to fully understand the child consideration must be given to the other qualities and circumstances that are experienced outside the classroom.

It is important to realize that a change in one characteristic may and probably will affect the other characteristics. Bohr concluded that his knowledge of an electron rested upon the knowledge of the qualities of the electron (position and velocity). Educators must come to realize that when working with children the more information known about the whole child, the more likely the teacher will be able to understand the child's reality and thus be a more affective teacher.

Not only does Bohr's contribution to quantum reality offer insight into understanding the whole child, but it offers new alternatives for curriculum theorists. Bohr was convinced that science could no longer hope to comprehend fully an observed system due to quantum reaction. Therefore, he was forced to accept statistical descriptions of possible characteristics. Bohr found that once a measuring instrument was introduced into the system, the motion of the particles was altered. As a result, reality was in a constant state of change like Twain's metaphor of the ever changing river. Bohr concluded that the attempt to isolate a measurement resulted in the disruption of the continuum of motion.

If this finding offers any insight into curriculum theory, one must reevaluate the concept of education. Is education a static reality as the Newtonian paradigm suggests or is it an ongoing and emerging process? If it is an ongoing process, then how do you try to measure or test a student's progress in the learning continuum. The continued emphasis in curriculum reform on increased testing of students to improve student learning flies in the face of the reality that testing only shows a small part of an ongoing process. Just as the measurement for velocity altered the knowledge of the position of an electron, so too, does measuring or testing alter the whole view of the educational process.

I believe that quantum theory has the potential to allow curriculum reform to move into Twain's everchanging river metaphor. The river and the river boat pilot must become one. The captain cannot be separated from the river; therefore, measurement becomes impossible. To understand the river, one must understand the pilot, and to understand the pilot requires an understanding of the river. There are no separate objects that exist outside of their relationship to the whole; therefore, knowledge is not "out there to be acquired" but rather is ongoing and emerging, with the individual child being an active participant in the learning process.

Curriculum reform utilizing quantum reality suggests that effective change can only occur when there is a cooperative learning environment, structure, and order that comes within the system, rather than mandated from an outside force. Structure and order will emerge as is needed within systems. If systems organize themselves according to their purposes, the classroom and curriculum will organize according to the needs of the students rather than the bureaucratic needs of administrators, state departments of education, or even state legislatures.

If one looks to quantum theory as a possible metaphor for curriculum reform, one finds like Heisenberg, and Bohr that one is forced to relinquish a desire for "absolutes." Quantum reality is statistical, probabilistic, and appears random. Yet, by gaining an understanding of the randomness of nature, we, like Heisenberg and Bohr are able to restore order to our own reality.

The alternatives that I have mentioned suggests that randomness be introduced into the field of curriculum decision making; however, by understanding that apparently chaotic and a disorderly approach to curriculum, and curriculum reform, order is once again restored to the learning process.

Conclusion

The language of quantum reality suggests holism, process, complexity, and uncertainty. True education is an evolutionary process where the whole structure needs to be considered before any real understanding takes place. Twain's metaphor of the everchanging river more accurately defines the state of learning and unpredictability of the learning process. Educators as Huebner (1975) suggests must:

> free themselves from the self-confining schemas, in order that they may listen anew to the world pounding against their intellectual barriers. The present methodologies which govern curricular thought must eventually give away. (p. 235)

Dobson and Dobson (1981) discuss in their work <u>The Language of Schooling</u> the necessity of forming a new language base in curriculum theorizing. I, too, agree that a new language base is critical for true curriculum reform. A language premised on the metaphor of quantum theory is a legitimate possibility for curriculum reformers.

Quantum theory addresses the science of probabilities. It also presents us with new possibilities because it allows us to recognize the value of nature. Each child, each human being, is to be viewed in the context of the cosmos. No child can be discounted without discounting the whole. Educators must recognize that all aspects of human life are fundamentally interconnected. True curriculum reform must be concerned with the physical, emotional, social, aesthetic/creative, and spiritual qualities of every person, as well as traditionally emphasized intellectual and vocational skills. Spirituality and subjectiveness once again must find a place in the curriculum.

In conclusion, we find ourselves in the midst of one of those rare periods in history when large numbers of people are receptive to major changes in education. Governors, legislators, and educational commissions mandate new curricula. Deans and captains of industry propose to reshape the education of teachers and ponder the future of the profession. Half the populace seems receptive to curricular reforms. Are these reforms merely fleeting innovations or are they a true reflection of a paradigm shift away from an eighteenth century epistemology? Let us hope that we can press forward with the search for meaning and attempt to create true curriculum reform grounded in a quantum reality of process and holism.

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